ISSUES&ANSWERS REL 2008–No. 053

REL NORTHEAST & ISLANDS
Regional Educational Laboratory At Education Development Center, Inc.

Math education practices for students with disabilities and other struggling learners: case studies of six schools in two Northeast and Islands Region states

ies NATIONAL CENTER FOR EDUCATION EVALUATION AND REGIONAL ASSISTANCE
Institute of Education Sciences
U.S. Department of Education

ISSUES & ANSWERS REL 2008–No. 053

REL NORTHEAST & ISLANDS
Regional Educational Laboratory
At Education Development
Center, Inc.

Math education practices for students with disabilities and other struggling learners: case studies of six schools in two Northeast and Islands Region states

August 2008

Prepared by

Josephine Louie
Education Development Center

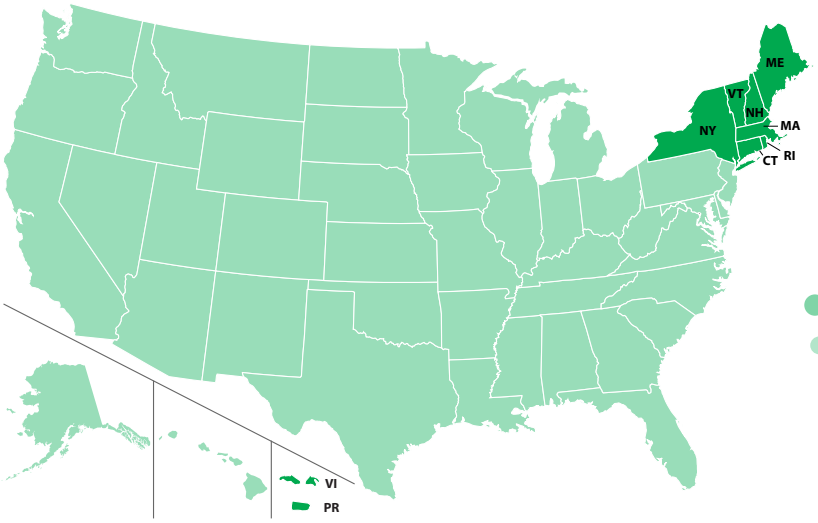
Amy Brodesky
Education Development Center

Jessica Brett
Education Development Center

Li-Ming Yang
Education Development Center

Yvette Tan
Education Development Center

ies NATIONAL CENTER FOR EDUCATION EVALUATION AND REGIONAL ASSISTANCE
Institute of Education Sciences
U.S. Department of Education



REL NORTHEAST & ISLANDS
Regional Educational Laboratory At Education Development Center, Inc.

Issues and Answers is an ongoing series of reports from short-term Fast Response Projects conducted by the regional educational laboratories on current education issues of importance at local, state, and regional levels. Fast Response Project topics change to reflect new issues, as identified through lab outreach and requests for assistance from policymakers and educators at state and local levels and from communities, businesses, parents, families, and youth. All Issues and Answers reports meet Institute of Education Sciences standards for scientifically valid research.

August 2008

This report was prepared for the Institute of Education Sciences (IES) under Contract ED-06-CO-0025 by Regional Educational Laboratory Northeast and Islands administered by Education Development Center, Inc. The content of the publication does not necessarily reflect the views or policies of IES or the U.S. Department of Education nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government.

Louie, J., Brodesky, A., Brett, J., Yang, L.-M., and Tan, Y. (2008). *Math education practices for students with disabilities and other struggling learners: case studies of six schools in two Northeast and Islands Region states* (Issues and Answers Report, REL 2008–No. 053). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Northeast and Islands. Retrieved from http://ies.ed.gov/ncee/edlabs.

This report is available on the regional educational laboratory web site at http://ies.ed.gov/ncee/edlabs.

Summary

REL 2008–No. 053

Math education practices for students with disabilities and other struggling learners: case studies of six schools in two Northeast and Islands Region states

This report describes in-depth practices at six schools that are making targeted efforts to improve math education for students with disabilities and other struggling learners. It examines each school's practices for improving the math learning of all students as well as specific supports for students with disabilities and other struggling learners and identifies the challenges that schools face to serve students with diverse needs.

The No Child Left Behind (NCLB) Act of 2001 requires states to ensure that all students make adequate yearly progress in achieving proficiency in English language arts and math. This study examines how six diverse schools have responded to the challenge of educating their students in math, particularly students with disabilities and other struggling learners. The report intends to help educators by providing examples and ideas to consider for their own school or district efforts to improve math teaching and learning.

A multistep nomination and screening process was used to select six schools—three from Massachusetts and three from New York—for the study. All the schools educate general education students and students with disabilities and serve medium- or high-need populations.[1]

Education leaders (state special education leaders, district superintendents, special education directors, math coordinators, university professors, and leaders of research projects focusing on math education and students with disabilities) were asked to use their knowledge of district or school initiatives to nominate schools that were making strong, targeted efforts to improve the math learning of students with disabilities and other struggling learners. To provide a common set of nomination criteria, the research team provided a list of suggested practices (drawn from the research literature) and asked the education leaders to identify the school's strengths in these areas. This nomination process yielded 38 schools, 19 each in Massachusetts and New York. Ultimately, six schools (three from each state) were selected for the report's case studies. These schools were deliberately chosen to illustrate a wide variety of practices adopted by schools perceived by education leaders to be exemplary in their math education efforts.

School practices in seven areas—classroom math instruction, math supports and interventions, assessment, collaboration, professional

development, leadership, and school culture—guided the collection and analysis of information from the six schools. These areas were selected after a rigorous review of research in the field.

During six two-day site visits researchers collected primary documents, observed classrooms, and spoke with administrators and staff, including principals, special educators, general educators, and math coaches. The report provides a descriptive analysis of each school's practices, structured around three research questions:

- How do schools provide math education to students with disabilities and other struggling learners? What practices are used and how are they implemented?
- What do school leaders and teachers identify as their school's strongest practices for improving teaching math to students with disabilities and other struggling learners?
- What do school leaders and teachers identify as their greatest challenges for improving math teaching and learning for students with disabilities and other struggling learners?

The six schools have made diverse efforts to improve math instruction for students with disabilities and other struggling learners. Cedar Elementary School used a central math lead teacher, who helped struggling students by providing direct support to students and teachers and by playing a key role in analyzing district and state math assessments for all of the school's students. At Redwood Elementary School an experienced administration and talented teaching staff helped boost student achievement through a consistent, schoolwide instruction model. At Maple Elementary School professional learning communities and a clear school mission enabled a close-knit staff to build a strong, structured, but flexible collaboration to support struggling students. Aspen Elementary School applied an inclusive philosophy, supporting the learning of struggling learners with a variety of services and learning environments. Beech Elementary School provided extensive support and intervention services before, during, and after school. It used in-house math coaches to support math instruction and dedicated teachers to help design and analyze assessments for students in grades K–2. At Willow School teachers took advantage of the expertise available in a K–8 school by pairing middle-grade teachers with elementary-grade teachers in the lower school grades.

Although each school found its own ways of providing math instruction to students with disabilities and other struggling learners, many schools adopted similar practices:

- *Classroom math instruction.* All schools provided students with disabilities access to the general education math curriculum. All schools had highly experienced administrators and staff in key roles that were relevant to math and special education and teachers who described using similar kinds of instructional strategies for making math accessible. And all schools used published math programs and provided teachers with support for implementing them. Five schools used an inclusion model as their primary classroom placement for students with disabilities. Three

schools had implemented schoolwide instructional models.

- *Math supports and interventions.* The schools deliberately created specific staffing arrangements or additional programs to provide math support services for struggling students without Individualized Education Programs (IEPs). Two schools had a teacher whose full-time job was to provide math support to struggling learners. Four schools had formal out-of-class math programs. Three schools offered support through flexible staff arrangements. Three schools had implemented a Response-to-Intervention program for math.

- *Assessment.* All schools used experienced staff to analyze state assessment results and share their findings with the entire faculty. Five schools conducted frequent benchmark testing, and four schools used assessments to identify struggling math learners in grades K–2.

- *Collaboration among teachers.* Five schools scheduled common planning time and held regular grade-level meetings. At five schools general educators collaborated with special educators through coteaching, meetings, and other arrangements. Districtwide collaboration was uncommon but highly valued.

- *Professional development.* All schools had highly experienced in-house math leaders to provide curriculum and instructional guidance to teachers. Math leaders also provided support to special educators. None of the math leaders evaluated teachers. Collaboration among colleagues at five of the six schools played a key role in teachers' professional development.

- *Leadership.* Principals at each school described a variety of governing approaches and management styles for their organizations. Staff at all schools described school leaders as empowering, respectful, and supportive.

- *School culture.* Teachers at all schools described collegial and supportive staff cultures that promoted higher levels of creative risk-taking and job satisfaction among staff. Teachers commonly described a nurturing staff culture of shared responsibility and high expectations. Many staff and administrators described their schools as safe and stable environments that were conducive to learning—schools in which students, including those with disabilities, feel accepted by their peers.

Teachers and administrators at the case study schools consistently identified several practices as particularly effective:

- A strong, collaborative staff culture that provides staff members with ongoing, in-house professional development.

- Development and retention of high-quality staff.

- Use of a variety of math instruction practices to meet the needs of struggling learners and students with disabilities.

- Strong and supportive school leaders who encourage teachers to grow and give their best efforts to students and the school.

- Extensive out-of-class math support.

Teachers and administrators at the case study schools also consistently identified several challenges:

- Insufficient staffing for student math support and insufficient time for math instruction.
- Inadequate math content knowledge among many teachers.
- Lack of high-quality math assessments and interventions for students in lower grades.
- The inherent difficulties of raising achievement levels among students with high and often multiple needs.

Staff members at the case study schools identified a number of practices—including in-house math leaders, strong leadership, and collaborative school cultures—that may be beneficial to other schools. Findings from this study call for further research on how the roles of math specialists, schoolwide leadership practices, and different forms of teacher collaboration may affect math learning for students with disabilities and struggling learners.

August 2008

Note

1. Medium- and high-need student populations are based on percentages of students eligible for free or reduced-price lunch in both Massachusetts and New York and, in New York, also on percentages of students with disabilities and students with limited English proficiency.

TABLE OF CONTENTS

This report describes in-depth practices at six schools that are making targeted efforts to improve math education for students with disabilities and other struggling learners. It examines each school's practices for improving the math learning of all students as well as specific supports for students with disabilities and other struggling learners and identifies the challenges that schools face to serve students with diverse needs.

WHY THIS STUDY?

State and local education agencies across the nation face a critical need to improve the math learning and achievement of students with disabilities. Since passage of the No Child Left Behind (NCLB) Act of 2001 and the Individuals with Disabilities Education Acts (1997 and 2004) schools, districts, and states are required to include students with disabilities in statewide assessments and to show that these students make adequate yearly progress in math. Most students with disabilities perform at low levels on standardized math assessments. State, district, and school leaders have therefore been grappling with what practices and policies to use to improve the math learning of these students.

This report provides in-depth descriptions of practices at six schools that are making targeted efforts to improve math education for students with disabilities and other struggling learners. (The term *struggling learner* does not have a formal definition; it is used broadly in this report to refer to students who perform poorly on math assessments or are perceived by teachers as needing extra help.) Selected through a multistep nomination and screening process, the six schools—all in Massachusetts or New York—include three urban, one suburban, and two rural schools, with student bodies ranging from 231 to more than 1,200 students. All of the schools received Title 1 funding.

This report focuses on math education at the elementary school level, because these years are critical for building a math foundation. The project examined each school's practices for improving the math learning of all students, as well as specific supports for students with disabilities and other struggling learners. It did so for two reasons. First, during the elementary school years some students fail to be identified as having disabilities because of the complexities of determining whether their difficulties are developmental or related to a disability. Second, the Individuals with Disabilities Education Act of 2004 recommends that schools provide early intervention services to

students without disabilities who need academic support. The practices schools use to help struggling learners may help reduce the number of students who later need special education services.

The report is the third in a series of three. The first report analyzes math performance data for grade 4 students with disabilities in New York; the second does the same for grade 4 students with disabilities in Massachusetts. This report looks in-depth at math education practices in a small number of schools in both states and complements the analyses of statewide performance data in the other two reports. Together, the three reports extend and deepen the understanding of math education practices for students with disabilities and the achievement patterns of this important subgroup. For administrators the case studies provide examples of approaches and structures that they may consider for their own schools and districts. For researchers the case studies help identify practices worthy of further examination.

To provide context for the case studies, the next section provides background information on math learning disabilities and identifies practices associated with improving math learning for struggling students.

MATH DISABILITIES AND PRACTICES THAT AFFECT MATH PERFORMANCE

The term *students with disabilities* is broad and encompasses cognitive, emotional, and physical disabilities. The federal government defines 13 categories of disabilities: autism, deaf-blindness, deafness, hearing impairment, mental retardation, multiple disabilities, orthopedic impairment, other health impairment, serious emotional disturbance, specific learning disability, speech or language impairment, traumatic brain injury, and visual impairment including blindness. States have their own definitions.

In 2005, 13.8 percent of students enrolled in public schools in the United States had disabilities that qualified them for services under the Individuals with Disabilities Education Act

In 2005, 13.8 percent of all students enrolled in public schools in the United States had disabilities that qualified them for services under the Individuals with Disabilities Education Act (Individuals with Disabilities Act of 2004). The percentages were slightly lower in New York (12.2 percent) and higher in Massachusetts (15.9 percent; New York State Education Department 2006; Massachusetts Department of Education 2006b).

Nationally, the largest percentage of these students (40.6 percent in 2006) are identified as having *specific learning disabilities* (Individuals with Disabilities Act of 2004), defined as

> *a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which . . . may manifest itself in the imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations, spoken or written. Such term includes such conditions as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia. . . . Such term does not include a learning problem that is primarily the result of visual, hearing, or motor disabilities, of mental retardation, of emotional disturbance, or of environmental, cultural, or economic disadvantage* (20 United States Code §1401 [30]).

Numerous studies show that students with specific learning disabilities have persistent difficulties with computation and problem-solving (Miller, Butler, and Lee 1998). Other studies note difficulties with number processing and number sense (Mazzocco 2007). Fuchs and Fuchs (2002a) find that students with both reading and math disabilities have difficulties solving word problems that differ from those of students with only math disabilities. Cawley and Miller (1989) report that students with learning disabilities perform far below their grade-level peers and progress at half their speed. Other kinds of disabilities, such as attention deficit hyperactivity disorder, can also

affect student performance in computation and word problem-solving (Zentall 2007).

Difficulties with math are not unique to students with disabilities. Among 2nd graders 35 percent described math as difficult; only 10 percent said the same for reading (Mazzocco 2007). As students progress in school, difficulties may arise as math content becomes more complex and greater skill is required. Solving problems involving fractions is a well known difficulty for students with learning disabilities and many students without disabilities, as indicated by the National Assessment of Educational Progress (Hecht, Vagi, and Torgesen 2007; National Center for Education Statistics 2006).

Another cause of difficulty is math anxiety, defined as "the negative emotional reaction some people experience when placed in situations that require mathematical reasoning or problem solving" (Ashcraft, Krause, and Hopko 2007, p. 329). Math anxiety can have a negative effect on student performance on standardized tests. Poor math achievement is also related to external factors, including inadequate math instruction, environmental factors, and low socioeconomic status (Jordan et al. 2006).

Math disabilities is an emerging field. Because there is neither a standard definition for a math learning disability nor a standard assessment tool for diagnosis, there is debate over how to differentiate between math learning disabilities and math difficulties unrelated to a disability. Thus, there is considerable variation in the extent to which struggling students are identified as having math learning disabilities. For this and other reasons this report focuses on both students with disabilities and other struggling learners.

PRACTICES FOR IMPROVING THE MATH PERFORMANCE OF STUDENTS WITH DISABILITIES AND OTHER STRUGGLING LEARNERS

Over the past several decades researchers have studied education practices that may improve math teaching to and learning by students with disabilities and other struggling learners. Some studies focus on instruction strategies and interventions to help students overcome barriers that may hinder their abilities to learn and demonstrate achievement specifically in math (Baker, Gersten, and Lee 2002; Fuchs and Fuchs 2007; Woodward, Baxter, and Robinson 1999; Xin and Jitendra 1999). A few studies identify common education practices among schools in which students with disabilities perform at relatively high levels in math or English language arts (Hawkins 2007; Nagle et al. 2006; University of Massachusetts Donahue 2004). One of these studies (University of Massachusetts Donahue 2004) finds that urban schools in Massachusetts with relatively high-performing students with disabilities displayed common characteristics, such as a schoolwide emphasis on including students with disabilities in general education classrooms, efforts to align curricula with state standards, use of student assessment data to guide decisions about instruction, targeted professional development for school staff, flexible and effective leadership, and a school culture marked by high academic standards and a disciplined environment.

Because there is neither a standard definition for a math learning disability nor a standard assessment tool for diagnosis, there is debate over how to differentiate between math learning disabilities and math difficulties unrelated to a disability

Many of the practices identified by the University of Massachusetts Donahue report are similar to practices that have been linked to high-performing schools in general. Shannon and Bylsma (2007), for instance, find that high-performing schools across the United States display nine common characteristics: curricula and assessments aligned with state standards, regular monitoring of teaching and student learning, focused professional development, effective leadership, high standards and expectations for all students, high levels of staff collaboration, supportive learning environments, extensive family and community

involvement, and a clear and shared focus. Practices in the areas of leadership, teacher collaboration, professional development, and school culture typically involve coordinated action across the school faculty and organization. Thus, practices that benefit the achievement of students with disabilities may include systemic or schoolwide practices that go beyond classroom teaching.

Seven categories of practices

From these and other studies it appears that seven categories of school practice may be particularly relevant to the math performance of students with disabilities and other struggling learners:

- Classroom math instruction (including student placement practices, staffing for math instruction, and math-specific instruction strategies that are accessible to all learners).
- Math supports and interventions.
- Assessment.
- Teacher collaboration.
- Professional development in math and special education.
- Leadership.
- School culture.

How schools coordinate practices within their organizations and in specific contexts may also have implications for student learning and math outcomes. The rest of this section describes practices in each of these categories and other factors that affect math teaching to and learning for students with disabilities and other struggling learners.

How schools coordinate practices within their organizations and in specific contexts may have implications for student learning and math outcomes

The seven categories do not include the full range of practices and factors that may be related to math learning of students with disabilities and other struggling learners. For example, research links parent involvement and district leadership to student achievement (Marzano 2003; Waters and Marzano 2006). It was beyond the scope of this project, however, to examine these other factors. Future studies might examine how parent involvement and district leadership can improve math education for struggling math learners, particularly students with disabilities.

Classroom math instruction. Classroom math instruction includes student placement and curriculum access, instructional strategies for accessibility, teacher staffing and the use of math specialists, and math instructional time.

Student placement and curriculum access. Fundamental to the Individuals with Disabilities Education Act of 2004 is the mandate to improve education results for students with disabilities by "having high expectations for such children and ensuring their access to the general education curriculum in the regular classroom, to the maximum extent possible" (section 682). To fulfill this mandate for math, schools need to provide students with disabilities access to the general education math curriculum in ways that match their individual learning needs.

Because students with disabilities include 13 disability types that occur with varying levels of severity, schools cannot use a one-size-fits-all solution to educate students with disabilities. They need to consider students' individual needs in making decisions about where they will receive math instruction, who will teach them, and what instructional practices and supports will help them succeed. The Special Education Elementary Longitudinal Study (SEELS) of more than 11,000 students with identified disabilities finds that "schools can influence the level and trajectory of students' learning through decisions regarding instructional settings and activities" (Blackorby et al. 2007, p. 9). In particular, for students with disabilities taking more academic classes in general education settings was positively correlated with higher reading and math scores.

Providing access to the general education curriculum can improve student performance on math state assessments because it gives students the opportunity to learn the content that is assessed (Access Center 2008). Among the factors examined, Marzano (2003) also identifies the opportunity to learn as having the strongest relation to student achievement. Research on urban districts with high-performing students with disabilities finds that successful schools emphasized providing students with disabilities access to the general education curriculum and aligning the curriculum with the state frameworks (University of Massachusetts Donahue 2004).

Instructional strategies for accessibility. Implementing strong instructional practices is central to providing high-quality math education to all students. The National Council of Teachers of Mathematics' *Principles and Standards for School Mathematics* recommends that teachers focus on math processes, such as problem-solving and making connections between math and the real world in their instruction (National Council of Teachers of Mathematics 2000). A focus on abstract thinking poses extra challenges for students with learning disabilities (Maccini and Gagnon 2005). Multiple approaches to teaching math concepts are needed to help students with disabilities reach a deep understanding of math. The National Council of Teachers of Mathematics Equity Principle states that "equity does not mean that every student should receive identical instruction; instead it demands that reasonable and appropriate accommodations be made as needed to promote access and attainment for all students" (National Council of Teachers of Mathematics 2000, p. 12).

To put this principle into practice, teachers need to use a variety of instructional approaches to help students with disabilities learn math. The Access Center (2005) identifies strategies that have significant research support, including adopting a sequential instructional approach known as concrete-representational-abstract (in which students progress from working with concrete materials to making drawings to using abstract symbols) and using a range of learning strategies, such as peer-assisted learning. The Council for Exceptional Children (2007) recommends the use of graphic organizers, formative evaluation, and direct instruction. Both organizations identify cooperative learning, differentiated instruction, and grouping strategies as practices that have some research support but need further validation.

Implementing strong instructional practices is central to providing high-quality math education to all students

Several studies support the use of a concrete-representational-abstract instructional approach to help students with disabilities grasp mathematical concepts (Maccini and Gagnon 2000; Miller and Mercer 1993). Some evidence suggests that students who use concrete materials develop more precise and more comprehensive mental representations and are more successful at applying math ideas to real-life situations (Harrison and Harrison 1986; Suydam and Higgins 1977). And manipulative materials—models, blocks, tiles, and other objects used to explore math ideas and solve math problems—can help students grasp mathematical ideas while promoting flexible thinking (English and Halford 1995), although the particular manipulatives used in a lesson must be carefully chosen so that the concept being taught is not misinterpreted (Dufour-Janvier, Bednarz, and Belanger 1987).

Graphic organizers can also help many students grasp math content (Horton, Lovitt, and Bergerud 1990). Organizers commonly used include hierarchical graphic organizers, sequence charts, and Venn diagrams (Maccini and Gagnon 2005). Swanson (1999) finds that small-group instruction and directed questioning and response improve students' math problem-solving abilities. In peer tutoring models students are taught by peers who receive training and supervision from classroom teachers. An experimental longitudinal study of the classwide peer tutoring approach finds improvements in student achievement (Greenwood, Maheady, and Delquadri 2002). Research on

another model, PALS (peer-assisted learning), suggests that it enables students to make connections with abstract math concepts (Fuchs, Fuchs, and Karns 2001; Fuchs et al. 1997).

Teacher staffing and math specialists. Studies find that teacher expertise and student achievement are correlated (Darling-Hammond 2000; National Commission on Teaching and America's Future 1996). Teacher knowledge of content and pedagogical method is essential to effective math instruction (Ball, Hill, and Bass 2005). Struggling students, particularly students with disabilities, benefit from teachers who have strong math content knowledge and expertise with a variety of instructional strategies.

Despite this evidence, students with disabilities often receive math support and instruction from special educators, who often possess limited math content knowledge. Most special educators lack sufficient knowledge of math standards, which limits their ability to provide support to students with disabilities (Maccini and Gagnon 2002). Math content knowledge is also an issue for general educators at the elementary level. Because preservice programs prepare elementary teachers for teaching many subject areas, they typically do not provide substantial training in math (Reys and Fennell 2003).

Many groups have recommended using math specialists in elementary schools (National Research Council 1989; Reys and Fennell 2003; Lott 2003; Maryland State Department of Education 2001). A math specialist is a "teacher whose interest and special preparation in math content and pedagogy are matched with special teaching or leadership assignments" (Reys and Fennell 2003, p. 280). Math specialists may have a variety of titles—math coach, math support teacher, math lead teacher—and a variety of roles. In the lead teacher model the math specialist supports and mentors teachers by demonstrating teaching strategies, leading planning meetings, and providing professional development. According to Reys and Fennell, this model's success depends on the "commitment and expertise of the specialist, as well as the respect and confidence that fellow teachers have for the specialist" (p. 280). Another model, the specialized teaching assignment, involves redistributing teaching tasks so that elementary school teachers take responsibility for particular subject areas. This allows teachers who specialize in math to hone their instructional practices and focus their professional development in this area.

Students with disabilities often receive math support and instruction from special educators, who often possess limited math content knowledge

Instructional time. Research has long demonstrated the important relation between time spent on instruction and student learning outcomes (Suarez et al. 1991). This relation is stronger when the time is spent on instructional strategies that are appropriate for students' individual needs. Woodward, Baxter, and Robinson (1999) indicate that some low-achieving students require considerable time to learn certain math concepts—time that teachers often underestimate. The amount of math instruction schools provide to students with disabilities and other struggling learners and the scheduling arrangements schools use to deliver instruction may therefore affect student math outcomes.

Math supports and interventions. Math interventions can be effective supports for students with disabilities (Cawley 2002). In fact, all elementary school students appear to benefit from math problem-solving support (Fuchs and Fuchs 2003). Some interventions target specific topics in the math curriculum; others focus on systemic problem-solving processes and strategies that can be applied across topics. Examples include interventions that use technology to help students build fluency in math facts (Hasselbring, Goin, and Bradsford 1987); gain strategies for solving word problems (Jitendra 2002); build relations between real quantities, counting numbers, and formal symbols (Griffin 2007); and develop the cognitive processes that underlie general math problem-solving (Montague 1997). A synthesis of 15 empirical research studies on math interventions identified the following approaches as having positive effects on low-achieving students: explicit

instruction, peer tutoring, and using progress-monitoring data with instructional recommendations (Baker, Gersten, and Lee 2002).

Additional support and interventions to remediate academic deficits may occur after school, on weekends, or outside the regular school calendar. The University of Massachusetts Donahue study (2007) finds that higher performing schools tend to provide additional academic support services, including individual tutoring, which may help students with disabilities develop the strategic knowledge required to solve complex math problems (Woodward, Monroe, and Baxter 2001).

Support to students with disabilities and other struggling learners is often provided in a special education resource room. One study reports that teachers believe that resource rooms provide settings in which intense and individualized instruction can be adapted to a student's individual needs (Meyers et al. 1990). Other studies show that the amount of time spent on instruction in resource rooms is relatively low (Carpenter 1985; Haynes and Jenkins 1986). More research on the effectiveness of resource rooms for students with disabilities is needed.

Response to Intervention is a form of early intervention for all children at risk of school failure (Fuchs and Fuchs 2006). Under this approach students are continually assessed and monitored; results of these tests are then used to further inform instruction. "[Response to Intervention] assessment . . . is a form of dynamic assessment because its metric is change in students' level or rate of learning. Such information assists practitioners' efforts both to design early intervention and to identify special-needs children" (Fuchs and Fuchs 2006, p. 94). Response to Intervention has recently gained momentum as a means of identifying students with learning disabilities in response to the Individuals with Disabilities Education Act of 2004, which recommends its use (Strangman et al. 2006). The approach recognizes that poor achievement may not be indicative of a learning disability but may partly reflect poor instruction (Strangman et al. 2006).

Some research shows that monitoring student progress can identify students at risk of academic failure (Deno 2003). Teachers who use progress monitoring (formerly called curriculum-based measurement) appear better able to identify students in need and to create stronger instructional programs than teachers who do not (Fuchs and Fuchs 2002b).

Assessment data can be used for multiple purposes, including identifying struggling learners, informing lesson planning, and revealing weak areas in the curriculum

Assessment. The National Council of Teachers of Mathematics recommends that assessment "be an integral part of instruction that informs and guides teachers as they make instructional decisions" (National Council of Teachers of Mathematics 2000, p. 22). It emphasizes that assessment methods need to be accessible to students with special needs to enable such students to demonstrate their knowledge and skills without impediments. The National Council of Teachers of Mathematics recommends that teachers use a variety of assessment tools, including formative methods that guide instruction and summative methods that measure progress. Formative evaluation has been identified as a research-supported practice for improving the learning of students with disabilities (Espin, Shin, and Busch 2000).

In selecting assessment tools, teachers can draw from materials in their math curriculum and other sources, such as schoolwide or districtwide tests. One study finds that district or building specialists develop math assessments more often than they develop literacy assessments, which tend to be published products (University of Massachusetts Donahue 2004). The difference may reflect the larger research base on reading than on math, particularly math disabilities.

Assessment data can be used for multiple purposes, including identifying struggling learners, informing lesson planning, and revealing weak areas in the curriculum. The University of Massachusetts

Donahue (2004) study finds that using assessment data to inform instruction is a common practice in urban schools in which performance by students with disabilities is relatively high. In a more recent study the same researchers find that higher performing schools "used assessment data to guide instructional planning and delivery, and benefited from principals and coaches who could translate assessment results into instructional action" (University of Massachusetts Donahue 2007, p. 31). The role of these "translators" was cited as central to helping staff apply the findings to their instruction.

Teacher collaboration. High levels of collaboration and communication are characteristics of high-performing schools (Shannon and Bylsma 2007). Bruner and Greenlee (2000) find that there is more collaboration among teachers in higher performing schools than in lower performing schools. Teacher collaboration has also helped to promote shared goals among staff, create opportunities for teachers to learn from one another, and enhance professional development opportunities (Rosenholtz 1989). Newmann and Wehlage (1995) find that teacher collaboration can also have a positive effect on student achievement. Snell and Janney (2000) find that staff collaboration facilitates inclusive practices at schools.

The opportunity to reflect on classroom practice has been identified as having a major influence on a teacher's professional growth (Clarke 1997). Consequently, fostering a collaborative atmosphere has been identified as critical to building a strong and inclusive school. Driscoll (1986) and Little (1982) break down the idea of effective collaboration into concrete behaviors. According to them, math teachers need to have opportunities to discuss the teaching and learning of math with other teachers, observe their peers and be observed by them, engage in group planning and implementation of curriculum, share knowledge about math, and support one another in taking risks.

Coteaching and coplanning among teachers are ways of fostering staff collaboration and have become widely used to integrate students with disabilities into general education classrooms

Coteaching and coplanning among teachers are ways of fostering staff collaboration. And these practices have become widely used to integrate students with disabilities into general education classrooms (Friend and Cook 1998; Lawton 1999). Lack of common planning time is often cited as one of the barriers to coplanning success (Karge, McClure, and Patton 1995). One meta-analysis of research finds that coteaching is moderately effective in math instruction (Murawski and Swanson 2001). The research on the effect of coteaching is still emerging, however, and some educators have called for more research to evaluate its effectiveness for students with disabilities and other struggling learners (Lawton 1999).

Questions remain about how collaboration directly affects math instruction for students with disabilities and other struggling learners, what kinds of collaborative structures (for example, planning meetings and study groups) teachers find most beneficial, and the ways in which collaboration can promote teachers' professional growth. Collaboration with colleagues is also a key component of professional development, as described in the next section.

Professional development in math and special education. To teach math to students with disabilities, teachers need to build their own content knowledge and pedagogical skills. A survey by the U.S. Department of Education, National Center for Education Statistics (1999) reveals that only 19 percent of math teachers report feeling "very well prepared" to address the needs of students with disabilities. Math teachers often lack training in working with students with disabilities, and special educators often lack training in math and math education. How schools address these issues—and the models of professional development they adopt—shapes the math instruction students receive, affecting students' math outcomes.

A growing body of research exists on models of professional development and their effect on teachers' content knowledge and instructional practices. Teacher collaborative groups and study

groups can help strengthen teacher practices (Guttierez 2002; Langer, Colton, and Goff 2003; Little et al. 2003; Rueda and Garcia 1997). Engaging teachers in learning opportunities that involve interactions between teachers has positive effects on teacher knowledge and practices (Garet et al. 2001; Banilower and Shimkus 2004).

As schools around the country face heightened pressure to raise student achievement, they have been exploring a variety of professional development approaches. Efforts include programs that focus on building teachers' content knowledge; developing collaborative arrangements, such as coaching and peer study groups; and helping teachers analyze student work and differentiate instruction. Teacher organizations have recommended ongoing coherent professional development that is practice based and school contextualized (National Council of Supervisors of Mathematics 2007; Goertz, Floden, and O'Day 1995). Few studies have rigorously examined the relation between professional development and student achievement: a research review identifies only 9 of 1,300 studies as meeting scientifically based research standards (Yoon et al. 2007). Six of these studies find a positive and significant effect on student achievement in elementary schools in which teachers received more than 14 hours of professional development (Yoon et al. 2007).

Even less is known about the relation between the professional development of teachers and the math achievement of students with disabilities. Little, for example, is known about the effects of professional development that focuses on deepening teachers' math content knowledge, building skills in accessible instruction, or understanding a specific curriculum. More research is needed to understand the methods and content of professional development that can best train teachers to improve math instruction for students with disabilities.

Leadership. A review of the literature shows that school leadership is the second most important school-related factor affecting student learning in schools after teaching (Leithwood et al. 2004). Effective school leadership has also been identified as one of the nine characteristics of high-performing schools (Shannon and Bylsma 2007). A meta-analysis of 69 studies finds that leadership can have a small but educationally significant effect on student outcomes (Marzano, Waters, and McNulty 2005). Cotton (2003) finds that principals affect student achievement indirectly through their effect on teachers. And a synthesis of research on eight years of school reform in Chicago shows that the quality of the principal's leadership is a critical element in school improvement (Stringfield et al. 1997).

The idea of inclusive schooling encompasses more than just the placement of special and general education students in the same classroom—it encompasses a school climate in which all students feel a sense of belonging

Leaders also play a significant role in promoting inclusive practices for students with disabilities. The idea of inclusive schooling encompasses more than just the placement of special and general education students in the same classroom (Consortium on Inclusive Schooling Practices 1996). According to Stainbeck and Stainbeck (1990), an inclusive school is a "place where everyone belongs, is accepted, supports, and is supported by his peers and other members of the school community in the course of having his or her educational needs met" (p. 3). Principals are key in creating a school climate in which all students feel a sense of belonging. Using case study methodology, Salisbury and McGregor (2002) find that principals promote inclusive practices in their schools through a range of administrative strategies designed to change practices and beliefs about students with disabilities. Questions remain about how effective leaders establish and sustain inclusive environments and how these practices influence teachers' expectations and instruction for students with disabilities.

School culture. School culture is "the sum of the values, cultures, safety practices, and organizational structures within a school that cause it to function and react in particular ways" (West

Regional Equity Network 2007). A positive school culture can positively influence student achievement. In a study of urban public schools in Massachusetts researchers found that higher performing schools had positive staff and student cultures (University of Massachusetts Donahue 2007). Staff cultures in these schools were exemplified by "collegiality, a sense of efficacy, a unified vision and shared accountability for school improvement"; student cultures were "safe and nurturing, but also challenging, supportive and goal- and accountability-focused" (University of Massachusetts Donahue 2007, p. 4). These findings are consistent with research by Barth (1990), who finds that collegiality in a school affected the school's quality, character, and student accomplishments. Sebring and Bryk's (2000, pp. 442–43) synthesis of research on school reform in Chicago identifies social trust as a characteristic of improving schools:

> *Schools that are improving are characterized by cooperative work relations among all adults. To achieve this state requires a strong base of social trust among teachers, between teachers and parents, between teachers and the principal, and between teachers and students. In schools that are improving, where trust and cooperative adult efforts are strong, students also report that they feel safe, sense that teachers care about them, and experience greater academic challenge. In contrast, in schools with flat or declining test scores, teachers are more likely to state they do not trust one another, and both teachers and students report less satisfaction with their experiences.*

Math learning for students with disabilities and other struggling learners may require coordinated schoolwide efforts by general educators, special educators, and administrators across multiple practice areas

In a synthesis of research Marzano (2003) identifies a "safe and orderly environment" as one of the top five factors affecting student achievement. Using case study methodology, the University of Massachusetts Donahue Institute (2004, p. 2) finds that "a well disciplined academic and social environment" is a common characteristic of urban schools with high-performing students with disabilities. These schools maintain rules and structures that help students focus on learning.

Some researchers argue that, in addition to creating a safe and respectful community, administrators and staff need to make deliberate efforts to create an inclusive culture that welcomes students with disabilities (Schaffner and Buswell 1996). Many schools participating in the Working Forum on Inclusive Schools (1994, p. 9) found that fostering a sense of community was critical to establishing cultures in which all students felt they belonged. The principal plays a key role in communicating, creating, and maintaining an inclusive school climate. Teachers and administrators need to communicate high expectations to all students and to provide the support and encouragement students need to achieve those expectations.

School culture also encompasses the relationships between school personnel and parents and the larger community. Parent and community involvement in schools has positive effects on student achievement (Marzano 2003). Schools can create cultures that are welcoming to parents by communicating frequently with them and providing opportunities for them to participate in school activities and decisions. Establishing these positive relationships is particularly crucial for helping the parents of students with disabilities navigate the Individualized Education Program (IEP) process and work in partnership with teachers (Hunt et al. 2003).

A systemic approach

Practices in each of the seven categories just discussed may help promote math learning for students with disabilities and other struggling learners. But ongoing math achievement for these students may require coordinated schoolwide efforts by general educators, special educators, and administrators across multiple practice areas. Indeed, schoolwide practices may be critical to achievement among struggling learners. Malmgren, McLaughlin, and Nolet (2006) find that the performance of general education

students is the single most consistently significant variable correlated with performance of students with disabilities on statewide assessments in English language arts and math. They find that "schools that got good results for students without disabilities also tended to get good results for students with disabilities" (p. 8). They note that "the success of students with disabilities, as well as their difficulties, is usually linked to special education variables . . . [In contrast, viewing] the achievement of students with disabilities as a result of general schoolwide variables shifts the 'ownership' of special education students' success to a broader set of educators" (p. 92).

A schoolwide approach to improving student learning may require schools to implement a combination of practices in a coherent and systematic manner (Individuals with Disabilities Act of 2004; D'Agostino and others 1998). In the 1980s researchers began developing models for schools seeking to implement whole-school reforms (Desimone 2000). Since then thousands of schools have adopted various reform methods—the most popular is the elementary literacy program Success for All (LaPointe and Stullich 2004; Slavin and Madden 2003). A meta-analysis of comprehensive school reform research finds that, despite quantitative and qualitative limitations in the studies, the research shows positive achievement effects for students in comprehensive school reform schools compared with students in control schools (Borman et al. 2003). Other studies find mixed achievement results and significant variation in how whole-school reforms have been implemented (Berends, Bodilly, and Kirby 2002; U.S. Department of Education 2004; Yin and Kim 2003).

How practices in different areas may work together to promote math achievement among students with disabilities and other struggling learners remains unclear. A quantitative study comparing high-performing and low-performing high-needs elementary schools examines the relations among four areas of school practice (leadership, professional community, school environment, and instruction) that have been identified as critical to school effectiveness (Mid-continent Research for Education and Learning 2005). It finds that leadership is a driving force influencing the professional community and school environment.

The unique configuration of practices observed in each school may reflect contextual factors, such as resources, size, student demographics, and location

Leadership practices may help to build inclusive and supportive school cultures, which in turn may motivate staff to set high expectations for all students, encouraging students with disabilities to succeed. Math instruction practices may be enhanced by new strategies teachers learn through professional development and collaboration with colleagues. More research is needed on how different practices operate in concert.

School context

The unique configuration of practices observed in each school may reflect contextual factors, such as resources, size, student demographics, and location. Resource levels can affect the amount and kinds of staffing and support services available for math instruction and whether the school is able to schedule common planning time for staff members. (Insufficient planning time is a commonly cited barrier to implementation of comprehensive school reform models; Muncy and McQuillan 1996; Ross et al. 1997; Smith et al. 1997.)

Other studies find variations in implementation of comprehensive school reform models that may be related to student demographics. In particular, lower levels of implementation are found in schools with large numbers of poor and minority students as well as in schools with high student mobility (Berends, Bodilly, and Kirby 2002; Stringfield et al. 1997). And elementary and smaller schools have implemented more whole-school reform than secondary and larger schools (Berends, Bodilly, and Kirby 2002).

For schools and districts the number of concurrent initiatives and their coherence may affect the

implementation of reform programs. Case studies of the schoolwide restructuring models developed by the nonprofit New American Schools Development Corporation find that this reform was just one of many that schools were implementing. "In many instances this caused teacher overload, and reduced the capacity of teachers to implement the design," according to Berends, Bodilly, and Kirby (2002, p. xxxiii). The University of Massachusetts Donahue (2007) study of urban schools finds that many were in the process of implementing multiple school improvement initiatives, including reforms in curriculum and assessment. Multiple concurrent reforms and ongoing changes created "a level of upheaval and a sense of unending transition" that may have negatively affected school improvement (University of Massachusetts Donahue 2007, p. 28). Schools with reform models or strategies that are not aligned with their district or state policies struggle to improve student outcomes (Tushnet, Flaherty, and Smith 2004; Yin and Kim 2003).

Research reveals a strong correlation between student achievement and community demographic factors, including average income, poverty, education level, English language proficiency, and single-parent status (Gaudet 1998). Urban schools face numerous challenges that affect teaching and learning. In a study of 30 urban schools in Massachusetts educators identified several factors, including poverty, housing insecurity, and limited parental support, as having "a complex and profound influence on the educational process" (University of Massachusetts Donahue 2007, p. 6). Funding for students with disabilities tends to be lower in urban than in suburban areas (U.S. Department of Education 2005) and the need for support services higher (Voltz and Fore 2006). In addition, many inner-city districts, particularly larger ones, have difficulty hiring and retaining special educators (U.S. Department of Education 2001; Fleischner 1993). Through interviews with a national sample of urban special educators Voltz (2000) finds that the cultural and linguistic diversity of urban students is often cited as a challenge for teaching.

Research reveals a strong correlation between student achievement and community demographic factors, including average income, poverty, education level, English language proficiency, and single-parent status

Rural schools face similar challenges, including high poverty rates, low funding levels, and difficulties in hiring and retaining highly qualified teachers and administrators (Williams 2003; Arnold, Gaddy, and Dean 2004; Mitchem, Kossar, and Ludlow 2006). While shortages of special educators and high turnover rates affect schools across the country, staffing issues are particularly acute in rural areas, partly because of lower salaries and geographic isolation (Brownwell and others 2004; McLeskey, Tyler, and Flippin 2004; Reeves 2003). Consequently, rural schools tend to have more special education staff who are uncertified or minimally qualified (Tyler et al. 2003). In a survey of rural educators across the United States Mitchem, Kossar, and Ludlow (2006) note that respondents point to the NCLB requirement for highly qualified teachers as a serious challenge, particularly in special education. In a study of special education services in rural, suburban, and urban secondary schools Bouck (2005) finds that the number of cotaught classrooms is lowest in rural schools, perhaps because of the low level of special education staff. Survey results also reveal that the percentage of special educators with graduate degrees is lower in rural than in suburban and urban locales.

Special education practices may also be affected by the small size of many rural schools—75 percent enroll fewer than 400 students, and 20 percent enroll fewer than 100 (Williams 2003). Because it is costly to provide a variety of service options for a small number of students and because rural schools tend to spend less per pupil than schools in other areas on special education services, in rural areas students with disabilities have fewer program options (McLaughlin et al. 2005; Milloy et al. 2003). In contrast, research on general education students suggests that the small size of many rural schools may be a positive factor in student achievement (Williams 2003; Howley, Strange, and Bickel 2000). Some of the positive features of small schools are lower student–teacher ratios, supportive and cohesive environments, and stronger

community connections (Fairman 2003; Howley, Strange, and Bickel 2000).

Thus, research has identified a variety of contextual factors that may affect education outcomes. More work is needed, however, on how contextual factors may affect the kinds of practices schools adopt to improve math learning for students with disabilities.

SYNTHESIS OF CASE STUDY FINDINGS

A case study method was used for this project because case studies offer researchers and educators rich information about how schools are implementing specific practices in varying contexts. Six schools in Massachusetts and New York were selected as case studies based on nominations from experts in education and a screening process devised by the research team (see box 1 and appendix A for details). The research team then visited the six schools and, through classroom observations, interviews, and cross-case analysis, sought to answer the three research questions:

- How do schools provide math education to students with disabilities and other struggling learners? What practices are used and how are they implemented?
- What do school leaders and teachers identify as their school's strongest practices for improving teaching math to students with disabilities and other struggling learners?
- What do school leaders and teachers identify as their greatest challenges for improving math teaching and learning for students with disabilities and other struggling learners?

This section synthesizes the findings for the six schools onto each of these questions.

Math education practices at the six schools

Many similarities were apparent in the math instruction strategies, levels of math support, and other school practices across the six schools. And many of the approaches and characteristics the schools shared have been cited as hallmarks of good instruction within the education literature. The schools' shared practices, as well as notable differences, are examined for each of the seven practice categories.

Many similarities were apparent in the math instruction strategies, levels of math support, and other school practices across the six schools. And many of the approaches and characteristics have been cited as hallmarks of good instruction within the education literature

Classroom math instruction. The six case study schools offered students with disabilities and other struggling learners diverse classroom placement options, maintained varied student–teacher ratios, and used different curricula for math instruction. Despite these differences the schools displayed a number of similarities.

Five of the six schools used an inclusion model as their primary classroom placement tool for students with disabilities. The Individuals with Disabilities Education Act recommends that students with disabilities be placed "in the regular classroom, to the maximum extent possible" while also recognizing the need for "a continuum of alternative placements" (Individuals with Disabilities Education Act of 2004, Sections 682c and 300.115). Four of the six schools (Redwood, Maple, Aspen, and Beech) included some students with disabilities in regular classrooms (referred to as "inclusion," "integrated," or "collaborative" classrooms) staffed by a full-time general educator and a part- or full-time special educator or teaching assistant (table B1). Willow School placed all elementary school students with disabilities in inclusion classrooms. The proportion of students with Individualized Education Programs in all classrooms at Willow approximated the proportion throughout the school, as recommended by the Individuals with Disabilities Education Act of 2004.

Redwood, Maple, Aspen, and Beech Elementary Schools offered various classroom settings to

BOX 1

Study methodology and limitations

Nomination, screening, review, and selection of case study elementary schools took place from fall 2006 through spring 2007. Two-day site visits at each school were conducted between March and June 2007.

Education leaders (state special education leaders, district superintendents, special education directors, math coordinators, university professors, and leaders of research projects focusing on math education and students with disabilities) were asked to nominate schools that were making strong, targeted efforts to improve the math learning of students with disabilities and other struggling learners. To provide a common set of nomination criteria, the research team provided a list of suggested practices (drawn from the research literature) and asked the education leaders to identify the school's strengths in these areas (see table A1 in appendix A). This process yielded 38 schools, 19 each in Massachusetts and New York.

Publicly available data on each school's demographics, math adequate yearly progress status, and grade 4 math state assessment results were used to screen the nominated schools. Researchers spoke with designated contacts at each school to learn about the practices identified in the nominations and to determine whether the practices were implemented throughout the school, had been implemented for at least a year, and were potentially replicable. Only 10 schools met these criteria.

Through phone conversations with principals or math specialists at the schools researchers gathered more detail about these and other practices that educators felt were benefiting the math learning of students with disabilities and other struggling learners. To describe a wide variety of math education practices for students with disabilities in diverse settings, the team gave more weight to schools whose practices appeared more strongly aligned with research and policy recommendations, that had implemented them longer, and that had higher need levels and more diverse student populations (see appendix C for details of need-level categories). Using these criteria, the project team selected the final set of six schools. These cases were chosen to illustrate a variety of practices adopted by schools perceived by education leaders to be exemplary in their math education efforts.

At each school the researchers observed math lessons in general education, inclusion, and separate special education settings. Classroom observations (typically one class period) were conducted by pairs of researchers following a common protocol. Altogether, 52 classroom observations were conducted to gather descriptive information to guide conversations with teachers and provide evidence on practices and examples to illustrate the case studies. The categories of staff members selected for interviews and observations were principal, math coach or leader, general education teachers, special education teachers providing in-class or resource room services, teaching assistants or paraprofessionals, and any other key informants suggested by the school's primary contact. The data were used to analyze each school separately and to conduct cross-case analysis.

There are several limitations of the data and the methodology. First, the data do not provide evidence that specific school practices are effective; the methods do not allow for valid causal inferences. Second, because of small sample sizes and the sample selection methods used, school characteristics and opinions of teachers and administrators cannot be considered representative of all school system personnel. Third, because of time constraints, the study did not solicit the views of students, parents, and district administrators, and the visits to each site were limited in scope. Additional visits would allow researchers to observe school practices that do not occur daily. Also because of time constraints, researchers were unable to administer a systematic survey of standardized questions to school personnel across all sites. Thus, most data came from interviews on topics tailored to specific schools and personnel with specific roles. Variations in interview questions across schools and personnel may have resulted in different information on some practices for some schools. Findings about commonalities and differences across the schools, therefore, cannot be viewed as definitive.

Appendix A provides a detailed description of the study methodology. Appendix B provides side by side summaries of characteristics and practices at the six case study schools. Appendix C compares each school's performance with the averages for schools in the same need-level category.

accommodate students with different degrees of disability. Each school typically had one inclusion classroom per grade in which up to half of all students had disabilities (mild to moderate). Each school also had general education classrooms in which a few students with mild disabilities received instruction from a general educator and either in-class or out-of-class support from a special educator. Redwood and Beech Schools had the largest numbers of placement options for students with disabilities, which may have been related to the schools' large student bodies. The three urban schools (Cedar, Redwood, and Beech) all had completely separate multigrade special education classrooms. At Beech and Redwood Elementary Schools these classrooms are for students with severe disabilities; at Cedar Elementary School such classrooms are the primary placement for most students with disabilities. (Follow-up information from the school revealed that Cedar's new administration moved toward more inclusive student placements in 2007/08.)

All six schools provided access to the general education math curriculum for students with disabilities. Although student placement practices varied across the schools, all six followed the Individuals with Disabilities Education Act mandate to provide students with disabilities access to the general education math curriculum to the "maximum extent possible." Students with mild to moderate disabilities were taught the same grade-level math curriculum as their general education peers. They used the same math textbooks, with accommodations made according to their Individualized Education Programs. The schools used a variety of in-class and out-of-class supports to help students with Individualized Education Programs succeed in the general education curriculum. At Aspen, Beech, Maple, and Redwood Elementary Schools teachers tried to keep students with Individualized Education Programs in the general education classroom during regular math instruction. The inclusion classes at these schools were well staffed by full-time general educators and part- or full-time special educators or teaching assistants. Out-of-class math support was provided only when required by a student's Individualized Education Programs. When such support was provided, teachers tried not to pull students out of class during math period.

Although student placement practices varied, all six schools followed the Individuals with Disabilities Education Act mandate to provide students with disabilities access to the general education math curriculum to the "maximum extent possible"

Special educators provided instruction and support to students with disabilities and other struggling learners in a variety of classroom settings. At Maple Elementary School the special educator used a flexible approach to provide a combination of in-class and pull-out support based on the changing needs of students as they progress through the math curriculum during the school year. At Willow School all students (including those with Individualized Education Programs) were taught in classrooms led by general educators with the support of special education teaching assistants. In Willow's resource room a special educator provided pull-out support in math and other subjects to students with Individualized Education Programs in grades K–4. At Cedar Elementary School most students with disabilities and other struggling learners received their primary math instruction in separate special education classes. Special educators taught these classes using the same math curriculum and books used in the general education classes. The math leader worked with the special educators to help them make the general curriculum accessible to students with disabilities while maintaining the integrity of the math content. At Aspen Elementary School the separate special education classroom was for students with severe cognitive disabilities from across the district. The teacher provided individualized math instruction to match each student's IEP goals.

None of the schools has had difficulty hiring and retaining special educators. Many districts across the country, particularly in urban and rural areas, have trouble hiring special educators (Brownwell

et al. 2004; Tyler et al. 2003). None of the six principals identified hiring and retaining qualified special educators as a major challenge. The positive reputations of the case study schools and their principals may help them attract and retain qualified candidates. For instance, one special educator at Maple Elementary School commutes long distances to teach at the school and turned down other job offers because she greatly values the school's supportive community.

Administrators and staff in key roles relevant to math or special education were highly experienced. All six schools had a formal or informal math leader who had been teaching for more than 10 years (table B2). The math leader at Cedar Elementary School, The Title I math teacher at Aspen, and a math coach at Beech had also played leadership roles at the district level.

All six principals were seasoned educators with at least 25 years' experience in the field. All served as senior school administrators before taking their current positions. The principals at Cedar, Aspen, and Willow schools were former special educators. At Beech Elementary School the principal was a former district math coordinator and math teacher, one of the assistant principals was a former special educator, and another was a former math teacher. And all but one of the principals had been in their current positions for at least four years.

The vast majority of teachers at the case study schools were highly qualified (table B12 in appendix B). Staff tenure varied across schools. The percentage of veteran teachers was particularly high at Redwood (88 percent), Aspen (75 percent), and Willow (69 percent)—schools that also had principals with the longest tenure. The large percentage of experienced teachers may have had a positive effect on math practices and student learning at these schools, as studies show that teacher experience is related to student achievement (Darling-Hammond 2001).

Staff interviews and classroom observations revealed that teachers employed similar teaching strategies to make the general education math curriculum accessible to a range of learners

Among the general educators interviewed, all taught math to students with disabilities or other struggling learners; some taught many of these students in inclusion classrooms or math support settings. Within this subset of teachers at least one teacher at each school had many years of experience. A grade 3 teacher at Willow School who taught math paired with a middle school math teacher was a former assistant principal and member of a districtwide math curriculum committee. At Maple Elementary School the general educator in the grade 4 inclusion classroom had been teaching for 24 years, had National Board Certification, and was the school's informal math leader. At Aspen Elementary School a general educator in a grade 4 classroom, in which to half the students had language-based disabilities, had been teaching for 14 years and had a special education background. Every school also had at least one special educator with many years of teaching experience. Teachers interviewed spoke very highly of these veteran special educators. In some cases teachers in both special and general education had turned to these special educators as mentors or leaders. Several of these special educators had been recognized by administrators as extremely skilled and had been tapped to serve as formal leaders.

Teachers used similar instructional strategies for making math accessible. Staff interviews and classroom observations revealed that teachers employed similar teaching strategies to make the general education math curriculum accessible to a range of learners. At each school at least three staff members (including administrators, general educators, and special educators) reported that small-group instruction, one-on-one assistance, and efforts to tailor the math curriculum for individual students were important tactics that teachers used to differentiate instruction and reach students with diverse learning needs (table B3). At least one teacher at each school said that she regularly changes the composition of student groupings in her classroom. These teachers keep student groups flexible, both to adapt to students' changing learning needs and to minimize the stigmatization that can arise if students with learning difficulties are consistently placed in their own small group.

Teachers built students' understanding of math-specific vocabulary and used multisensory activities (such as the use of manipulatives and the incorporation of physical movement into lessons), multiple problem solving approaches, and games—strategies recommended by the National Council of Teachers of Mathematics (2000). At all six schools teachers tried to provide extra time for struggling learners by incorporating practice, reinforcement, and review into their lessons and by integrating math into other subjects during the school day. At Redwood, Maple, Aspen, and Beech—where full-time general educators and special educators coteach all subjects to both general and special education students in inclusive classrooms—teachers stressed the value of integrating math into other subjects during the school day. Teachers at all six schools also touted the benefits of peer instruction, a practice that has considerable research support (Fuchs, Fuchs, and Karns 2001; Greenwood, Maheady, and Delquadri 2003). Classroom observations revealed that teachers pursued this strategy in various ways: asking students to check one another's work, having students share problem solving strategies, asking students who already mastered a concept to teach it to their classmates.

Other strategies were also cited, if less frequently. Several teachers at Maple Elementary School said that computers had been particularly helpful for students with disabilities because of their interactive, multisensory, and instant-feedback features. At least one teacher at Redwood, Maple, and Beech Elementary Schools said that they frequently rephrased and simplified language to make math problems more accessible. At least one teacher at these schools and at Cedar and Aspen Elementary Schools either reported or demonstrated in the classroom that they would relate math lessons and problems to students' real-life experiences.

All six schools used published math programs and provided teachers with support for implementing them. Each school had aligned its program to its state math standards—a practice identified as a characteristic of high-performing schools (table B4; University of Massachusetts Donahue 2004). Five of the six schools either followed detailed districtwide curriculum pacing calendars or worked to meet districtwide quarterly benchmarks.

Teachers at each of the six schools had in-house math leaders (formal or informal) to whom they could turn with questions about the math curriculum

Teachers at each of the six schools had in-house math leaders (formal or informal) to whom they could turn with questions about the math curriculum. These math leaders supported teachers by providing curriculum training, modeling lessons, conducting workshops, and providing resources (see discussion on professional development below). At the rural Maple Elementary School teachers found curriculum support from colleagues through schoolwide and districtwide grade-level professional learning communities. These communities had developed curriculum scope and sequence plans to ensure a coherent and consistent math program districtwide. At the three urban schools in-house math leaders helped teachers implement the curriculum and follow the district pacing calendar. Suburban Aspen Elementary School and rural Willow School did not have in-house staff members who could play a comparable role for monitoring the implementation of the math curriculum. Teachers at these schools had to turn to curriculum coordinators at the district level for support.

Each of the six schools also supported the implementation of their math programs by providing teachers with resources, such as manipulatives. Many educators reported having the materials they needed to teach math and described their administrators and math leaders as receptive to requests for resources. At Cedar and Aspen Elementary Schools the math resource rooms were filled with math materials and books for teachers to use.

Three schools were implementing schoolwide instructional models in addition to published math programs. Redwood Elementary School had been implementing the America's Choice

comprehensive school reform model since 2001.[1] Beech Elementary School had been implementing the Teachers College Workshop model since 2003.[2] And Willow School had been implementing the Responsive Classroom model since 1997.[3] Although these models are not specific to math, they were praised by educators at all three schools for their contributions to improving math learning.

Staff at two schools (Redwood and Willow) identified their instructional models as major strengths of their schools' approaches to improving math learning. These schools appeared to have widespread acceptance of their models. Multiple teachers at Redwood and Willow said that adopting consistent practices throughout the school aided communication among teachers, improved student behavior, and thereby promoted student learning. A Willow School educator said that its model was instrumental in establishing a supportive and respectful school environment that was particularly helpful for students with disabilities. Teachers at Beech Elementary School, however, expressed more varied opinions about their school's model.

Different levels of acceptance of schoolwide instruction models may be related to the number of years models have been in place in a school and the way they were introduced. Both factors are identified as important in studies of whole-school reform and school change (Berends, Bodilly, and Kirby 2002; Borman et al. 2003). Beech Elementary School teachers had fewer years of experience using their instructional model than teachers at Redwood or Willow. In addition, Beech teachers were not involved in the decision to implement the model; use of the model was mandated by the New York City Department of Education. In contrast, the other models were adopted through school-based initiatives that incorporated teacher input. Both Redwood and Willow had poor reputations within their communities when they adopted their models. Negative public perceptions of their schools may have increased staff members' motivation to try new approaches to improve their schools.

Different levels of acceptance of schoolwide instruction models may be related to the number of years models have been in place in a school and the way they were introduced

Cedar, Maple, and Aspen Elementary Schools were not implementing schoolwide instructional models other than the published math program. It is difficult to link the use of specific practices to the presence or absence of schoolwide instructional models because the two sets of schools differed in a variety of ways (location, student demographics, math curricula). To examine how math programs and schoolwide instructional models may combine to influence teachers' math practices, future studies could examine random samples of schools or similar schools that differ only in whether they are using a schoolwide instructional model.

Math supports and interventions. All of the schools offered a variety of out-of-class math supports and interventions for students with disabilities and other struggling learners. Although the schools shared some common supports, they provided out-of-class math assistance to students in distinct ways. And schools that had launched new support programs had also introduced them differently. Their experiences may offer lessons for other schools considering similar initiatives.

Two schools had designated a single full-time staff person to provide out-of-class math support. The math leader at Cedar Elementary School and the Title I math teacher at Aspen Elementary School provided regular out-of-class math support to students without Individualized Education Programs in a separate math resource room (table B5). These math leaders served students primarily in grades 2–4. Each was assigned primary responsibility for providing math support to struggling learners at the school.

Administrators and teachers at Aspen and Cedar Elementary Schools believed that regular instruction by in-house math leaders had led to large gains in math learning among struggling students. Under this arrangement students with the greatest math needs received instruction from the schools' strongest math teachers. There was not enough time in

the day, however, for the Cedar math leader to serve all the school's struggling learners. Both the math leader and other Cedar teachers expressed the need for a second math leader who could provide direct support to students in the early grade levels.

At Cedar and Aspen Elementary Schools the math support teachers were not classroom teachers; they worked with struggling students from many classes. In contrast, Maple and Willow Schools did not have math support positions (though both schools had such positions for reading). Because Maple's informal math leader was a full-time grade 4 teacher, she had limited availability for helping students in other classes. Maple's principal identified the lack of a designated math support person as one of the school's major challenges. At Willow School middle school teachers provided only part-time math support to students because they worked with elementary-level classrooms only twice a week.

Some schools had formal out-of-class math programs, while others offered support through flexible staff arrangements. A common feature among the six schools was a special education resource room in which students with disabilities received academic support in math from special educators. At most of the schools this resource room was only one component of a broader array of out-of-class math support services. Two of the urban schools, Cedar and Beech, had formal before- and after-school math classes for general education students and students with disabilities (see table B5). The third urban school, Redwood, had replaced its after-school program with a three-hour Saturday morning program that included a block for math instruction. All three urban schools had summer school programs that reviewed math content from the school year and helped struggling learners prepare for standardized testing. At Cedar Elementary School the math leader also provided regular math assistance to students at lunchtime throughout the school year as well as Massachusetts Comprehensive Assessment System (MCAS) preparation classes during the February and April school vacations.

A common feature among the six schools was a special education resource room in which students with disabilities received academic support in math from special educators

The suburban Aspen School provided a variety of support services, most of which took place during the regular school day (Aspen's 10-week MCAS preparation program took place before school). These programs included Title I services and a Response to Intervention program. The two rural schools relied on core groups of dedicated teachers and flexible staff arrangements to provide additional math instruction for struggling learners. At Maple Elementary School teachers collaborated to identify which students had extra needs in math. They then tried to match students with teachers who could best support their needs (during recess, lunch, or when teachers were helping a small group in their own class with a relevant topic or skill). Willow School set up a schedule that enabled middle school math teachers to provide in-class math support to lower grade teachers twice a week.

Most schools had started or were initiating a Response to Intervention program for math. In response to calls by educators and policymakers to address student learning difficulties at early grade levels, schools around the country have begun to explore a variety of Response to Intervention (RtI) programs for literacy and, more recently, math (such calls were issued in the Individuals with Disabilities Education Act of 2004). Three schools (Aspen, Maple, and Beech) had launched intervention programs for both subject areas and were in the early years of implementation. Two schools (Redwood and Willow) had launched programs for literacy and were investigating assessments and interventions they could use for math.

Several educators noted the dearth of established assessment tools and accompanying intervention programs for math at the early grade levels. Educators at Aspen, Maple, and Beech Elementary Schools had assembled different sets of diagnostic instruments and intervention strategies. At Aspen

the early intervention specialist, called a primary preventionist, used a computer-based assessment tool (AIMSweb) to screen every kindergarten student for low levels of math comprehension and provided the lowest performing students with a 10-week math intervention course. The school-based intervention team (SBIT) coordinator at Maple Elementary School and the general education teacher support services (GETSS) teacher at Beech Elementary School assessed only students referred to them by classroom teachers. The SBIT coordinator used diagnostic instruments and math interventions that were available through the school-based intervention team program's web site. The GETSS teacher used tools and strategies she had accumulated during many years of teaching experience.

At each school several respondents described all three programs (primary prevention Response to Intervention, the school-based intervention team, and general education teacher support services) as very helpful for struggling learners. The general education teacher support services and school-based intervention team programs seemed better integrated into the fabric of the case study schools; the Response to Intervention program appeared to be on the sidelines. A few general educators at Aspen Elementary School said they knew little about the school's Response to Intervention program and were uncertain about its purpose. In contrast, several of the general educators interviewed at Maple and Beech Elementary Schools described the school-based intervention team coordinator and the GETSS teacher as extremely valuable resources for both students and teachers.

The intensity of the six case study schools' assessment activities suggest that educators at these schools are greatly invested in monitoring and supporting the academic performance of all their students, especially those with disabilities and other struggling learners

These differences may be related to the ways the programs were designed, staffed, and launched within the schools. Both the primary preventionist and the GETSS teacher have many years of experience as special educators supporting students with a variety of learning needs. The GETSS teacher works with students referred to her by general education teachers. Her experience as a special educator helps her to determine whether students need to be referred for special education testing. But whereas the primary preventionist at Aspen Elementary School was brought in by the district and was new to Aspen, the GETSS teacher at Beech Elementary School and the school-based intervention team coordinator at Maple Elementary School were well respected veteran staff members. The school-based intervention team coordinator and GETSS teacher could build on their relationships with teachers to communicate about and implement their programs. And they were introduced to the staff as resources they could call on when they felt a student needed extra support. In contrast, the primary preventionist at Aspen divided her time between two schools and was charged with screening every kindergarten student at the school and providing out-of-class intervention services for the lowest performers, thus working mainly with students rather than teachers.

For early intervention initiatives that require the support and involvement of both general and special educators, the way initiatives are introduced may have important implications for how quickly and fully they become incorporated into the workings of schools. Because all three programs are still in their early years of implementation, it is too early to know how these differences may affect their long-term success. Future research could explore possible links among methods of program implementation, levels of program integration within the school, and effects on student learning.

Assessment. Under the NCLB Act, states, districts, and schools across the country have been developing, administering, and paying more attention to the outcomes of standardized student assessments as they work to demonstrate adequate yearly progress (for definitions of key terms used in this report see box 2). Assessment practices at the six case study schools illustrate this trend. The intensity of the schools' assessment activities suggest that educators at these schools are greatly invested in monitoring and supporting the academic

BOX 2

Key terms used in this report

Adequate yearly progress. An individual state's measure of annual progress toward the goal of 100 percent of students achieving to state academic standards in at least reading/language arts and math. It sets the minimum level of proficiency that the state, its school districts, and schools must achieve each year on annual tests and related academic indicators. (For more information see http://www.ed.gov/nclb/accountability/ayp/edpicks.jhtml?src=ln.)

504 plan. Legal document mandated under section 504 of the Rehabilitation Act of 1973 that outlines a plan of instructional services for students with disabilities, such as modifications and accommodations needed for students to have an opportunity to perform at the same level as their peers in a general education setting. It is different from an Individualized Education Program. (For more information see www.ed.gov/about/offices/list/ocr/504faq.html.)

Individualized Education Program (IEP). Tailored education plan, required under the Individuals with Disabilities Education Act of 2004, designed to meet the particular needs of each child with disabilities.

Manipulatives. Tools, models, blocks, tiles, and other objects used to explore math ideas and solve math problems.

Professional learning communities. Collaborative teams of educators who work together on common goals for improving student learning.

Pull-out services. Services provided when a teacher or paraprofessional works with a student outside of the classroom to provide individualized assistance.

Push-in services. Services provided when a teacher or paraprofessional goes into the classroom to help one or more students.

School improvement plan. Two-year plan required by state and federal regulations for schools that do not make adequate yearly progress for two consecutive years.

Title I. Federal program that provides financial assistance to local education agencies and schools with high numbers or high percentages of poor children to help ensure that all children meet state academic standards.

performance of all their students, especially those with disabilities and other struggling learners.

All six case study schools committed experienced staff to analyze state assessment results and shared their findings with the whole faculty. As required by their states, the six schools administered their state's standardized assessment to students in grades 3–8. Each year the math lead teacher, senior administrators, or both reviewed the results of the assessments for each grade and presented their findings to school staff. They examined the previous year's assessment results in math to identify topics that were difficult for many students and planned ways to further emphasize these topics in their curriculum (table B6). Often with the guidance of the school's in-house math leaders, teachers used this information to guide their classroom math instruction the following year.

Five of the six schools also used state assessment results to identify individual students for additional math support services. At Cedar Elementary School low math performers and those on the border of passing the MCAS received intensive instruction from the math lead teacher in the math resource room. Aspen Elementary School provided a 10-week before-school MCAS tutoring program for students who performed poorly and were identified by teachers as at risk of failing. A New York State law requires Beech, Maple, and Redwood Elementary Schools to provide academic intervention services to all students who score below proficient on the state test. Redwood administrators also used assessment results to set achievement targets for the school as a whole and for individual students.

Five of the six case study schools conducted frequent benchmark testing. Many benchmark tests were created by math educators at the district level (see table B6). These assessments were administered five times a year at Beech Elementary School and four times a year at Cedar and Maple Elementary Schools. Teachers at Aspen Elementary School

administered a mid- and end-of-year district math assessment. Since 2006/07 Aspen teachers have also been required to administer tests from their curriculum at the end of every two chapters and to submit the results to the district. Redwood teachers administered a district math test to students at the beginning of each school year.

District tests were scored and reviewed by district math staff, school math leaders, or classroom teachers, with the assistance of the math specialist. Teachers and math leaders used the results to identify problem areas, guide instruction, and identify students in need of support. Teachers at schools that administered quarterly benchmark tests could use the results to monitor student progress. These results supplemented the regular classroom and curriculum-based assessments that teachers at all six schools administered throughout the year. Districts appeared to use the benchmark tests both to monitor student progress and to hold schools accountable for implementing the curriculum. Regularly scheduled districtwide assessments set clear expectations about what math content needed to be taught in a particular time frame.

Five of the case study schools used assessments to identify struggling students in grades K–2. Assessment and test preparation efforts at most schools across the nation have focused on students in grades 3–8—the grades in which state tests are expected for states that receive federal funding under the NCLB Act of 2001. Five of the six case study schools had expanded their assessment initiatives to include students in grades K–2. Redwood Elementary School administered the TerraNova standardized assessment at the beginning of the school year to its K–2 students. At Cedar, Maple, and Aspen Elementary Schools districtwide assessments were administered to students below grade 3. At Beech Elementary School a team of teachers and math coaches created design your own assessments for grades K–2 to complement the school's use of Princeton Review tests for grades 3–5. These schools use benchmark assessments to identify struggling learners in early grades (as recommended by the Individuals with Disabilities Education Act of 2004) and monitor student progress.

In almost every school with regular grade-level meetings at least one teacher or administrator noted the value of these meetings

Teacher collaboration. Teachers at all the schools described high levels of collaboration among staff members. Some described formal collaborative practices, such as regularly scheduled coplanning meetings; others described informal collaboration with colleagues, such as discussions before school and through email. Whether the collaboration was formal or informal, teachers at every site appreciated the support and cooperation of colleagues and reported that collaboration had benefited their work with students.

Five of the six schools provided common planning time and held regular grade-level meetings. In two schools (Cedar and Redwood) all or most grade-level teachers had daily common planning time (table B7 in appendix B). Maple, Beech, and Willow schools provided common planning time each week. Aspen Elementary School did not provide shared planning periods—a fact several staff members lamented.

Teachers at five of the six schools came together regularly for formal grade-level meetings, which occurred in a variety of formats. Cedar Elementary School teachers in each grade met twice a week, once to focus on student literacy instruction and once to focus on math with the math lead teacher. Grade-level teachers at Maple and Willow Schools convened weekly to discuss topics such as lesson planning, student assessment scores, and curriculum issues. General educators at Redwood and Beech Elementary Schools met with their grade-level peers at least once a month. Across the six schools grade-level meeting agendas were set by administrators in some cases and by teachers in others (table B14 in appendix B).

In almost every school with regular grade-level meetings at least one teacher or administrator noted the value of these meetings. Multiple staff members at Maple Elementary School spoke of

the professional learning community meetings as times for brainstorming solutions to student issues, sharing teaching strategies, and learning from others' expertise. A teacher at Maple Elementary School also noted that communication during professional learning community meetings helped build consistency in math instruction by "putting everyone on the same page." In her view, people are no longer "doing their own thing" in separate classrooms. An assistant principal at Redwood Elementary School reported great excitement among grade 1 teachers after they jointly analyzed their students' assessment scores and learned more about their own teaching strengths and weaknesses. A teacher at the school described how everyone benefits when teachers come together to "dissect something after we try it and talk about what worked, what didn't work, how are we going to change what didn't work, and how are we going to make it better."

In five of the six schools general educators collaborated formally with special educators through coteaching, meetings, and other arrangements. General educators worked closely with special educators through a variety of formal arrangements. At Redwood, Maple, Aspen, and Beech Elementary Schools general and special educators who cotaught in inclusion classrooms worked closely every day. These teachers also collaborated informally outside the classroom (in the mornings, during lunch, through emails, over the phone at night) to prepare lessons and discuss teaching strategies for specific students. Many educators who worked in inclusion classrooms spoke positively about their coteaching experiences (though one principal cited the challenges of coteaching, including selecting compatible teaching partners and addressing situations in which coteachers have difficulty working together). A general educator at Redwood Elementary School said that having a special educator coteacher in the classroom allows teachers to divide duties, gain greater expertise in a smaller set of subjects, and give students more individual attention.

Grade-level meetings provided another opportunity for collaboration between general and special educators. At Beech and Maple Elementary Schools special educators were treated as members of general educator grade-level teams and invited to participate in weekly grade-level meetings. It was often a challenge, however, for special educators who worked with students from multiple grade levels to collaborate with all of their general educator colleagues because they were unable to attend multiple grade-level meetings. To address this issue, special educators at Maple Elementary School chose one grade-level professional learning community to attend and received minutes from the other meetings. While this helped keep the special educators informed, it meant that some grade-level professional learning community meetings consisted of only general educators. With the exception of general educators who cotaught with special educators, across the six schools general educators typically appeared to plan more with one another than with special educators.

The amount of out-of-classroom collaboration between general educators and special educators may be linked to whether or not they work together in classrooms

The amount of out-of-classroom collaboration between general educators and special educators may be linked to whether or not they work together in classrooms. At Cedar Elementary School special and general educators held separate planning meetings, a practice that mirrored the school's structure of separate special education classrooms. General educators at Willow School did not have common planning time with the lower grade special educator, who provided pull-out services in a resource room.

Districtwide collaboration was not common, but it was valued where it occurred. General educators at Redwood, Maple, and Aspen Elementary Schools met monthly with other general educators in their districts; only at Maple Elementary School did teachers at every grade level meet with peers across the district for a full day each month to develop student assessments, coordinate curriculum approaches, and share teaching strategies. Maple teachers noted that their collaborative efforts to

create a coherent and consistent districtwide math program benefited students, because many students frequently move from school to school. At Aspen Elementary School kindergarten teachers met monthly with their district counterparts to share best practices, discuss curriculum, and learn from guest speakers. At Cedar and Redwood Elementary Schools math leaders met once or twice a month with colleagues from the district to discuss curriculum alignment issues and student assessments. Educators appeared to value these opportunities to learn about practices and challenges in other schools and to broaden their professional networks.

Professional development in math and special education. Collaboration among teachers played a key role in promoting professional growth. All of the case study schools had formal or informal school-based math leaders who provided in-house math professional development and support for school staff members. These in-house resources, as well as opportunities to receive ongoing training within the district and beyond, made many teachers feel well supported and prepared for their work with students, including those with disabilities.

Each case study school had highly experienced in-house math leaders who provided curriculum and instructional guidance to teachers (table B8A and B8B). Largely because some of these staff members were responsible for supporting students while others served primarily teachers, math leaders offered different kinds of math training and support to their in-house colleagues. In-house math leaders may:

- Serve as the resource person for questions about the math curriculum, math content, and instructional practices (all schools).
- Model lessons and coteach with teachers in their classrooms (Cedar, Redwood, Beech, and Willow).
- Lead math-related professional development sessions at grade-level and faculty meetings (Cedar, Redwood, Maple, and Beech).
- Meet regularly with groups of grade-level teachers to plan for upcoming lessons and assessments (Cedar).
- Provide math curriculum training, support, and mentoring to new teachers (Cedar, Redwood, Maple, Aspen, and Beech).

Like their general education peers, special educators at several schools regularly received support from math lead teachers

Teachers at all six schools greatly appreciated the support they received from the math leaders. Because these leaders did not supervise or evaluate them, teachers may have felt more comfortable asking for assistance.

Like their general education peers, special educators at several schools regularly received support from math lead teachers. A special educator at Cedar Elementary School met weekly with the math leader for help in implementing the math curriculum in her separate special education classroom and for assistance in administering alternative math assessments to students with more severe disabilities. When needed, she also received in-class support from the math leader. Special educators at Redwood and Beech Elementary Schools who cotaught in integrated or collaborative classrooms worked with the math specialist or math coaches whenever they provided assistance in their classrooms. Special educators who taught in self-contained classes at Redwood Elementary School could draw on the math specialist's expertise inside and outside the classroom.

Collaboration with colleagues played a key role in teachers' professional development. Teachers at all of the case study schools described the key role collaboration plays in teacher professional development. At Redwood Elementary School and Willow School teachers formed groups to study specific topics (table B15 in appendix B). At Maple Elementary School teachers had not only in-house access to an informal math expert but also the instructional support of grade-level colleagues from their professional learning communities. The

principal at Maple Elementary School believes that collaboration through professional learning communities had helped all teachers learn new teaching strategies and gain confidence in their own and their colleagues' teaching skills. A new special educator at Maple Elementary School said that the professional learning community provided her weekly access to experienced teacher mentors. A teacher at Maple summarized: "I think the best professional development we get is when we work collaboratively with another teacher, and we learn from their strengths and they learn from ours."

Leadership. The six schools had different leadership and administrative structures. Both of the large urban schools (Redwood and Beech) had a principal and three assistant principals.4 Each of the mid-size schools (Cedar and Willow) had a principal and an assistant principal. And the two smallest schools (Maple and Aspen) were led solely by a principal.

Principals played slightly different roles at each school. Whereas at Cedar and Willow Schools the principals were frequently in the classroom to observe and advise teachers, at Redwood and Beech Elementary Schools the principals delegated these activities to the assistant principals (table B17). Comments by administrators revealed subtle differences in leadership philosophies and styles. Comments by teachers, however, suggested a number of common characteristics among the leaders at the six schools.

Principals at the six schools described different governing approaches and management styles. In some schools the principals deferred to staff input when making schoolwide decisions (table B16). As the Aspen principal commented, "We're all here for the same reason, so I don't get a bigger vote than anyone else." At Willow School the assistant principal noted that although the principal has ultimate decisionmaking authority, "normally it's the teachers [who] decide what's going to happen." In contrast, the Beech Elementary School principal said that he listens to people's input but holds the final veto. The Redwood Elementary School principal had adopted an approach of soliciting teacher opinions and allowing collective decisions to be made "bottom-up and side-to-side."

Principals said that they granted teachers freedom in the classroom, bounded by the expectations they set and the accountability they required

Principals described their own management styles in slightly different ways. Principals at Cedar, Aspen, and Beech Elementary Schools said that they granted teachers freedom in the classroom; the principals at Beech and Cedar Elementary Schools added, however, that this freedom was bounded by the expectations they set and the accountability they required (table B16). Maple's principal also emphasized teacher accountability for improving the learning of struggling students but gave teachers leeway in choosing strategies. At Redwood and Beech Elementary Schools the principals described their efforts to "equip" or "scaffold" teachers to become competent and confident professionals who could take on more responsibility and leadership in the schools. Aspen's principal also noted the importance of empowering teachers, not through deliberate guidance but by encouraging ownership of their work.

School leaders were viewed as empowering, respectful, and supportive. Educators at many of the schools consistently described their school leaders as empowering, respectful, and supportive (table B9 in appendix B). The educators indicated that their school leaders granted teachers great autonomy in the classroom and did not "micromanage." Teachers and administrators at four schools said that their school leaders encouraged risk-taking, creativity, and initiative inside and outside the classroom. Teachers could try new approaches, some of these educators suggested, because they knew that their leaders would appreciate and support their efforts even if the efforts were not completely successful.

Respectful leadership was another common theme at most of the schools. Leaders showed respect toward their staff by listening to and soliciting

teachers' opinions. Leaders also respected teachers by treating them as equals.

Teachers at many of the schools portrayed their leaders as extremely supportive and nurturing. Leaders provided this support by working hard to find money, staff, and professional development opportunities to help teachers perform their jobs well. The Beech principal added a second math coach to support the large staff and secured funding for teachers to design their own math assessments. The principal at Maple Elementary School set up the school schedule to support teacher collaboration in professional learning communities and encouraged staff to attend conferences. A special educator at Willow School noted that administrators encouraged new ideas and helped teachers obtain the resources they needed to bring ideas to life. Leaders at Redwood and Aspen Elementary Schools were described as approachable and available to listen to teachers' concerns and offer their advice. A new special educator described Cedar Elementary School as "a very nurturing place to work," where leaders welcome new staff and make efforts to help teachers resolve questions and issues.

School culture. Teachers and administrators frequently used common descriptors to characterize relations among staff members and between staff and students. They described their schools as collegial organizations with high levels of mutual support, dedicated teachers, and a sense of shared responsibility for the success of all students—characteristics that University of Massachusetts Donahue (2007) finds in high-performing schools. Administrators and teachers at the six schools appeared to be working hard to create inclusive environments for students with disabilities while holding all students to the same high standards. In the eyes of many teachers these schools were providing the safe and stable environments necessary to support student learning.

Teachers and administrators frequently described their schools as collegial organizations with high levels of mutual support, dedicated teachers, and a sense of shared responsibility for the success of all students

At all six schools teachers described collegial and supportive staff cultures that may promote higher levels of risk-taking and job satisfaction among staff. Teachers at every school described their fellow staff members as a "family" or a "community" (see tables B10 and B19). In the words of a special educator at Maple Elementary School, "The teachers, the quality of teachers, and the community—we're like one big family on personal levels and school levels, which helps us build that collaboration for the kids." General and special educators collaborated closely, and many staff members viewed their colleagues as friends.

At every school staff members also described their colleagues as extremely supportive and helpful team players. At Cedar Elementary School a special educator described the staff as a team, noting "we all can share resources and ideas and work together." A special educator at Maple Elementary School echoed this description: "We have a lot of great teachers here who will bend over backwards and do anything for anybody to really help out." The supportive culture helps many teachers feel comfortable asking colleagues questions about how to help a struggling student or teach a particular math topic. Because teachers know they will not be judged by their colleagues or by the math leaders at their school, they are more willing to take risks in the classroom to improve their instruction. As a special educator at Willow School explained, "There is a freedom to try new things . . . to share your strengths and your weaknesses. . . . There is a level of comfort. There is just a sense of 'we're all in this experience together.'"

Out of this supportive culture emerged the high level of respect and admiration staff members held for one another. A general educator at Redwood Elementary School explained that teachers feel this respect because they see their colleagues' dedication and hard work. As described by teachers in several schools, the commitment that teachers display is accompanied by flexibility and willingness to "go above and beyond" to do whatever it takes to serve students' needs (table B18 in appendix B).

Within these collegial and creative environments teachers at several schools expressed contentment with their work. One general educator at Aspen said, "Everyone seems to get along. . . . I look forward to coming to work everyday." Contentment among at least some staff members may contribute to high levels of teacher retention at several of the schools. In the words of one of the math coaches at inner-city Beech, "We have longevity here—and longevity says a lot."

Staff cultures stressed shared ownership, high expectations, and nurturing of all students. A refrain heard across several schools was the shared accountability teachers felt for the success of all students in their school. A special educator at Maple Elementary School said that her fellow teachers "view every child here as one of their kids." A special educator at Willow School said that "everybody has all the kids." An assistant principal at Redwood Elementary School portrayed the teachers at his school as "treating the children as everybody's children or all of our students" (tables B11 and B19).

The shared ownership several teachers described reflects a philosophy of inclusion. The inclusive orientation of school staff was reflected in the fact that almost all schools had inclusion classrooms. Inclusive cultures may have helped to promote close relationships between staff and students. The math leader at Cedar Elementary School reported having known the vast majority of the school's students since they entered the school. At Beech Elementary School, which educates more than 1,200 students, a special educator reported that one of the assistant principals knows the name of every child with a disability in the school.

At least one teacher or administrator at Redwood, Aspen, Maple, Beech, and Willow schools said that staff members set the same academic and behavioral standards for all students, both general education and students with disabilities. To help students reach these high standards, the schools provided academic support and encouragement. One general educator at Cedar Elementary School described her approach as "strict but nurturing."

Several educators said that the nurturing staff, basic services, and consistent classroom routines in their schools created settings that in many cases were more stable than students' home environments

Many schools were described as safe and stable environments that were conducive to learning and promoted peer acceptance among all students. Creating a safe school environment has been identified as a key factor for improving student learning (Marzano 2003). Several educators said that the nurturing staff, basic services, and consistent classroom routines in their schools created settings that in many cases were more stable than students' home environments (table B20). The special education administrator at Redwood Elementary School explained that teachers at her school provided a great deal of support because "many of our students are very needy and really are seeking out attention and love and guidance . . . beyond just the academic piece." Because several of the schools serve students who not only have disabilities but also come from disadvantaged economic backgrounds, their schools need to offer basic services and supports that other schools might not need to provide. As a special educator at Redwood noted, "[We can't assume that] of course they're going to feel safe and of course they're going to have shelter and of course they're going to have food [outside of school]. . . . [Students can't learn unless we] make sure they're eating breakfast."

Within these stable, supportive, and inclusive environments several teachers and administrators said that students with disabilities are accepted by their peers. An administrator at Redwood Elementary School described his perceptions of student relations in an integrated classroom: "I don't think that the general education kids know who the special kids are or vice versa. I think it's just one family." At Aspen Elementary School a general educator remarked, "There are so many different ways that students are getting help that I don't think the ones who are getting help feel different or isolated." Every classroom at Willow School contained students with disabilities. According to a special educator at the school, students "treat

each other so nicely because they've been in school with, say, an autistic kid since kindergarten, and they all love him in 6th grade."

Strongest practices and challenges at the six schools

Each of the case studies later in this report describes practices staff members perceived to be their schools' strongest. The following sections describe these practices as well as the most common challenges teachers and staff face in improving math learning for students with disabilities and other struggling learners.

Common school strengths. The six schools were nominated by education leaders because of specific practices the schools had adopted:

- A math leader who supports students and teachers (Cedar).
- Integrated classrooms and multiple math support services (Redwood).
- Full-scale adoption of professional learning communities (Maple).
- A Response to Intervention program for the primary grades (Aspen).
- In-house math coaches and multiple support services (Beech).
- The pairing of middle school math teachers and elementary teachers (Willow).

Informal encouragement from peers and classroom creativity may not be enough to promote sustained improvements—formal schoolwide collaborative structures may be necessary to truly affect student outcomes

Many other strengths emerged during the interviews and observations at each school. Several common strengths also emerged (table B22 in appendix B):

• *A collaborative staff culture that provides staff members with ongoing, in-house professional development.* Supportive staff relationships allow teachers to feel comfortable revealing weaknesses and taking risks with their instruction (table B19). Although important, informal encouragement from peers and classroom creativity may not be enough to promote sustained improvements in teaching and learning. Formal schoolwide collaborative structures may be necessary to boost and maintain the types of classroom practice that can truly affect student outcomes. In the opinion of a special educator at Maple Elementary School:

Everyone has to get on the same page curriculum-wise. . . . Personal creativity is great, but it doesn't necessarily benefit the kids. . . . I think the major problem that could make schools unsuccessful is if you have students come in, you close your door, and you're in your own little world. That's not how it is here. . . . [You need] to have time scheduled into your day [for] that collaboration time.

Based on the insights of this teacher, collaboration may have to be systemic to promote professional growth for teachers across the whole organization and to support widespread student achievement.

- *High-quality staff.*
- *The use of a variety of instructional strategies to meet individual student needs.* Staff members at every school described efforts to provide more individualized support to students by using small-group instruction, lowering student–teacher ratios, and tailoring curriculum lessons and activities to meet student needs. Teachers at Redwood, Aspen, and Beech (schools with full-time general and special educator coteachers in their inclusion classrooms) described many ways that inclusion classrooms improve instruction for students with disabilities and other struggling learners (table B21). Teachers at all six schools also advocated using peer teaching and increasing math instruction time by integrating

math throughout the school day or providing additional opportunities for math practice and review.

- *Significant math support services.* Cedar, Redwood, Aspen, and Beech Elementary Schools provide an array of formal out-of-class math support services and programs to struggling learners. Multiple educators at Cedar, Aspen, and Beech described these services as their strongest practice.

- *School leaders who are strong and supportive and encourage teachers to grow and give their best efforts to students and the school as a whole.* Similar leadership characteristics across the schools point to the potential importance of systemic and schoolwide factors for learning by all students in any academic subject.

Common school challenges. Educators at the case study schools described similar challenges in improving math education for students with disabilities and other struggling learners (table B23 in appendix B):

- *Insufficient staffing and time for student math support and instruction.* Educators also cited the difficulty of boosting math learning among students with disabilities within allotted math periods and the hours of the school day. Educators at Cedar Elementary School felt pressure to keep up with what they said was a fast-paced curriculum calendar for struggling learners; teachers at Maple Elementary School believed that it was harder to integrate math learning into other academic subjects after a new, time-intensive English language arts program was introduced. Scheduling out-of-class math support services during the school day was cited as a common challenge across the six schools.

- *Inadequate math content knowledge among teachers.* Teachers' math professional development needs are often greater than can be served by a single in-house math leader.

Educators at the case study schools described similar challenges in improving math education for students with disabilities and other struggling learners

- *Lack of math assessments and interventions for students with disabilities and other struggling learners.* Some administrators lamented the lack of diagnostic and support tools for math similar to those available for English language arts. The lack of tools hampered administrators' abilities to confidently launch early math intervention programs.

- *Inherent difficulties of raising achievement levels of students with disabilities.* Many students with disabilities are far behind their grade-level peers. A few teachers noted that in classrooms with students displaying a variety of learning or other needs it can be hard to fully serve every child—even with more teachers in the classroom or smaller class sizes. Some teachers noted how difficult it can be to "reach the toughest kids" even after they "try everything." One teacher described how difficult it can be "to get strugglers to talk" and to participate in general education classes so they do not feel left out. Other teachers noted the difficulty of harmonizing the pace of students with disabilities and other struggling learners with that of other students in the general curriculum without more staff or support.

- *Inherent difficulties of raising achievement among students with high and often multiple needs.* At all three urban schools and one of the rural schools (Maple) many of the students came from low-income, highly mobile families. Many students with disabilities therefore came to school not only with learning difficulties but also with a variety of unmet physical and psychological needs. Some schools provided a variety of social services, such as breakfast and lunch programs

and on-site health clinics. Schools were unable to address all of students' complex needs to raise their readiness to learn, however. High student mobility, for example, makes learning difficult both for the student who changes schools as well as for the rest of the students in the class, who must adjust to a frequently changing set of classmates. Many teachers noted that raising student achievement was much more difficult without parental involvement, which was often lacking. The issues raised by these educators were consistent with research on the importance of parent and community involvement and on the many challenges faced by urban, rural, and high-need schools (Marzano 2003; Voltz and Fore 2006; Mitchem, Kossar, and Ludlow 2006).

Key findings from the cross-case analysis

Two salient findings emerged from the cross-case analysis, and several hypotheses can be made about relations among practices.

In-house math leaders played a key role. All schools had formal or informal in-house math leaders who played key roles in their schools' approach to improving math learning, providing support to both general and special educators.

The three urban schools had formal math leaders who supported teachers and students. The Redwood math specialist and the Beech math coaches worked primarily with teachers, teaching model lessons, providing professional development, and supporting curriculum implementation and pacing. At Cedar Elementary School the math lead teacher provided direct services to students and support to teachers, a combination that had several benefits. The math lead teacher's direct experience working with struggling students gave her useful information to share with teachers at planning meetings and also helped her earn the teachers' respect. In addition, struggling students benefited from instruction from the school's strongest math teacher.

All schools had formal or informal in-house math leaders who played key roles in their schools' approach to improving math learning, providing support to both general and special educators

Having math leaders provide support to both teachers and students may not work well in all school contexts. For instance, because Redwood and Beech Elementary Schools were very large schools, administrators may have had their math leaders focus on teacher support. The math coach position at Beech Elementary School was created to support teachers in implementing the math curriculum and the workshop model. These examples raise questions for future research about the types of roles math leaders can play in different school contexts and how these roles may affect teacher and student outcomes.

Three schools had informal math leaders—teachers whose knowledge and enthusiasm for math made them invaluable resources for their colleagues. Although their primary responsibilities involved teaching students, these informal leaders supported teachers in several ways: serving as the resource person for questions about math content and curriculum, sharing math resources and activities, providing professional development, and working with a few teachers in their classrooms. Although these teachers had no official position as math leaders, administrators and teachers appeared to recognize, respect, and capitalize on their expertise. Because the schools did not have formal math leader positions, the informal support teachers were receiving could disappear if these math leaders were to leave. This issue raises questions about how schools can nurture teachers to become informal math leaders and how schools support and use the strengths of their informal leaders.

Math leaders at all six schools played a systemic role in their schools' efforts to improve math learning. They made contributions in multiple areas, including math instruction, support and interventions, and professional development. By working across practice areas, they helped their schools build coherent approaches to math education for all students with disabilities and other

struggling learners. At Cedar Elementary School, for example, the math leader used assessment results to identify struggling students, provided these students with math support services, collaborated with the students' classroom teachers to plan lessons, and offered professional development on math topics that were difficult for students on the assessments. Her multifaceted role enabled her to create a unified set of practices to serve struggling learners in math.

The findings about the positive contributions of the math leaders are consistent with those of other studies. The University of Massachusetts Donahue report (2007, p. 22) on urban schools finds that "instructional coaches, identified by a range of titles, have perhaps the broadest impact on instructional design and delivery." The authors suggest that the coaches were able to lead instruction and collaborate with teachers more fully when they did not supervise the teachers. They also note the importance of hiring qualified candidates for the positions and deploying them effectively.

This study finds that the roles of the formal math leaders are consistent with the "lead teacher model"—one of the two main models described by Reys and Fenell (2003). None of the schools was using the specialized teaching assignment model, in which some elementary school teachers teach math exclusively instead of all subject areas. More research is needed about the prevalence of different models and how they affect math teaching and learning.

Several schoolwide practices benefited all students. Educators identified a variety of practices as major strengths of their school's approach to improving math learning for students with disabilities and other struggling learners. Strengths included high-quality staff, accessible instructional practices, and numerous math support services—practices that provide direct instruction and support to students. Surprisingly, educators also consistently identified practices that have an indirect relationship with student learning, have schoolwide reach, and are not specific to students with disabilities. These strengths include a strong collaborative culture, supportive leaders, and in-house professional development from math leaders and other teacher colleagues. These practices provide support to all teachers in a school, improve their working environment, and help create a school climate conducive to student learning.

Strengths of school approaches to improving math learning for students with disabilities and other struggling learners included high-quality staff, accessible instructional practices, and numerous math support services—practices that provide direct instruction and support to students

Echoing findings from University of Massachusetts Donahue (2004) and Nagle et al. (2006), teachers and administrators at the six case study schools emphasized the importance of offering flexible, varied services to support students with disabilities and other struggling learners, creating a culture of high standards for all students, maintaining high levels of collaboration among staff, and providing strong school leadership. High student expectations, extensive staff collaboration, and empowering leadership are also cited as characteristics of high-performing schools in general (Shannon and Blysma 2007; University of Massachusetts Donahue 2007).

Specific practices in targeted areas (such as math support services and interventions) are important for meeting the needs of students with disabilities and other struggling learners. The teachers and administrators interviewed also suggested that certain schoolwide practices (like extensive teacher collaboration) that aim to benefit learning among all students in all subjects may play a critical role in improving math achievement among students with disabilities and struggling learners. The comments of these educators may help explain the recent finding that the achievement of students with disabilities is highly correlated with the achievement of general education students within the same school (Malmgren, McLaughlin, and Nolet 2006). Schoolwide practices that fuel higher achievement among the broader population

of general education students in a school may provide a necessary foundation for raising achievement among students with disabilities and other struggling learners.

Many questions remain about what kinds of practices, schoolwide and targeted, are needed to improve math achievement for students with disabilities and other struggling learners. This study focuses on schools with medium- to high-need student populations; it is possible that schoolwide practices may be particularly important for student achievement in schools with higher need levels. More research is required to explore the relative importance of schoolwide versus area-specific practices in schools of varying need levels.

Hypotheses about relationships among practices. The common strengths cited by educators across the six case study schools led to the formulation of preliminary hypotheses about how different school practices improve learning for students with disabilities, other struggling learners, and perhaps all learners. These hypotheses include the following:

- Strong school leadership promotes teacher autonomy, empowerment in the classroom, risk-taking with instruction, and greater teacher job satisfaction.

- Strong school leadership promotes professional development opportunities for teachers by hiring in-house content and instruction experts and creating collaborative structures, such as common planning time or coteaching arrangements.

- Formal collaborative practices, such as regular staff meetings or professional learning communities, promote staff exchanges of teaching strategies and opportunities for classroom collaboration or peer consultation. They also provide opportunities for teachers to collaborate in planning assessments, analyzing assessment data, and coordinating support and intervention services.

- Informal collaborative cultures develop through formal collaborative meetings, encouragement from leadership, and external factors, such as location in a more isolated rural community.

- Formal and informal collaboration among teachers promotes sharing of weaknesses and strengths, willingness to take risks with instruction, development of new teaching strategies, and group discussion that may lead to refinement and improvement of teaching strategies.

- Formal and informal collaboration among teachers promotes positive staff relationships, mutual respect, supportive working conditions, and greater teacher job satisfaction.

- Greater teacher job satisfaction promotes greater teacher retention and the development of instructional expertise and of more teachers who can serve as resources for other teachers.

- Skilled teachers and the ongoing testing and refinement of teaching strategies may lead to instruction that promotes improved student outcomes.

The teachers and administrators interviewed suggested that certain schoolwide practices that aim to benefit learning among all students in all subjects may play a critical role in improving math achievement among students with disabilities and struggling learners

These hypotheses represent only one path that may lead from practices at the leadership level to practices at the teacher level and ultimately to improved student outcomes. The chain of events proposed above omits the important roles that school structures and resources, such as high-quality staff, the presence of a math specialist, and the availability of math support programs, may play in promoting math achievement among students with disabilities and other struggling learners. The hypotheses also omit potentially important variables (such as the role of parental involvement or district policy) that could not be collected in this study.

The remainder of this report describes practices at the six case study schools. It does not provide evidence that any of the practices are effective or ineffective in raising math achievement. Rather, it offers a window into practices that some exemplary schools have adopted to promote math achievement among students with special needs. The case studies may provide educators and researchers with strategies to consider and examine further as they work to improve the math teaching and learning of students with disabilities and other struggling learners.

OVERVIEW OF THE CASE STUDY SCHOOLS

Each case study contains four components:

- School background information, including student demographics and classroom placement for students with disabilities and other struggling learners.
- A brief overview of the school's practices in the seven areas of focus of this study.
- Detailed descriptions of three or four practices that staff and administrators identified as particularly strong or representative of their school's approach to improving math learning for general education students and students with disabilities and other struggling learners. One notable practice at each school is highlighted.
- A discussion of the school's challenges, as identified by its administrators and staff.

The case studies are presented in an order that emphasizes contrasts in practices (table 1). Cedar Elementary School is presented first to illustrate the various roles that a schoolwide math lead teacher can play. Redwood Elementary School is presented next to show how strong leadership and consistent schoolwide instructional practices

TABLE 1
Overview of the six case study schools, 2006/07

School and setting	Highlighted practice
Cedar Elementary School Massachusetts Urban	Math leader was involved in all aspects of math education, including teaching students; supporting teachers; and doing curriculum planning, schoolwide professional development, and assessment analysis.
Redwood Elementary School New York Urban	School leadership gave teachers the freedom and responsibility to teach creatively. Staff members praised principal for his leadership, dedication to teachers and students, and multifaceted school reform efforts that have contributed to improvements in math teaching and learning.
Maple Elementary School New York Rural	Teachers met weekly in professional learning communities to share instructional strategies and brainstorm ways to help struggling math learners. Full-day district meetings were held every month to align curriculum with standards, develop assessments, and analyze student data.
Aspen Elementary School Massachusetts Suburban	A variety of math support services were provided in inclusion and pull-out settings. Students with language-related learning disabilities were placed in side-by-side classrooms with their general education peers and received in-class support. The school also provided Title I math services, a special education resource room, and a Response to Intervention program.
Beech Elementary School New York Urban	Math supports and interventions were available before, during, and after school. Each grade had a collaborative class in which students with disabilities were taught by full-time coteaching pairs of general and special educators. The school provided extensive intervention services for struggling students.
Willow School Massachusetts Rural	Middle school math teachers were paired with upper elementary teachers in a teacher-generated initiative to provide twice-weekly classroom support in math to elementary teachers. Middle school teachers provided math content expertise. They worked alongside the classroom teacher with small groups of struggling learners and led whole-class instruction.

Source: Authors' analysis based on classroom observations and interviews with teachers and administrators.

can promote improvement in the specific areas of math teaching and learning for students with disabilities and struggling learners. Maple Elementary School illustrates how professional development in math education can be achieved for both general and special educators through schoolwide professional communities and teacher collaboration. Aspen and Beech Elementary Schools provide examples of schools with a wide variety of math support services for students and teachers, including early intervention in math for struggling learners and math coaching for both general and special educators. Willow School demonstrates a creative staffing arrangement that was devised to enhance teacher math professional development and classroom math instruction.

To protect the confidentiality of the schools, the research team assigned pseudonyms to schools and staff.

CEDAR ELEMENTARY SCHOOL: CREATING A VITAL HUB OF MATH SUPPORT

Staff members at Cedar Elementary School, located outside a large urban center in Massachusetts, cited a variety of school practices they believe aid math instruction. One practice was described as particularly important:

- *Having a math lead teacher who works with students and teachers.* This teacher teaches students who struggle in math and trains classroom teachers. The knowledge the teacher gains by working with both students and teachers informs her efforts to support classroom instruction, curriculum planning, and schoolwide professional development.

The knowledge the math lead teacher gains by working with both students and teachers informs her efforts to support classroom instruction, curriculum planning, and schoolwide professional development

Other practices highlighted by school staff include the following:

- *Regular student assessment to inform instruction and identify students in need of support,* including frequent classroom assessments and quarterly district tests.
- *A supportive school culture,* fostered by regularly scheduled common teacher planning periods, a dedicated staff, and an energetic new administration.

These practices are just part of Cedar's approach to math education (table 2).

Overview of Cedar Elementary School

Cedar Elementary School was one of four elementary schools in a small, densely populated, high-poverty city near a large urban center in Massachusetts. The majority of adults in the city had only a high school education, and many families live below the poverty line. All four elementary schools are housed in a single 10-year-old central complex.

Cedar was part of a school district that had been led by a local university since 1988. This partnership has been credited with many district improvements, including building the complex that houses Cedar, establishing standards-based education in all subject areas in all grades (PreK–12), and developing a comprehensive professional development program. The partnership agreement expired at the end of 2007/08.

At the time of the study Cedar served about 430 students in grades 1–4. Most of its students were low income (91 percent), and 71 percent were Hispanic. Most students were proficient in English by state standards, but many (73 percent) came from homes in which English was not the first language. At 12 percent the proportion of students with disabilities is below the Massachusetts state average of 17 percent (table 3).

The principal and assistant principal (both in their first year at the school) headed a staff of 35 teachers, all licensed and highly qualified according to state standards (table 4). The school had three special educators, one of whom worked in the

TABLE 2
Snapshot of practices at Cedar Elementary School, 2006/07

Practice	Description
Classroom math instruction	Math instruction time: 60 minutes a day
	Curriculum: Scott Foresman-Addison Wesley Mathematics implemented for two years; district curriculum aligned with Massachusetts math curriculum frameworks
	Placement of students with disabilities: separate classroom with special educator and paraprofessional and general education classroom with pull-out services from resource room special educator
	Other: pacing calendar; accessible instruction (strategies include multimodal approaches, manipulatives, small group work, and peer tutoring)
Math supports and interventions	Math lead teacher, who provides support to students and teachers, including direct instruction to struggling students, some coteaching, and support for curriculum implementation and planning*
	Math resource room, where math leader provides pull-out support for all struggling learners (including students with disabilities)
	Special education resource room, where some students with Individualized Education Plans receive math instruction
	Before- and after-school math programs, lunch math group, February and April vacation and summer school math programs
Assessment	District math assessments, administered quarterly, analyzed by math leader*
	Ongoing chapter assessments from math curriculum, analyzed by classroom teachers
	Preparation for Massachusetts Comprehensive Assessment System (MCAS; math leader prepares material for classroom teachers and provides direct support to students)
	Analysis of MCAS results (math leader analyzes MCAS data to identify weak areas and hone instruction)
	MCAS alternative assessment portfolios, prepared by special educators and math leader
Collaboration among teachers	Common planning time: grade-level teachers have same preparation time daily; math leader meets with grade-level teams; math leader meets with new general educators every other week
	Special education staff meets every other week with principal and assistant principal
	Math leader provides materials, models lessons, offers teaching strategies, and coteaches
Professional development	In-house professional development in math provided by math leader, who supports teachers in the classroom and facilitates workshops on math topics and instructional strategies during faculty meetings; out-of-school professional development provided by district and university partner includes workshops on a variety of topics
Leadership	School administrators: principal and vice principal observe all teachers throughout year; principal chairs instructional support team, vice principal oversees special education
	Math and special education are high priorities for principal
	Leadership goals include greater inclusion of students with disabilities in general education classrooms
School culture	Supportive school culture, fostered by regular staff and grade-level meetings (including weekly common planning), dedicated staff that works to create stable environment with high expectations for students, and mentors for new teachers*

* Practices considered central to school's approach to improving math learning.

Source: Authors' compilation based on primary documents gathered at the school, classroom observations, and interviews with teachers and administrators; see appendix A for details.

TABLE 3
Student demographics at Cedar Elementary School, 2006/07

Characteristic	Value
Grade span	1–4
Number of students enrolled	430
Average class size (students)	20–25
Percentage of students with disabilities (percent with Individualized Education Programs)	12
Percentage of students from low-income families[a]	91
Percentage of students of races other than White	88
Percentage of students with limited English proficiency	18
Percentage of students whose first language is not English	73
Attendance rate	96

a. The Massachusetts Department of Education defines a low-income student as one who is eligible for free or reduced-price lunch, receives Transitional Aid to Families benefits, or is eligible for food stamps.

Source: Authors' compilation based on data from Massachusetts Department of Education (2008) and interviews with the school principal; see appendix A for details.

TABLE 4
Staff and administration at Cedar Elementary School, 2006/07

Characteristic	Value
Staff	
Number of teachers	35
Student–teacher ratio	12.5 : 1
Percentage of teachers licensed in teaching assignment	100
Percentage of core academic teachers identified as highly qualified[a]	100
Percentage of teachers at school five or more years	16
Percentage of teachers at school less than five years	19
Number of special educators	3
Number of teaching assistants and paraprofessionals	8
Administration	
Number of years principal has been at school	1
Number of assistant principals	1
Number of years assistant principal has been at school	1

a. To be considered highly qualified, Massachusetts teachers must possess a valid Massachusetts teaching license at either the preliminary, initial, or professional level (formally known as the provisional, provisional with advanced standing, and standard level) and demonstrate subject matter competency in the areas they teach.

Source: Authors' compilation based on school profile data from the Massachusetts Department of Education(2008), primary documents gathered at the school, and interviews with the principal; see appendix A for details.

school's special education resource room and two who taught in the school's two separate special education classrooms. Teacher-certified paraprofessionals supported the special educators in these classrooms.

Classroom placement for students with disabilities and other struggling learners

Cedar placed students with disabilities into one of two classroom settings. The first setting was a "substantially separate"[5] special education classroom, a model used by all elementary schools in Cedar's district. Each of Cedar's two substantially separate classrooms—one for grades 1 and 2 and one for grades 3 and 4—was staffed by a special educator and a paraprofessional. The second setting was a general education classroom, staffed by general educators, with pull-out services provided in the special education resource room. The school's instructional support team—principal, assistant principal, math leader, social worker, and grade-level teachers—met regularly to evaluate each student's need for special services, decide appropriate placement, order support strategies, evaluate the results, and order further evaluation if necessary. These students and other struggling math learners were also eligible to receive a variety of math support services (table 5).

Highlighted practices at Cedar Elementary School

Three strengths were consistently highlighted during interviews with Cedar staff: the work of the math lead teacher, the ongoing assessment and analysis of results, and the supportive school culture.

TABLE 5
Instructional settings and services at Cedar Elementary School, 2006/07

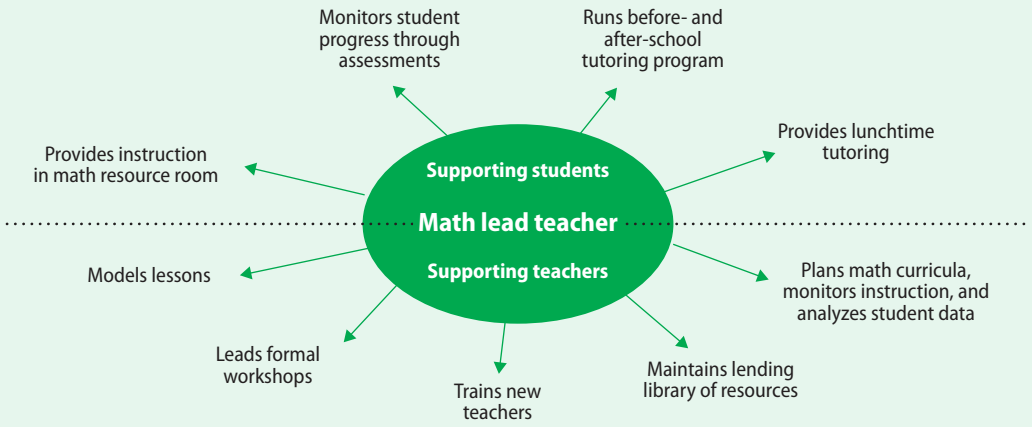
Instructional setting and services	Staffing
Primary math instruction for students with disabilities	
Substantially separate special education classroom (grades 1 and 2; 3 and 4)	Special educators, paraprofessionals
General education classroom (grades 1–4)	General educators, math lead teacher (pull-out), special educators (pull-out)
Math support for students with disabilities and other struggling learners	
Math resource room	Math lead teacher
Special education resource room	Special educator
Before-school tutoring	Math lead teacher and general educators
After-school tutoring	General educators
Lunch tutoring	Math lead teacher
Vacation tutoring	Math lead teacher and general educators

Source: Authors' compilation based on primary documents gathered at the school, classroom observations, and interviews with teachers and administrators; see appendix A for details.

The hub of math support: the math lead teacher. The math lead position was introduced in the district by the university-led administration. After spending time at the district's schools university professors selected a classroom teacher at Cedar Elementary School to be the initial math leader for the district. After substantial training Mrs. Green began working as the math leader, visiting schools in the district to model lessons. Over time a math leader was placed in each of the district's four elementary schools, with Mrs. Green remaining at Cedar, where she worked with both students and teachers (figure 1). According to teachers, Mrs. Green and the roles she played were critical in improving the math learning of students with disabilities and other struggling learners. She was noted for her hard work, extensive knowledge of math, dedication to students, and ability to coach teachers.

Support for students. The math leader provided direct instruction in the math resource room, offered additional math help during before-school classes and lunch-period tutoring sessions, and monitored student progress through student assessments. She maintained comprehensive records on the math achievement of every student at Cedar. In the past the math leader also helped conduct tutoring sessions after school. She had

FIGURE 1
Multiple roles of the math lead teacher at Cedar Elementary School, 2006/07



Source: Authors' compilation based on primary documents gathered at the school, classroom observations, and interviews with teachers and administrators; see appendix A for details.

recently relinquished this role to other general education teachers, however.

The math leader provided math instruction to groups of students in grades 2–4 in the math resource room, which was equipped with manipulatives and other math resources. As the school's strongest math teacher, the math leader worked with students who were weakest in math. According to a Cedar teacher, students looked forward to working with Mrs. Green and envied those who did. The teacher suggested that the school as a whole has encouraged this positive view, by telling students, "[Mrs. Green], she's a fun lady. You get to go and have fun with her."

Students may have indeed felt that it was a privilege to be in the math resource room, which was clean and bright: Mrs. Green had created an environment that was welcoming, active, and well organized. And she used a variety of strategies to build students' understanding of math, as illustrated in the following vignette.

A group of students with disabilities and other struggling learners from different 4th grade classrooms is seated at tables in the math resource room. Bookshelves are filled with containers of brightly colored manipulatives and other math materials. A poster shows math in the home, store, and neighborhood. The bulletin board is covered with images of feet and proclaims "3rd and 4th graders are on the right foot for MCAS." Each foot has an individual student's goals for the upcoming test.

While they wait for more classmates to arrive, students work on a warm-up activity on math fact families. One student tells the math leader about a crisis at home. The math leader listens carefully and asks the student if he would like to talk with the school's social worker. The student declines and remains in his seat, seemingly calmed.

The math lead teacher created an environment that was welcoming, active, and well organized, and she used a variety of strategies to build students' understanding of math

The math leader introduces the lesson on probability. She asks students if they are familiar with the word probably. *She holds up a piece of construction paper with the word* probability *and has the students repeat the word several times. To introduce the concept, she uses brightly colored construction paper and asks students what the probability is that she will pick a specific color. She adds colors, asking questions and keeping the students engaged and then continues with spinners and coins.*

Next, she explains the day's main activity: a penny toss. Each student gets a penny and a recording sheet. After explaining the directions, the math leader asks the students to predict the result—more heads or tails—of tossing the penny 20 times. She asks students to talk about their thinking with others at their table and then tell the group their predictions.

After students finish tossing the coins, they come to the front of the classroom to write their results on chart paper. Once all tallies are recorded, one student helps at the board as the math leader guides the class through adding up the numbers for heads. Students work on the same problems at their desks. She encourages them to ask one another for help.

When they have finished adding up the heads, she calls on a student to help with tails. The student seems hesitant, so she offers a choice of adding or reading off the numbers and then asks for a volunteer to take the other job. After both heads and tails are totaled, students compare the results with their original predictions. The lesson ends with a short activity on vocabulary terms for describing different probabilities.

Throughout the lesson students are on-task and engaged in learning key concepts in the probability strand. To an outside observer, it is not apparent that this is a class of struggling math learners.

Throughout the year Mrs. Green conducted lessons in the math resource room similar to the one just described. At the beginning of the year she supplemented regular math lessons by meeting three times a week with students with disabilities

and other struggling learners in grades 2–4. Students were grouped first by grade level and then in smaller groups. Groups were flexible. Some students could join the group for a few weeks to work on one area, while others could work with Mrs. Green throughout the year. Starting in January, she worked only with students in grades 3 and 4, preparing them for the MCAS test in May. She selected students—from both the general education and the substantially separate special education classroom—whom she felt were close to passing the MCAS. They came to the room for support during their regular math instruction time three days a week.

The math leader also coordinated a variety of additional math programs for students:

- *Before-school tutoring for students with disabilities and other struggling learners in grades 3 and 4.* These sessions were taught by the math leader (twice a week for 3rd graders, three days a week for 4th graders). There was no set curriculum and content was based on the needs of the students. Although designed for a targeted number of struggling learners, all were welcomed by the math leader: "I open my door to anyone that wants to come in . . . whether they're on that attendance list or not, I don't care."

- *Informal lunch-time support for 4th graders.* Based on her availability, the math leader reviews newly introduced concepts with students during their lunch period.

- *Additional before- and after-school classes for grades 2–4.* Students attended classes twice a week in the morning or afternoon.

- *District programs during spring and summer vacations for grades 2–4.*

Mrs. Green's dedication and her direct work with students were underscored as a strength of the school. According to one special educator, "We have a math lead teacher who's allowed to—willing to—take children before school, after school; any down time they have in the day . . . to work and practice the skills they need for the MCAS." Mrs. Green noted, "I think you need one person in place who is really dedicated to the program, who really wants to know the kids, who wants to see the kids' success."

At the beginning of the year the math lead teacher supplemented regular math lessons by meeting three times a week with students with disabilities and other struggling learners in grades 2–4

Support for teachers. Mrs. Green's work with teachers includes analyzing student data, planning curricula, discussing strategies for students with disabilities and other struggling learners, and providing math resources and direct professional development. She models math lessons, leads formal workshops, holds weekly meetings with teachers, and spends time at the beginning of the year orienting new teachers to the curriculum. Ongoing contact with students and teachers enhances her ability to build a strong math program. Many teachers cited the math leader's support of teachers as one of Cedar's strengths. As one general educator noted, "We always have the math lead teacher for any help. She's right there for us. She's got a wealth of stuff."

The math leader worked with teachers in their classrooms, modeling lessons, offering strategies, and coteaching (a role similar to that of math coaches in many districts). She believed she could offer important assistance because her role was not evaluative:

> *I'm a colleague, and I do no evaluation. I think that they can come to me and really genuinely ask for advice, and they know it's not going to go any further than that. I'm very nonthreatening. . . . And if they feel they need help, I can go in and model lessons or demonstrate—just be there for them as a resource.*

At the beginning of the year Mrs. Green supported new general educators by meeting with them twice

a month. She introduced the curriculum, focusing on the framework, scope, and sequence, and made sure teachers were familiar with the use of manipulatives. During the year this study was conducted, she also met weekly with the new special educator in the substantially separate classroom for grades 3 and 4. Together they worked on adapting the general education math curriculum to meet the needs of students with disabilities.

Once a week Mrs. Green held meetings with each grade-level team and the new special educator. Teachers pointed to such meetings as important to the school's success: "A strength for us is our collaboration, because we meet weekly on what we're doing, what's working, what's not working. Our math lead teacher gives us materials that can help." During these meetings Mrs. Green discussed the progress of students receiving instruction in the math resource room, offered information about districtwide quarterly assessments, and identified which topics need greater attention in the classroom. The meetings also allowed her to check the pacing of the curriculum and make adjustments.

During faculty meetings Mrs. Green ran workshops on math topics, instructional strategies, and the math curriculum. Twice a year she held special meetings on the school's MCAS results. One teacher described the benefits of these meetings: "I think [the meetings] help us know what we're doing well and what we're not doing well. . . . Looking at those [MCAS scores] really helped us tailor our math instruction." These meetings were schoolwide so that all teachers (not only those whose students are taking the MCAS) learned about the MCAS concepts and gained a broader understanding of the math program and what skills should be taught in each grade.

Cedar Elementary School consistently used assessments to inform instruction—gathering data from districtwide quarterly assessments, yearly Massachusetts Comprehensive Assessment System tests, and formal and informal classroom assessments

In 2005/06 Cedar introduced a new math curriculum, accompanied by a detailed pacing calendar developed by the four math leaders in the district. The calendar was adjusted after the first year of implementation based on feedback from teachers. Every September teachers receive the calendar, which outlines when topics should be covered. During the school year the math leader was in and out of teachers' classrooms, providing support to help teachers keep up with the pacing schedule. As one teacher commented, "She's usually a step ahead of us. She'll write stuff for us, or say 'This is coming up. This is your third quarter. Make sure you review this. . . . You can spend less time on these two lessons—let's just teach the simplified version.'"

Regular student assessment to inform instruction. Cedar Elementary School consistently used assessments to inform instruction—gathering data from districtwide quarterly assessments, yearly MCAS tests, and formal and informal classroom assessments. Teachers used the results to tailor instruction and identify students who needed additional support. In the words of one teacher: "Our biggest strength, I think, is the [use of] ongoing assessments. . . . You can see who's getting the material and who isn't." Cedar staff viewed the school's frequent student assessments and performance analyses as beneficial tools they could use in planning instruction.

The math leaders from the four schools in the district helped develop quarterly assessments that were administered by classroom teachers. At Cedar Mrs. Green analyzed the results and produced detailed reports, which she shared with the school principal. Throughout the year she tracked information on student performance by classroom and topic, identifying students for placement in the math resource room or other support programs. She used the reports to tease out the source of problems—whether students do not understand a concept or were never taught it, for example—to guide curriculum planning.

Other assessments included a pretest at the beginning of the year, curriculum chapter tests, and various informal assessments, including observations of students. Except for the districtwide quarterly assessments, most classroom assessments

were graded and analyzed by classroom teachers, with support from Mrs. Green as needed.

All teachers met with Mrs. Green to discuss the school's yearly MCAS data. Teachers found these analyses of student MCAS performance very helpful in improving math teaching and learning. As one commented:

> *I think really understanding our data on the kids [is very useful]. We keep a lot of data—we go over the MCAS results and compare each question [with the state's results]. We know that our kids struggled last year in measurement . . . so we know that [it should be a focus] . . . this year.*

The math leader also played an important role in preparing students for the MCAS test by providing practice problems and intensive student support. Mrs. Green had created books of open-response and computation problems to familiarize students with the kinds of problems they would encounter on the test. (Open-response problems tend to challenge students because they contain multiple steps and involve showing and explaining work.) For grades 3 and 4 she used problems from past tests. For grade 2 students, who do not take the MCAS test, she designed her own problems. She provided these books to each student so that the books could be used for homework assignments throughout the year. She offered intensive support in the math resource room three days a week to students who, based on assessments, were on the border of passing the MCAS test. Cedar Elementary School also ran a vacation program, which placed strong emphasis on MCAS preparation. The program ran during both the February and April vacations. Students who were identified as low performers in math were invited to receive additional instruction Monday through Thursday mornings.

Some students with significant disabilities took the MCAS alternative assessment test (MCAS-alt). Mrs. Green worked with the special educator of the substantially separate grades 3 and 4 classrooms to prepare extensive assessment portfolios of student work to demonstrate performance on each math strand and show the student's progress in mastering various math skills and concepts.

The thriving math program at Cedar Elementary School resulted in part from strong administrative backing and organizational support

A supportive school culture. The thriving math program at Cedar Elementary School resulted in part from strong administrative backing and organizational support. This support made possible much of the flexibility and vigor of the program—from the math lead position to the many structures for math support, from ongoing collaboration to the use of assessments. Thus, two noteworthy aspects of the culture at Cedar were its collaborative staff and supportive leadership.

Dedicated and collaborative staff. Teachers spoke about Cedar Elementary School as a positive environment in which to work. Many noted the level of support that they received. As one new teacher said:

> *The support is really amazing here. . . . We meet as a team every week for literacy, every week for math. We have the literacy coach checking in. We have the math leader checking in. New teachers have mentors. . . . It's comforting, because we do deal with kids coming from a rough home life or . . . stressful situations, and it's nice to have that collaboration.*

Regularly scheduled meetings provided opportunities for collaboration. The school's three special educators met biweekly with the principal and assistant principal. Grade-level teachers had the same preparation time every day. They decided how often they wanted to meet (most teachers met weekly). During these meetings teachers often discussed instructional strategies and planned for upcoming math lessons. They valued this opportunity to learn from one another: "We have great teachers. And everybody listens to each other's ideas." A veteran general educator summarized her view of the school: "We always think it's like our second home."

Extending their collaborative outlook to their instruction, teachers at Cedar Elementary School employed multiple strategies to help different students succeed in math, including hands-on activities and manipulatives for visual and kinesthetic learners and peer learning. As one explained:

> *[We] do a lot of partner activities. I try to pair a high-performing student with someone that she can help. . . . [S]ometimes kids teach other kids in a way you wouldn't think of using. And they get it from their peers more than they get it from you.*

Their success was apparent in students' performance and interest levels. As the principal remarked, "The kids are still . . . so excited about what they're doing—they're asking all these questions. It's [been] an hour, and we're still doing math, and they're still motivated."

Students with disabilities were supported by a collaborative team of special educators. During math instruction in the upper elementary special education classroom the resource room teacher provided in-class help with small group work. Cedar's special educators tried a variety of approaches to reach all learning styles. As one explained, "I pretty much try everything. I try all kinds of approaches. I use a multimodal approach: hands-on, kinesthetic, visual, auditory. Whatever works."

In the substantially separate classrooms special educators were supported by paraprofessionals who are certified teachers. One teacher described the flexibility this affords: "I'm very fortunate to have a para—she's a certified teacher. So . . . she takes the 1st grade children for math, and I take the 2nd grade, so we can break the groups up. It works really well because they work on a totally different curriculum."

Cedar's staff and administration worked hard to create a stable environment for students—one in which students felt safe and encouraged—by creating routines and making students aware of expectations

Cedar's staff and administration worked hard to create a stable environment for students—one in which students felt safe and encouraged—by creating routines and making students aware of expectations. Teachers had a high level of respect for one another and provided mutual support. As the math leader explained:

> *I think the teachers in this building work extremely hard. They're so good. They're so dedicated. They love the children. And that's so important. And sometimes in some cases, this is the only stability the kids have. There's us. I can honestly tell you there are kids that would stay here every day until 6:00, 7:00 at night.*

In this very supportive environment all students were held to high standards. The math leader described the school attitude: "I think the bar is up there. The expectations are up there. They're all going to reach it. They're going to reach it at different times, but they will reach it. . . . And I think that they know it. And they feel proud."

The school also worked to connect learning at school with students' lives at home. Some teachers expressed concern that the level of parent involvement tended to be low, for a variety of reasons, including language and cultural issues. Many students came from homes in which English is not the primary language. Some families came from cultures in which there was little parent involvement in schools. So, to foster understanding Cedar held many activities for the community, including an open house in the fall to introduce parents to the school and its teachers.

Supportive leadership. Although Cedar had a new principal and assistant principal the year this study was conducted, the school had a long history of highly experienced leadership (the previous principal had been at the helm for 10 years). Continuing this legacy, the new principal brings years of administrative experience in other districts and a clearly defined vision for the school and its teachers. "Our job," she says, "it's what the kids need. We're here for them. I think that's really the motto of the school; teaching and learning happen for all students [based on] each student's learning style."

The principal, who was highly committed to special education, worked with both math and special educators to fulfill Cedar's mission of educating all children. She and the vice principal observed grades 1–3 classroom math lessons. Each administrator also supervised veteran teachers. The principal spent at least an hour in a classroom, because she believes it is important to observe all parts of the math lesson and how they work together. After her observation she met with the teacher to talk about the lesson. She asked for the teacher's opinion on how the lesson went and discussed strategies for improvement.

The math program was a priority for the principal. She checked in regularly with the math leader and served on the district's math committee, which addressed a variety of topics, such as curriculum implementation, the pacing calendar, and alignment with Massachusetts State frameworks. The principal chaired the school's instructional support team and the assistant principal tended to the administrative side of special education. They met biweekly with the special education staff.

The principal, who was highly committed to special education, worked with both math and special educators to fulfill Cedar's mission of educating all children

Remaining challenges

Cedar had made great strides in improving math learning for all its students. But teachers also cited challenges in trying to provide math instruction to all learners. These challenges included the following:

- *The pace of the district's pacing calendar is very quick.* Some teachers expressed frustration with the calendar, feeling that the pace is too fast and inflexible. One general educator said, "[We] would love to be able to teach one or two concepts a week and have the other times for more center-based [activities], where you can challenge your top kids and work with your low kids." One teacher suggested adding more time in the school day for teaching math to allow more flexibility and more opportunities to use available math resources.

- *Not enough support is available for grades 1 and 2.* Some grade 1 and 2 teachers believed that their students needed more math support. They noted that the extra resources allotted to prepare students in grades 3 and 4 for the MCAS meant decreased support for their students. Many teachers suggested adding a second math lead position to support students in grades 1 and 2.

- *Many parents are not involved in their children's education.* Many teachers noted the low level of parental involvement in their children's schoolwork. Teachers recognized that many parents work multiple jobs, limiting their availability to help with homework. In addition, some parents have limited knowledge of math. The school was addressing this issue through its extra layers of academic support for students, including vacation school programs and before- and after-school tutoring.

Looking forward

With a strong math program that was anchored by the school's math lead teacher, Cedar's principal was considering eliminating the substantially separate special education classrooms and including all students with disabilities and other struggling learners in general education classrooms. She was also developing different ways to address these students' academic needs. In moving forward, Cedar Elementary School was continuing to build on the strengths of its hard-working staff and administration, supportive culture, and use of assessments to continually guide and improve math instruction for all students.

REDWOOD ELEMENTARY SCHOOL: EMPOWERING LEADERSHIP TO DRIVE RENEWAL

Redwood Elementary School in western New York State has progressed from an extremely low-performing school to one that has received

widespread recognition for gains in student achievement. Staff members at this large, poor, urban school attributed enhanced math learning among students with disabilities and other struggling learners to multiple school practices. One practice was described as particularly important:

- *Leadership that empowers.* Redwood's principal, an experienced administrator, had worked to support and retain a talented and cooperative teaching staff. Faculty consistently praised his leadership, accessibility, trust in teachers' opinions, and dedication to teachers and students. Many staff members expressed deep appreciation for a school administration they felt gave them the freedom and responsibility to teach creatively and to the best of their abilities.

Other practices highlighted by school staff included the following:

- *A uniform teaching model,* adopted by the school in 2001/02 as part of a whole-school reform program developed by America's Choice.
- *Integrated classrooms and a continuum of services,* ranging from general education classrooms with in-class or pull-out support for students with mild disabilities to separate classrooms for students with severe disabilities.
- *Use of data to spur achievement,* led by the efforts of an assistant principal who oversaw all formal assessments and worked with the school's math specialist to analyze math test results, identify areas of student weakness, and set goals for student learning.

Redwood Elementary School progressed from an extremely low-performing school to one that has received widespread recognition for gains in student achievement

These practices were part of Redwood's approach to math education (table 6).

Overview of Redwood Elementary School

Redwood served almost 970 students in PreK–grade 6 in a disadvantaged urban setting in western New York State in 2006/07 (table 7). Many of its students were from poor families. Most participated in the school's free breakfast program, and 84 percent were eligible for free or reduced-price lunch. Some 68 percent of the students were Black, 26 percent Hispanic, 5 percent White, and 1 percent Asian. And about 21 percent of students (higher than the state average of 12 percent) qualified for special education services.

Redwood was run by a principal, three assistant principals, and an administrator of PreK and kindergarten programs (table 8). This team oversaw a veteran staff of teachers (88 percent of whom had been at the school more than five years), including 21 special educators. Supporting them were 30 teaching assistants, a math specialist, an English language arts specialist, academic intervention services providers, special service providers (such as speech pathologists and occupational therapists), and a full-time coordinator of services for students with disabilities. And a few years ago the school opened an on-site health center, operated by a regional health organization.

Classroom placement for students with disabilities

Redwood students with disabilities were placed in one of three settings:

- *A general education classroom,* where students with disabilities received either in-class or pull-out support from a special educator or resource room teacher. Based on their Individualized Education Programs, these students required less than 30 hours of special education services a week.
- *An integrated classroom,* led by a pair of full-time general and special educators, which contained an almost equal share of general and special education students. Based on their Individualized Education Programs, these students required 30 hours or 5 full days a week of special education services.

TABLE 6
Snapshot of practices at Redwood Elementary School, 2006/07

Practice	Description
Classroom math instruction	Math instruction time: 60 minutes a day Curriculum: Investigations (since 2005/06 school year) Placement of students with disabilities: general education classroom with in-class or pull-out support services, integrated classroom with general and special educators as coteachers, and substantially separate classroom taught by special educator Highly consistent structures and instructional practices throughout all grades, including use of workshop model for classroom instruction*
Math supports and interventions	Continuum of services for children with disabilities, including various classroom placements and in-class or pull-out support* Full-time math specialist, who supports teachers in all grades by providing materials, offering guidance on state standards, modeling lessons, and providing classroom help Saturday morning program open to all students
Assessment	Math assessments to guide instruction,* including: • Benchmark assessments in all grades at the start of the school year (grades 1 and 2: TerraNova math achievement test; grades 3–6: district-designed assessment) • Statewide math assessments to measure adequate yearly progress in grades 3–6 • Schoolwide analyses of student data to help teachers focus instruction • Ongoing classroom assessments throughout the year
Collaboration among teachers	Daily common planning time for most grade-level teachers; monthly grade-level meetings that include special educators Weekly staff meetings Support from a math specialist Full-time coteachers (general and special educators) in integrated classrooms
Professional development	In-house professional development provided by math specialist during staff and grade-level meetings Many opportunities for professional development provided by the district, including workshops and online courses
Leadership	Administration that teachers find supportive, open to their concerns, and willing to fight for resources they need* Supervision by each assistant principal of two grades and oversight over a particular education area (support services, schoolwide testing, and special subjects)
School culture	Collegial and mutually respectful culture, bolstered by supportive administration Dynamic principal who has been key player in turning school around by reinforcing positive attitude Dedicated staff that holds high expectations for all students

* Practice considered central to school's approach to improving math learning.

Source: Authors' compilation based on primary documents gathered at the school, classroom observations, and interviews with teachers and administrators; see appendix A for details.

TABLE 7
Student demographics at Redwood Elementary School, 2006/07

Characteristic	Value
Grade span	PreK–6
Number of students enrolled	970
Average class size (students)	20
Percentage of students with disabilities (percent with Individualized Education Programs)	21
Percentage of students eligible for free or reduced-price lunch	84
Percentage of students of races other than White	95
Percentage of students with limited English proficiency	11
Percentage of students whose first language is not English	—
Attendance rate (percent)	91

— is not available.

Source: Authors' compilation based on New York State Education Department (2006a) and interviews with the principal; see appendix A for details.

TABLE 8
Staff and administration at Redwood Elementary School, 2006/07

Characteristic	Value
Staff	
Number of teachers	91
Student–teacher ratio[a]	15 : 1
Percentage of core classes taught by highly qualified teachers[b]	97
Percentage of teachers with valid teaching certificates[c]	99
Percentage of teachers with master's degree plus 30 hours or doctorate	7
Percentage of teachers at school five or more years	88
Percentage of teachers at school less than five years	12
Number of special educators	21
Number of paraprofessionals	30
Administration	
Number of years principal has been at school	8
Number of assistant principals	3
Number of years assistant principals have been at school	3, 6, 10

a. This ratio includes integrated classrooms that are cotaught and separate special education classrooms. If these settings are excluded, the school's student–teacher ratio rises to 17: 1.

b. To be considered highly qualified, New York State teachers must have at least a bachelor's degree, be certified to teach in their subject area, and demonstrate subject matter competency.

c. Information on teacher qualifications is reported differently in New York and Massachusetts.

Source: Authors' compilation based on primary documents gathered at the school and interviews with the principal; see appendix A for details.

- *A self-contained special education classroom,* which consisted of either 8 or 12 students with Individualized Education Programs and one special educator and paraprofessional.

Students whose needs were so severe that the school could not meet them could move to a day treatment center, a residential treatment facility, or a Board of Cooperative Educational Services classroom.

Highlighted practices at Redwood

Almost a decade ago Redwood Elementary School was identified as a school in need of improvement because of its low student performance levels. The school responded by adopting the America's Choice reform program, which provides school-wide intervention strategies to improve student achievement. Redwood was an America's Choice school for three years, implementing comprehensive instruction, assessment, staffing, and professional development initiatives. For two years the school focused on improving reading and writing. In the third year it turned to math achievement. The results were dramatic, with the percentage of students with disabilities scoring proficient or above on the New York State grade 4 math assessment rising from 12 percent in 1999 to 44 percent in 2005. Math scores for general education students also improved—with the percentage of students scoring proficient or above rising from 31 percent in 1999 to 91 percent in 2005. Similar gains were made on the English language arts assessment (New York State Department of Education 2005a). Although at the time of the study Redwood no longer received assistance

from America's Choice, many of its practices were still in use.

Leadership that empowers. Staff members repeatedly attributed Redwood's marked improvement in math and other subjects to the leadership of the principal and his administrative team. An assistant principal at Redwood praised the principal, describing him as knowledgeable, respectful, and patient: "He has a lot to do with how, in my opinion, things came about here. I wouldn't have come here if it wasn't for him."

The principal's approach. To place the school on a path to improvement, the principal started rebuilding its organizational structures and culture. According to him, when he first arrived at Redwood Elementary School, the school was perceived as very unfriendly: "Essentially, we were viewed as a school that wasn't effective." So, the principal focused first on creating a more positive image of the school among staff and in the community. He improved the physical environment by removing overflowing dumpsters and repairing decayed entryways. And he worked to rebuild staff morale by displaying his own commitment to change.

The principal's core approach had been to attract committed administrators and teachers and empower them to become education leaders. He provided as many resources and as much support as possible. He outlined his leadership philosophy as follows:

> *We need to have committed individuals coming here, looking to take a leadership role. . . . We need to have the resources in place. We need to have a good curriculum in place. . . . We don't have to go out and spend a billion dollars on some of the basic pieces, [but we need to] equip people adequately to do the job; equip them in a manner where they're going to feel very competent. . . . Provide incentives along the way—recognition for the work that they do. And in doing those things, I think people latch on to a sense of caring and love and what-not that's extended to children.*

The core approach of Redwood's principal had been to attract committed administrators and teachers and empower them to become education leaders

The principal also stressed the importance of a strong work ethic and a positive outlook among staff members—a requirement for tackling the significant challenges of educating a disadvantaged population. "If we're willing to work hard—because it's not going to be easy—and be patient with our charge, our roles . . . there is going to be forward movement. . . . You have to believe that."

Administrative structure and support for instruction. The principal assembled a team of veteran administrators to serve as assistant principals and program coordinators. Each had a defined set of responsibilities:

- The first assistant principal supervised teachers in grades 1 and 2 and chaired the school's student support services team, which received and evaluated requests for special education referrals.
- The second assistant principal supervised teachers in grades 3 and 4 and oversaw schoolwide testing.
- The third assistant principal supervised teachers in grades 5 and 6 and oversaw special subjects, such as art, music, and physical education.
- The senior administrator coordinated the PreK program and supervised kindergarten teachers.

These administrators appeared to appreciate the authority and trust the principal gave them. One assistant principal explained: "You have the freedom, but you also have responsibility." Following the principal's example, administrators tried to help teachers develop their own leadership and independence. Because challenges in the school demand constant innovation and adaptation,

teachers were given the opportunity to take risks with their instruction. As one administrator explained:

> *People can be as creative as they want . . . try things and know that we're going to support them. We're not going to say if it doesn't work, you should have known better. . . . When children are coming with all kinds of needs, from one day to another, from medication issues, which are unbelievable, to community issues, teachers and staff have to be able to try to be creative in addressing the kids' needs. . . . Nobody understands unless they've been in an inner-city school.*

Staff culture. Teachers at Redwood Elementary School felt respected and able to exercise their judgment in the classroom. Special educators described the principal's management style as laissez-faire: "He doesn't micromanage. . . . He lets everybody do their job . . . in a manner that is very upstanding and very, very respectful."

Many administrators praised the teaching expertise in the building, noting that "the majority of our teaching [staff are] exceptional." One administrator lauded the special education staff, describing them as incredible teachers. With room to develop their own classroom leadership skills, teachers appeared to have confidence in their own teaching abilities and in those of their peers.

Although he took a hands-off approach to teachers' work in the classroom, the principal made himself available if they needed help. A special educator marveled at his accessibility in such a large school:

> *He is receptive. He's a good listener. He is going to tell you how it is. It does not mean that he says yes to everything by any means. But he's going to give an explanation as to why. He's going to give you that chance to always sit down with him and discuss what your concerns are, [and] tell you what other channels you might try to go through. . . . We all feel very comfortable with just being able to drop in his office.*

Teachers at Redwood Elementary School felt respected and able to exercise their judgment in the classroom

Some teachers cited the many opportunities for professional development—a high priority for the administration. Several also voiced appreciation for the administration's personal acknowledgements, such as the thank you notes and small gifts the principal and assistant principals regularly leave in teachers' mailboxes when they have performed a particularly valuable service.

Bolstered by a supportive administration, many faculty members described the staff culture as highly collaborative. An assistant principal noted, "The collegial learning in our building has improved over the last few years by leaps and bounds, and teachers are treating the children as everybody's children." Another assistant principal observed that there were fewer disagreements and union issues because "teachers feel like they've been heard." The math specialist suggested that the administration's willingness to listen and explain decisions has promoted a flexible team spirit. One teacher observed:

> *I think some of the best strengths [of this school are associated with] our willingness to accept new things. I think most of us are willing to get out of a rut and try new things to see if they work. . . . I think all of the colleagues work well together to improve upon something. We don't just say, "Well, this didn't work. Forget it." So, I think that one of our strengths is that we really look to see what did work, and [ask], "How can we make it better? How can we change in order to make this program work for our students?"*

Such attitudes generated a positive and productive climate in the school. Almost all the staff members attributed the school's renewal to the leadership of the principal and his administrative team. Given the school's high need levels, teachers suggested establishing an empowered and cooperative teaching corps was also critical for students' improved performance.

A uniform teaching model. Redwood students received math instruction for an hour every day. Although teachers had freedom to innovate within their classrooms, they generally organized class instruction (in math and other subjects) using the America's Choice workshop model. Within this model teachers used the Investigations math curriculum (TERC 1998). Math periods consisted of a 10-minute mini-lesson, 40 minutes of independent or small-group work, and a 10-minute closing, during which students could share their work with the class. Teachers suggested that these practices helped to improve math education at Redwood.

A full-time math specialist provided math support to teachers in all grades. The specialist supplied curriculum materials, offered guidance on meeting state standards, modeled lessons, and occasionally helped lead small-group work in the classroom. Two part-time resource room teachers provided in-class or pull-out math support (up to five hours a week) to general education students who had Individualized Education Programs in math. Support was also available to all students in the school's Saturday program, open from 9 a.m. to noon.

Before the introduction of America's Choice, instruction at Redwood Elementary School appeared haphazard. One special educator described her shock when she first arrived: "It was mind-blowing to me that there were no teachers' manuals and no real series being followed." She noted that before the school underwent reform, "You might not have seen an hour of math" in all classrooms, and "math instruction [was] done in very many different ways."

A teacher described how administrators introduced and implemented the America's Choice reform program:

> *[The administration told us], "This isn't a choice. This is how our school is running. For three years we are doing what they're doing, how they say we're going to do it." All of a sudden that is exactly what it was. In math, reading, and writing, there was a 10-minute mini-lesson, a 40-minute work period, a 10-minute closing. Mini-lessons and closings had to happen at a gathering area. There were rituals for how you sat at the gathering area. You needed to have your mini-lessons posted in the room for students to be able to go back and look at. Standards needed to be written on your bulletin board to be able to show that this isn't just a pretty bulletin board—we're doing it for a specific reason, and we're reaching the standard.*

The Redwood administration instituted a standardized lesson structure and common classroom routines across the school

In adopting America's Choice, the administration instituted a standardized lesson structure and common classroom routines across the school. Staff were offered significant professional development. Teachers learned how to implement America's Choice instruction strategies, measure student learning through formal assessments, and recognize appropriate academic standards for each grade level. Weekly staff meetings provided schoolwide professional development activities. And monthly grade-level meetings involved both general and special educators.

According to Redwood teachers, a common lesson structure and routine benefited them and their students. A special educator explained how schoolwide use of the workshop model improved communication among teachers:

> *It definitely unified . . . the building—we could all talk. I was a self-contained special ed teacher. I could talk to a 6th grade general ed teacher and a kindergarten teacher at the same time. And we could all talk about reading instruction or math instruction and know what the other one was talking about, because we all had to teach it in that same way.*

According to a Redwood teacher, consistent classroom practices facilitate instruction:

From the time they start in kindergarten they hear [the term] "gathering area." They hear rituals. They hear routines. . . . When you came into 2nd grade you knew you had a "reading journal." You knew you had a "source book." You knew you had your "math journal." And it sounds silly, but if every teacher calls those things different things, it [takes] a lot longer to implement [instruction] in your room.

Some faculty members linked use of the workshop model to greater student engagement. One administrator noted that students in a traditional math class would simply be told to work through problems in a textbook: "And you just sit there. And if you didn't understand [question] 5, you didn't understand [question] 35. And that was math class." In contrast, according to Redwood's principal, the workshop model "brought back the thought of children being able to think and unlock various problems . . . to solve an issue in a multiple number of ways, not just [hearing], 'This is how you do it.'"

Below, a grade 2 math lesson illustrates the multiple methods for solving problems within the workshop model and shows how the teacher provides individualized support to some students.

Mini-lesson: students are sitting on the carpet as their teacher starts the day's math lesson. To get them thinking about math, she asks the students to whisper to a neighbor one of the many ways to solve an addition problem.

As students return to their desks, the teacher writes on a piece of chart paper:

We took a field trip to _____ .

I saw ___ people wearing _____ .

Some faculty members linked use of the workshop model to greater student engagement

I saw ___ people wearing _____ .

She tells the students that they are going to take an imaginary field trip. One student suggests they visit Disney World. Together they talk about what people at Disney World might be doing, wearing, or eating. She then asks for a number. She fills in the number 35 on her chart paper and then asks what the 35 people are wearing. One student suggests Mickey Mouse ears. She asks for another number and what this number of people might be wearing. The students decide that they saw 40 people wearing sandals. She states that they need to come up with an addition problem for these two numbers. The students give her a question, and she writes it on the chart paper: "How many people did I see?"

As they begin to solve the problem, she circles the number 35 and underlines the number 40 to emphasize the important information. She splits the bottom of the paper into four and asks for four ways to solve the problem.

The first method the students suggest involves an algorithm. She has a student come to the board to line up the numbers. As he does so, she asks the class if they agree on how he has set up the problem: "Why is it right?" The student solves the problem at the board.

She asks for another way to solve the problem. One student suggests "decomposing." The teacher offers him a marker in a different color, and he writes his solution on the board.

The teacher then picks a pen of a different color and asks the students for a third method. One student suggests "counting on"—start with 40 and then add 35 more lines to get the answer.

The students' fourth method is a number line. The class discusses other ways to solve the problem as well, including drawing pictures. The teacher suggests that a faster way would be to draw a circle with a Mickey Mouse or a sandal inside it.

Independent work: The teacher hands out worksheets with a word problem and two blank columns. She tells the students to use any two ways to solve the problem, using the two columns provided on the sheet.

The students discuss and decide that if two methods produce different answers, they should try a third way to check their work. As students begin the worksheets, the teacher places colored connecting cubes on a desk in the center of the room. She tells students that they can come to the desk and use the cubes to help them with the addition. She encourages a few students in particular to work with the cubes.

Next, the teacher gives one student a worksheet with a more complex problem and then sits down with another student to whom she has given a less difficult problem. She asks the student to identify the information on the sheet he will need to solve the problem. After he has picked one way to begin solving, she leaves him to work on his own and circulates to check on other students' work.

As this lesson suggests, teachers could employ a variety of techniques within the workshop model. Teachers cited the value of using varied methods for diverse students as well as the contribution that uniform structures have made to fueling gains in achievement. With a high-need student population, consistent classroom practices and a stable school culture may indeed be prerequisites for improving student learning. In the words of one teacher:

I've just seen such a difference . . . [Many] kids feel this is their safer place, much more than for a lot of them home is. And this is where there is some continuity and consistency, and I think our teachers are really good at showing them that they're loved and cared for and respected. And then any math program that you use is going to work if they have all that.

Integrated classrooms and a continuum of services. Redwood Elementary School had a large number of students with disabilities and many other struggling learners who did not have Individualized Education Programs but who qualified for instructional support. These students were placed in different classroom settings, according to their needs.

Every grade at Redwood had an integrated classroom, taught by a pair of general and special educators

The integrated classroom. Every grade at Redwood had an integrated classroom, taught by a pair of general and special educators. Up to half of students in these classrooms had Individualized Education Programs. A special educator suggested that the teaching and learning that took place in these settings may have contributed to the school's gains in achievement:

I'd say for at least five years now, we have had that special ed teacher in an inclusion room, an integrated room, full-time every day, and that's totally to the [credit of the] administration and more often than not [the principal] for having to fight for staffing . . . and to listen to the staff saying that two hours a day [of special ed support] is not cutting it. We need full-time [special ed support]. These kids need it.

According to teachers, struggling learners benefited from peer mentoring and from "getting [exposure to] their peers who are working at a higher level." But teachers also benefited. One general educator described what she had learned by working with an experienced special educator:

I was pretty ignorant at one time, thinking "special ed kids, they're not that smart and they have behavioral problems." But that's not true. They have learning disabilities. So, I've come to appreciate what special ed is. . . . I'm really glad that [coteaching] brought me . . . out of my ignorance into awareness of special ed children in the population.

She also noted, "Because there are two of you, you can take a subject and master it." In her classroom she led reading and math lessons, while the special educator led science and social studies lessons. Both agreed that having full-time coteachers improved teaching. Coteaching also allowed teachers to tailor instruction to the range of needs in the classroom. As one teacher explained, "I can't

Redwood Elementary School offered many services beyond the integrated classroom

imagine how some of these teachers are doing this where you have five reading groups. I can pick up three, [my coteacher] could pick up two, or vice versa. Our program is so intense because we have two people in the classroom."

Services for a continuum of needs. Redwood Elementary School offered many services beyond the integrated classroom. A self-contained special education classroom was available for students with more severe disabilities. Self-contained settings offered students the ability to work at a slower pace. Teachers could also use a multisensory approach in such settings, which was very helpful when working with students with severe disabilities. In contrast, students with mild disabilities benefited more from in-class support in a general education classroom, although pull-out support was also valuable. As one teacher noted:

> *As much as I like being in the general ed room, there are also times that I would like to have a whole hour to be able to work with just my kids. . . . If I see that [students] are really struggling, I actually love the opportunity to just go to my office and have an hour to work [with them] on multiples and factors and do different things that are helpful for them. I can't always do that when I push in, because I need to take the lead from what the general ed teacher is doing.*

Using data to spur achievement. In a short period of time Redwood Elementary School has transformed itself from low-performing to high-performing, based on students' test scores. Teachers and administrators relied heavily on assessment results to guide classroom instruction and set clear goals for learning. This focus, administrators suggested, helped fuel student gains in math and other subjects.

An assistant principal oversaw all student testing. She worked with teachers to administer all formal assessments, analyzed the results, and used assessment data to help establish achievement targets.

The school administered a benchmark math assessment to students in every grade at the beginning of each school year. In the primary grades students took the TerraNova math achievement test. Results were scored electronically and returned to classroom teachers within a few weeks. Students in grades 3–6 took a district math assessment designed to prepare them for statewide tests. Teachers scored the assessment (with help from the math specialist if needed) and used the scores to determine where to focus instruction.

The assistant principal guided instruction by providing teachers with analyses of student data. The math specialist stressed the importance of this information: "You need data to drive your instruction. If you don't have that, you don't know where you're going."

Teachers assessed their students throughout the year. Many used unit assessments from the Investigations math curriculum; some designed their own assessments. One teacher examined the assessments from the curriculum workbooks to "see if anything needed to be altered or changed for those students who were struggling or advanced." Some teachers administered an assessment before and after April vacation to determine whether certain students qualified for special education support over the summer.[6]

Students in grades 3–6 also took the statewide math assessment, which measured adequate yearly progress. Redwood's math specialist worked with other math specialists across the district, analyzing each grade's scores to identify students' weaknesses to guide instruction for the following year. She shared her findings with teachers, who prepared students for the state assessments as early as grade 2. One grade 2 teacher began the school year by introducing the notion of standards to her students:

> *I tell my students, "We're going to work on exploring different ways that you can meet the*

standard." I always try to present to them a number of ways to do any kind of concept so that one person who isn't getting it this way can do it [another] way and still meet the standard. . . . I start [in September] letting them know that everything we're learning is going to be geared toward helping them pass that test.

As test time neared, another teacher began to teach such test-taking skills as reading through a problem twice, circling numbers in a problem, and using scratch paper to solve a problem. The math specialist also spent more time in upper grade classrooms as the test date approached. To better prepare students with disabilities and other struggling learners for the test, the school worked with teachers and students throughout the year to ensure that they knew what modifications they were entitled to and how to use them. Doing so made students comfortable with the accommodations during the test. Although teachers and students knew that the state test was important, the administration ultimately viewed it and other assessments as both a gauge and spur to student learning—a way to mark achievement and help motivate teachers and students to perform even better.

Remaining challenges

Despite the many positive changes at Redwood Elementary School, administrators and teachers continued to face challenges as they worked to improve the math learning of students with disabilities and other struggling learners. Among these challenges:

- *Math staffing was inadequate.* A single math specialist served teachers in 64 classrooms housing almost 1,000 students. With only one math specialist at such a large school, it was difficult to provide enough support to students who struggle in math.

- *Students with mild disabilities lacked sufficient support.* Some students required more support than the school could provide. Under current district rules students in general education classrooms who were eligible for special education support from a resource room teacher could receive only five hours of support a week. Many students needed more than five hours of support but less than the 30 hours they would receive in an integrated classroom. Having just three part-time resource room teachers serving the school made meeting student needs difficult.

To prepare students with disabilities and other struggling learners for the state test, the school worked with teachers and students throughout the year to ensure that they knew what modifications they were entitled to and how to use them

- *Student mobility was high.* Most Redwood students came from low-income households, and many came from highly transient families. Many students thus transferred in and out throughout the year. Teachers often found it difficult to integrate new students not familiar with the school's structures into their classrooms.

- *Students with disabilities faced long bus rides.* Redwood tried to preserve a stable education environment for students with disabilities by keeping them at Redwood even when their families moved to other parts of the district. As a result, many students with disabilities traveled long distances by bus every day. An administrator believed that these long bus rides were detrimental to students' behavior and ability to learn.

Looking forward

Administrators and teaching staff continued their efforts to improve Redwood Elementary School. With the district, the administration was planning to replace the current building with a new facility in the next two years. The teaching staff was continuing to experiment with instructional strategies to better serve students with disabilities and other struggling learners and generate further gains in student achievement.

MAPLE ELEMENTARY SCHOOL: COLLABORATING TO SHARE OWNERSHIP OF ALL STUDENTS

At Maple Elementary School, a rural school in upstate New York, leadership and staff worked collaboratively to help all students succeed. The school's enrollment of just 230 students enabled teachers to respond quickly and flexibly to meet the needs of struggling learners so that no one fell through the cracks. Administrators and staff highlighted the following practice as central to their approach to improving the math learning of all students, including those with disabilities and other struggling learners:

- *Working collaboratively in professional learning communities.* Teachers participated in weekly grade-level meetings—called professional learning communities—discussing math lessons, sharing instructional strategies, and brainstorming strategies for struggling learners. Every month they attended a full-day professional learning community meeting with their grade-level colleagues from two other elementary schools in the district. Teachers worked together to align their curriculum scope and sequence with state standards, develop benchmark assessments, and examine student data.

Other practices highlighted by school staff members include the following:

- *Whole-school collaboration,* in which teachers regard all students as their responsibility. Staff use one another's strengths to aid struggling learners.

Maple Elementary School's enrollment of just 230 students enabled teachers to respond quickly and flexibly to meet the needs of struggling learners so that no one fell through the cracks

- *Leadership and staff with a clear mission,* guided by the message "we're here for one reason: the students."

- *Inclusive math practices and support,* exemplified by inclusion classes in which students with disabilities and other struggling learners learn side by side with their general education peers and teachers emphasize small group work, multisensory approaches, math software programs, and the integration of math with other subject areas.

These practices are just part of Maple's approach to math education (table 9).

Overview of Maple Elementary School

Maple Elementary School was one of three elementary schools in a rural district made up largely of lower- to middle-income families. The nearest town center consists of a post office and a real estate office; all of the stores had closed or moved away. More than a third (37 percent) of Maple's students were eligible for free or reduced-price lunch (table 10). The percentage of students with disabilities (13 percent) was close to the New York State average.

Maple's staff included a principal and a range of veteran teachers and recent hires, including two special educators (table 11). Students with disabilities and other struggling learners received support from teaching assistants, special service providers (such as occupational and speech therapists), and academic intervention services teachers. A half-time coordinator led a school-based intervention team, part of the school's Response to Intervention initiative.

Classroom placement for students with disabilities and other struggling learners

Maple Elementary School used various classroom settings to serve its range of learners:

- *General education classrooms* were taught by a general educator, with in-class or pull-out support from a special educator.

- *Inclusion classrooms* were taught by a general educator and a shared teaching assistant, with in-class or pull-out support from special educators. Grades K, 3, and 4 each had one inclusion class, while grades 1 and 2 had a combined inclusion class. In kindergarten

TABLE 9
Snapshot of practices at Maple Elementary School, 2006/07

Practice	Description
Classroom math instruction	Math instruction time: 60 minutes a day
	Curriculum: Scott Foresman-Addison Wesley Mathematics, implemented for more than five years
	Placement of students with disabilities and other struggling learners: inclusion classrooms taught by general educators and teaching assistants; special educators provide in class and pull-out services
	Accessible instruction: varied instructional strategies include multimodal approaches, computer software programs, manipulatives, small group work, and peer tutoring*
Math supports and interventions	In-class and pull-out support services provided by special educators
	School-based intervention team plan interventions
	Teachers and teaching assistants who work with struggling learners from other classes
Assessment	Variety of informal and formal assessments
	Districtwide benchmark assessments for math created by teachers in professional learning communities
	Assessment data (including results of statewide assessments) analyzed by teachers in professional learning communities to identify struggling learners and inform instruction
Collaboration among teachers	Teachers (including special educators) meet weekly in grade-level, school-based professional learning communities and monthly with grade-level district colleagues*
	Teachers, teaching assistants, and special educators collaborate to provide instruction and support in inclusion classes
Professional development	Unofficial math leader provides in-house professional development and math support
	Districtwide professional learning communities meet once a month
	Teaching assistants are included in professional development
Leadership	Principal strongly promotes idea of always considering what is best for students, through inclusive practices, staff placement, professional development, and other activities*
	Principal holds teachers accountable for students' performance by examining assessments and following up on students who need improvement
	Principal initiated implementation of professional learning communities and actively supports their work
School culture	Staff culture is highly collaborative, springing from a small, close-knit community, long-term working relationships, regular professional learning community meetings, and a mission that involves shared ownership of all students*
	High expectations are held for all students, communicated through staff actions and a school pledge students recite each morning
	Inclusive and welcoming environment for students with disabilities and other struggling learners

* Practice considered central to school's approach to improving math learning.

Source: Authors' compilation based on primary documents gathered at the school, classroom observations, and interviews with teachers and administrators; see appendix A for details.

the classroom teacher was aided by a volunteer from AmeriCorps, a network of service programs that places volunteers in different settings, including schools.

- *A Board of Cooperative Educational Services (BOCES) classroom* was taught by a special educator and paraprofessionals. This program for students with emotional and behavioral disabilities attracted students from across the county. The separate classroom was funded, staffed, and supported by BOCES. To be more inclusive, the school had arranged for three students to attend math lessons each day in a

TABLE 10
Student demographics at Maple Elementary School, 2006/07

Characteristic	Value
Grade span	K–4
Number of students enrolled	230
Average class size (students)	18
Percentage of students with disabilities (percent with Individualized Education Programs)	13
Percentage of students eligible for free or reduced-price lunch	37
Percentage of students of races other than White	2
Percentage of students with limited English proficiency	0
Percentage of students whose first language is not English	—
Attendance rate (percent)	95

— is not available.

Source: Authors' compilation based on New York State Education Department (2006a) and interviews with the principal; see appendix A for details.

TABLE 11
Staff and administration at Maple Elementary School, 2006/07

Characteristic	Value
Staff	
Number of teachers	18
Student–teacher ratio	—
Percentage of core classes taught by highly qualified teachers[a]	100
Percentage of teachers with valid teaching certificates	100
Percentage of teachers with master's degree plus 30 hours or doctorate	11
Percentage of teachers at school at least five years	50
Percentage of teachers at school less than five years	50
Number of special educators	2
Number of paraprofessionals	3.5
Administration	
Number of years principal has been at school	7
Number of assistant principals	0
Number of years assistant principal has been at school	1

— is not available.

a. To be considered highly qualified, New York State teachers must have at least a bachelor's degree, be certified to teach in their subject area, and demonstrate subject matter competency.

Source: Authors' compilation based on data from New York State Department of Education (2006a), primary documents gathered at the school, and interviews with the principal; see appendix A for details.

grade 2 general education classroom, accompanied by a paraprofessional from the BOCES program.

Highlighted practices at Maple Elementary School

This section examines four highlighted practices at Maple Elementary School.

Working collaboratively in professional learning communities. In 2003/04 Maple's principal established the professional learning communities initiative after attending a national institute with other district principals and teachers. The goal was for teachers to work collaboratively to address three questions:

- What do we want all students to learn?
- How will we know when each student has acquired the intended knowledge and skills?
- How should we respond when students struggle so that we can improve learning? (Dufour et al. 2004).

The principal used these questions as guideposts for her staff, frequently communicating their importance:

> *I put up the three questions and said, "Our whole goal of why we're here is to answer these three questions. What is it we want children to know and be able to do? That means we all have to start talking to each other and make sure we all know what it is we want our kids to be able to do. You know we have three first grade teachers. Do you all teach the same thing and expect your kids to do the same? We have to be consistent and have to have a guaranteed, viable curriculum. How do we know what kids know? We have to talk to each other again and*

make sure we are assessing at the same time and assessing the same things and assessing in the same way. How do we respond to those kids who don't learn?" And those three questions have really truly been our guiding force.

School-level professional learning communities. Weekly professional learning community meetings were structured into the school calendar so that teachers met with grade-level colleagues throughout the year. They discussed upcoming lessons, planned activities, and shared strategies for helping students with disabilities and other struggling learners. Professional learning communities also helped new teachers feel part of the school team. In the words of one:

We're able to share all those wonderful ideas, which I love because I'm a new teacher, so I get all those really experienced teachers that say, "Oh, this works for me." If I have a problem with something [and say], "My kids are having so much trouble with fractions," I get to open that up to a whole huge table full of people who say, "Did you try this? Try this."

The principal set clear expectations for participation in professional learning communities, providing time to meet and requiring that groups take minutes. She arranged the school schedule so that professional learning community meetings preceded the lunch period, giving teachers the option of having an hour and 25 minutes to meet. Special educators, who worked with multiple grades, also participated in professional learning communities. They decided which grade-level community to join each week based on the discussion topics and received minutes of the meetings they could not attend. A special educator voiced her appreciation of the efforts to keep her informed: "I receive all the minutes, notes, documentation, and assessments and everything through my coteachers. They come back and talk to me about what happened at the meeting, so I'm never behind."

Districtwide professional learning community meetings. In the first year of the initiative teachers met in school-based professional learning communities. In the second year they began meeting monthly with grade-level colleagues from all three elementary schools in the district. The district provided substitutes so that teachers could attend a full-day meeting each month. One teacher underscored the benefit of this time with colleagues from other schools:

Weekly professional learning community meetings were structured into Maple's school calendar so that teachers met with grade-level colleagues throughout the year

Professionally, it's given me an opportunity to work with people I might not have worked with, especially in the other two buildings. [The other 4th grade teacher] and I are always going back and forth across the hall, so I know what she's doing and she knows what I'm doing. But we don't necessarily know what the other seven 4th grade teachers are doing across the district. . . . [Through] a formal professional learning community, the district carves out the time to make sure we do.

Through the professional learning community process, general and special educators strived to ensure that students in all schools in the district worked toward the same standards at any given time during the year. They believed that this consistency was essential because students moved from school to school in the district. Flexibility, however, still remained within a shared scope and sequence. As one teacher explained, "I'm not saying that anyone is telling me how to do it. We're just saying, 'Let's put our emphasis on fractions for this quarter.'"

Standards, assessments, and data analysis. Administrators set the main goals for the district professional learning community meetings, but each group had flexibility in carrying out tasks. In the year of the study one major task was to develop benchmark assessments for the math program. In the monthly full-day professional learning community meetings teachers examined state

standards, discussed ways to measure students' understanding, wrote assessments, and analyzed student data. One teacher described the process:

> *Before we do anything else, we look at the [New York State] standards. We have to come up with goals that match those standards, so we can make sure that all the standards are being covered. Once we get the goals down, we start [designing] the assessment: How are we going to assess this? What are we going to do? And then it goes on to forming [the assessments and] making rubrics to grade what [students] do.*

Initially, some teachers raised concerns about spending so much time away from their classrooms, but they came to believe that the time away was worthwhile. One teacher pointed out how the work of the professional learning community benefits students with disabilities: "It gives us a better insight on where they need to be and what we need to do to get them there."

Districtwide professional learning communities also let teachers examine patterns in student performance across schools. By analyzing data from their assessments and the New York State tests, teachers identified math content areas in which many students were performing poorly and planned ways to better address these areas. The principal and teachers agreed that a major benefit of districtwide meetings was the broad view it provided of student performance:

> *I think you have [to] start schoolwide. You have to get that trust going. But I think it's very important as a district that you get all [teachers] together once you start looking at data. The larger the group that you compare that data to, the more effective that data are. So, if you're only looking at your school, you're really not getting a broad picture of where your children are. Once we started comparing districtwide, that shed a whole new light on where we were with our kids and what we needed to do.*

By analyzing data from their assessments and the New York State tests, teachers at Maple identified math content areas in which many students were performing poorly and planned ways to better address these areas

A work in progress. Professional learning communities evolved over time. Group members needed to build trust so that they could feel comfortable asking one another for help and sharing student assessment results. Teachers and administrators needed to build trust in one another and in the value of the model. Initially, administrators were the driving force, setting goals and agendas and attending the meetings. Over time their role lessened. One teacher described the shift: "Once the administrators began to trust more and the teachers began to feel more empowered, I think things flowed more smoothly."

Regular meetings made teachers more comfortable sharing ideas with colleagues. But teachers also struggled to give up lessons that they had invested in over the years, which one teacher referred to as the greatest challenge. Although teachers shared the goal of having a consistent math program, they had to make many hard decisions and find compromises. "Discussions can get quite heated about the expectations and approaches, as well as what time of year to do [a lesson] or [when a test] should be given and what test should be the right one to give," noted one teacher. "There's a lot of give and take."

Professional learning communities often made final decisions based on majority preferences. As a result "some people can walk away very upset that day if the vote didn't go their way." At the same time, teachers felt that "there's always room for open conversation and everyone will listen." Years of working together had created a relaxed atmosphere and helped the group to feel more comfortable with disagreements.

Maple's teachers and principal found the professional learning communities extremely worthwhile. While sharing instructional strategies and building a consistent program helped teachers grow professionally, they also led to gains in student learning.

Whole-school collaboration. In the close-knit community of Maple Elementary School teachers reached out to colleagues and were willing to "go the extra mile" to help students succeed. Staff members identified teamwork as a vital practice for teaching math to students with disabilities and struggling learners. As one special educator noted:

> *I think overall it's the teamwork. We have a lot of great teachers here who will bend over backwards and do anything for anybody to really help out. . . . [We] really pull the strengths from every teacher for the benefit of the kids. Just lots of teamwork, always meshing together, and I think that's what makes this school successful.*

Staff members collaborated in a variety of ways. General educators worked closely with teaching assistants and special educators. Grade-level colleagues planned and brainstormed together in weekly professional learning community meetings. Meanwhile, teachers collaborated informally over lunch, through email, and in the hallways. When students had difficulty, they felt comfortable asking one another for help. The school found creative ways to use their small staff to meet the needs of struggling learners, and teachers often volunteered to work with students in other classes and grade levels. The principal described the open communication at the heart of the school culture:

> *It's just natural now for our teachers to talk to one another and say, "This child—I'm stumped." They'll go to the person next door; they'll go to somebody on their team. They will talk with one another in the staff room. And automatically another teacher will say "Try this" or "I have this in my class; you can borrow it" or "Gee, I'm free on Tuesday at 1, and I'll come observe." It's just the culture of the building.*

In interviews many teachers used the same phrase: "they're all our kids." "No child seems to fall through the cracks here," noted one teacher. "We're a small enough school where we can identify them and identify their needs and somebody will be there."

Maple's whole-school approach to addressing student needs was epitomized by the school-based intervention team, part of a two-year-old districtwide Response to Intervention initiative to help struggling students

Maple's whole-school approach to addressing student needs was epitomized by the school-based intervention team, part of a two-year-old districtwide Response to Intervention initiative to help struggling students. The team was a volunteer group made up of teachers, teaching assistants, the librarian, and other staff. It was led by a part-time coordinator, a former special education teaching assistant at Maple Elementary School who received extensive professional development for her new role.

When teachers observed a student with significant difficulties in class, they presented information on the child to the school's child study team. Once it ruled out medical issues, such as vision or hearing, as possible causes of the problem, the team determined whether to seek the assistance of the school-based intervention team. If such assistance was sought, teachers presented data on the student, and the team developed an intervention plan. One special educator described the meetings as follows:

> *The teacher comes in and shares his or her concerns about the student. Say there's a weakness in math specifically, [we will ask], "What's the weakness? What can we help with?" We come up with goals and who's going to be responsible for working toward those goals; we come up with the plan officially. . . . The teacher plays a big part in it, but the whole team [takes part]: "Hey, I'm free during lunch; I'm going to work on addition facts with the kid" or "I'm going to play a math game [with this student]once a week."*

The school-based intervention team would select one goal to work on for each student and identify staff members who could provide the needed support. They would look for staff whose strengths matched the student's strengths and needs. Teachers would often volunteer to work with students in different classes and grade levels. The school-based intervention team coordinator would then monitor the student's progress by conducting frequent assessments. Based on the student's response, the school-based intervention team committee could make a referral for special education testing.

Leadership and staff with a clear mission. The principal and staff were united in putting students at the center of their mission. One year the principal gave each staff member a compass as a reminder that they all need to point in the same direction: what is best for students. She described how they established a shared vision:

> *At the beginning of each year, we always start with "Here's what we wrote [our mission]. Do we still agree? Do we need to change?" And with new people on board, I want to make sure they know, because this is who we are. This is what we're about, and [I want to] make sure that everybody still agrees. So, we always start the year reminding ourselves this is who we are, and then everything helps to fall into place, because we can always go back to that mission statement.*

The principal emphasized the importance of putting this mission into daily practice. At faculty meetings staff members shared how they were putting the mission into practice. At one meeting, for example, staff wrote examples on sticky notes and put them on a poster of the mission statement. The principal also used the mission to guide decisions about staffing. For example, she divided the teaching assistants according to need, rather than equally:

The school-based intervention team would select one goal to work on for each student and identify staff members who could provide the needed support

> *Everybody knows that support staff are assigned based on student need, not teacher need. And we have the data to show this class really has some gaps, really has some kids that need some help, so I'm putting more support there than in a classroom where I don't see that data. And the teachers are fine with that. They're the first ones to say, "I'm okay, you need the help more than I do, so you take the support staff." And as the year progresses, and we are constantly assessing . . . they know the support changes to where the need is.*

The principal was vigilant about keeping students from falling through the cracks. She looked at all report cards and required teachers to administer and hand in quarterly assessments. When assessments revealed that students were struggling, the principal held the teachers accountable for showing evidence of improvement five weeks later by submitting new student assessments. On her desk report cards and assessments were organized in binders that allowed her to keep track of the data. For each class she had a manila folder with each student's name on a sticky note, which were organized into groups so that she could quickly see which students had met the benchmarks and which ones needed support.

In addition to focusing on accountability, the principal had been a driving force in adopting the professional learning community model. She enthusiastically embraced the initiative and implemented it in all grades at once. Her action-oriented approach was evident in her advice to other principals considering the professional learning community model: "Just do it. Just jump in and just go for it, because it really pays off big time with the staff." She attended the meetings regularly only the first year, but she read meeting minutes and attended meetings when teachers asked her to do so.

Teachers and teaching assistants described the principal as very supportive and respectful. One teaching assistant recounted that the principal told her, "If you get treated disrespectfully, immediately let me know." A teacher identified the

principal as instrumental in creating an atmosphere "in which every one of us is equal; we all just have a job to do." Another said, "We have great leadership . . . [and] our principal is very supportive of all the teachers."

Inclusive math practices and supports. The principal and staff established a respectful and inclusive culture. The school emphasized building the "character traits of highly responsible students: trustworthiness, respect, responsibility, perseverance, and cooperation," as one of its pamphlets proclaims. The students recited their own mission statement, the Maple Elementary School pledge, each morning after the national pledge of allegiance:

> *I promise to respect and care about my school and other people. I pledge to work hard and be responsible. I promise to show perseverance and self-control at all times. I will be honest and a good example for others, and I will treat people the way I want to be treated.*

In this respectful environment students with disabilities and other struggling learners were accepted and included by other students. Staff held students with disabilities and other struggling learners to the same high standards—in math and other subjects—as other students. The principal recalled the following experience:

> *I remember a few years ago, when we were writing goals for our school. . . . I remember at one point looking at [the data for] students with disabilities . . . [which] were lower than [those of] the other kids. And I said, "Well, maybe we need a goal here for those kids." And one of our teachers, instantly spoke up and said, "But they're all of our kids; they're not different from anybody else. These goals are for everybody that we're writing. We don't separate them out." And everyone [responded], "Yeah what are [you] doing asking us to write a separate goal for these kids?" They really don't see them as special ed. They're just kids who need help.*

Maple's students with disabilities and other struggling learners were typically placed in inclusion classes taught by a general educator and a special education teaching assistant

Math instruction in inclusion classrooms. Students with disabilities and other struggling learners were typically placed in inclusion classes taught by a general educator and a special education teaching assistant. Many teaching assistants had years of experience; each was known for a particular area of expertise. Some teachers and teaching assistants had developed strong partnerships from years of working together. Although the teaching assistants were assigned to support students with Individualized Education Programs, they were committed to all students. One teacher described how she and a teaching assistant worked together in the classroom:

> *We really do play off each other. . . . If I give an unclear direction, and she knows it, and she's looking at some child's face while thinking that child is never going to ask her and has no clue, she'll raise her hand and say, "I'm a little confused, can you explain that to me again?" And I'll do the same. Or if she realizes there's a vocabulary word that they're really not comfortable with, she'll say, "Now I've heard that word before but can anyone in the class explain it to me again, because I'm a little foggy?"*

Teachers used a variety of strategies to meet the needs of a range of learners. During observations students were highly involved in whole-class lessons, small-group work, and independent assignments. Teachers presented problems in verbal, visual, and tactile ways. They used kinesthetic activities, such as tying math concepts (such as angles) to body positions or skip-counting to stretching exercises. One teacher used peer coaching as a way to give all students (not just the strongest ones) the opportunity to help their classmates. The use of multiple strategies was evident in the following observation of a grade 4 class:

Students are seated at tables that are lined up to form two long rows, one on each side of the room. The teacher takes the lead in the lesson, giving instructions and modeling the tasks for students. The teaching assistant asks questions to clarify the teacher's directions. By speaking up, the teaching assistant models for students that it is okay to ask for help when confused.

The teacher provides resources to help students solve double-digit multiplication problems. Students write on large pieces of grid paper so that they have room to line up the numbers. They use small Post-its as place holders and a multiplication chart for reference. The teacher helps the students on one side of the room while the teaching assistant helps student on the other side of the room. The teaching assistant checks in frequently with one boy with an Individualized Education Program who is having difficulty focusing on the task. At one point she takes him out for a short break. While she is out of the room, the teacher circulates around the whole class.

As students finish, the teacher and teaching assistant direct them to check their work by talking with their "face" and "shoulder" partners. They ask two students to check the work of all the students in their group. Students then present their solutions to the whole class and describe their approaches. The teachers ask for volunteers who have solved the problem in different ways. Both she and the teaching assistant ask questions and reinforce the message that there are multiple ways to solve a problem.

Special educators used a flexible approach to providing services, collaborating with general educators to determine when to work with students in math class and when to pull them out

Math support from special educators. In addition to classroom math instruction, students with disabilities and other struggling learners received in-class and pull-out services from special educators. The special educators used a flexible approach to providing services. They collaborated with general educators to determine when to work with students in math class and when to pull them out. Typically, special educators met with students with Individualized Education Programs, but they could also work with other students who needed support.

During pull-out times students received instruction in small groups. Special educators used multiple strategies to provide individualized instruction and target difficult areas. One special educator used graph paper to help her students line up numbers. She also used laminated paper with units, tens, hundreds, and thousands columns marked on them, which students work with using dry-erase markers.

General educators often turned to special educators to create accommodations for lessons. Special educators received the lessons ahead of time and adapted them by enlarging the font size to make a problem more readable, for example, or redesigning a handout to help students organize their work. Special educators also communicated IEP goals and recommendations to general educators.

Use of computers. General and special educators used math software to build skills and differentiate instruction. In several classroom observations groups of students worked independently on math software programs (every class had at least five computers). Working with teachers, they then rotated through different activity stations.

Maple's extensive use of technology stems from a technology initiative in which teachers received professional development in the Classroom Computer Connection program. Special educators used this program and other programs, such as Math Facts in a Flash, extensively for students with disabilities. Software was particularly helpful because it provided immediate, nonthreatening feedback. Several teachers reported that their students loved working with computers.

Teachers also used the programs to assess student learning and guide instruction. Every week they printed student performance reports to identify

areas in which students were having difficulty. These data allowed them to focus on such areas.

Making math relevant. Maple Elementary School emphasized incorporating math into all subject areas and making it relevant to everyday life. One teacher ran a school store with students once a week. Art and gym teachers incorporated math into their teaching. A special educator described the whole-school approach to integrating math:

> *A lot of [nonmath] teachers have done an awesome job incorporating math everywhere. They're reading math books. The kindergartners are walking down the hall [counting] each step they take, or they're counting by five. . . . When [math] comes up in science or in a book, [teachers stop], and there's a math problem on the board.*

In-house math leadership. Staff members with math-related questions often turned to their colleague, Mrs. Johnson, a National Board Certified teacher. Although she did not carry the title of math leader, she was the resource person for math at Maple Elementary School. Mrs. Johnson had a wealth of knowledge about math content, activities, and instructional approaches for students with disabilities and other struggling learners. As a scorer for the New York State math assessment, she had first-hand knowledge of common student errors and how problems were evaluated.

Over the years the district had sent Mrs. Johnson to many math education conferences. When she returned she would share new ideas with such enthusiasm that they quickly spread among the staff. According to one teacher, Mrs. Johnson is "a phenomenal turn-key trainer. You can go to her. She has great ideas. She brings back ideas from trainings."

Every other month at staff meetings Mrs. Johnson provided 10- to 15-minute mini-lessons on such topics as problem-solving and writing in math. She emphasized ways to look at student assessments to identify strengths and difficulties and inform instruction. She also served as mentor to new teachers.

Maple Elementary School emphasized incorporating math into all subject areas and making it relevant to everyday life

Remaining challenges

Maple's principal and staff described some of the challenges that impede improvement in math teaching and learning. Such challenges included:

- *The school had no formal math specialists.* Maple had two and a half reading specialist positions but no similar positions for math. The school tried to arrange for students who were weak in math to work with staff members who were strong in this area. This could be a challenge, however, because those staff members had many responsibilities.

- *A new reading initiative had reduced time for math.* Teachers expressed concern about the effect of a new reading program on math instruction. Because the program had strict implementation guidelines, teachers no longer had the flexibility to incorporate math into English language arts as they once had. Although they recognized the importance of spending 90 minutes a day on English language arts, doing so reduced the available time for math.

- *Scheduling multiple services for students with disabilities was difficult.*

- *Newer teachers did not have the same training as veteran teachers.* About 10 years ago teachers at Maple Elementary School received extensive training in the Math Their Way program. Veteran teachers had incorporated its activities, such as calendar math, into their daily lessons. Because of their high regard for the program, they would like new staff members to receive professional development for it and for the Classroom Computer Connection software.

Looking forward

Maple's principal and staff wanted to build on the school's strengths to improve the math learning of all students. They planned to continue their focus on math instruction and assessment in professional learning communities. To extend their use of technology strategies, they wanted to use a wider selection of math software and to explore the potential of new tools, such as Smart Boards (interactive white boards) for improving math teaching and learning. The principal also suggested that students who needed extra support might remain at school an additional hour at the end of the day.

ASPEN ELEMENTARY SCHOOL: AN INCLUSIVE PHILOSOPHY WITH A VARIETY OF MATH SUPPORTS

Aspen Elementary School, in suburban Massachusetts, had long operated with a philosophy of inclusion and support for students with disabilities and other struggling learners. According to teachers, this philosophy and the practices that emerge from it contributed to improved math learning.

Aspen Elementary School offered several supports and interventions to students who struggled in math, including Title I math services, a special education resource room, and a Response to Intervention program

Staff believed that several key factors helped to promote strong math teaching and learning for students with disabilities and other struggling learners. One practice was described as particularly important:

- *Provision of a variety of math support services.* Aspen offered several supports and interventions to students who struggled in math, including Title I math services, a special education resource room, and a Response to Intervention program.

Other practices highlighted by school staff members included:

- *An inclusive philosophy and practices,* epitomized by the language-based classroom model, in which general and special educators work together to teach an almost equal mix of students with and without language-related learning disabilities.

- *Leadership that fosters a welcoming community,* demonstrated by a principal who is passionate about making all students feel accepted within the school community and who grants teachers both guidance and autonomy in their classroom instruction.

- *A highly experienced teaching staff,* including a majority who have been working together for more than five years and a principal and many general educators with special education backgrounds.

These practices are just part of Aspen's approach to math education (table 12).

Overview of Aspen Elementary School

Located in a suburban area of western Massachusetts, Aspen served more than 380 students in kindergarten through grade 4 in 2006/07 (table 13). The surrounding community was predominantly middle class; some 17 percent of students were eligible for free or reduced-price lunch. About 14 percent of Aspen's students had disabilities, the most common of which were speech and language disabilities and specific learning disabilities.

Aspen's principal led a staff that included many veteran teachers (table 14). The school's two special educators (assisted by 17 paraprofessionals) provided in-class and pull-out services to students with disabilities. A Title I math teacher provided instruction to students who struggled in math, while a primary preventionist oversaw the school's Response to Intervention program. Many of the paraprofessionals supported individual students.

TABLE 12
Snapshot of practices at Aspen Elementary School, 2006/07

Practice	Description
Classroom math instruction	Math instruction time: varies Curriculum: Scott Foresman-Addison Wesley Mathematics, implemented for two years Placement of students with disabilities and other struggling learners: language-based classroom staffed by a general educator and paraprofessional, with support from special educator and pull-out services; general education classroom with in-class and pull-out services; combination of intensive resource room and general education classroom; specific instructional program classroom staffed by special educator and paraprofessionals (for students with IQs of about 30). Accessible instruction: varied strategies include use of manipulatives, math games, computer programs, math journals, peer and partner learning, small group work, math stations, use of multiple representations, and real-world contexts.
Math supports and interventions	Wide variety of math support services, including the following:* • Math Title I teacher provides direct instruction for students with disabilities and other struggling learners in a math resource room or in class • Math Title I teacher provides mini-lessons to classes as well as math manipulatives and materials for students and teachers • Students from the district with IQs of 60–75 spend half their day in an intensive resource room staffed by special educators and paraprofessionals • A Response to Intervention program is provided for students in grades K–2
Assessment	Variety of informal and formal assessments, including observations, a diagnostic test, and ongoing benchmark assessments from the math curriculum Tutoring for grades 3 and 4 students at risk of failure or who scored poorly on previous Massachusetts Comprehensive Assessment System (MCAS) tests
Collaboration among teachers	Math Title I teacher offers mini-lessons, teaching strategies, and math materials to teachers General educator, special educator, and Title I teacher coordinate schedules to ensure daily math support for struggling learners Teaching staff is highly dedicated and have worked together for many years
Professional development	Title I teacher and kindergarten teacher trained in curriculum provide informal math support to staff District funds allow teachers to attend courses, workshops, and conferences offered by outside providers as well as the district
Leadership	Principal has background in special education and encourages inclusive, child-centered culture Principal started many initiatives, including student council, language-based classrooms, and community outreach events Principal is committed to staff professional development in math teaching
School culture	Highly inclusive, collaborative school culture,* fostered by: • Leadership from a supportive principal • Highly experienced staff, most of whom have been at the school for more than five years • Staff that is willing to try new initiatives and accommodate the needs of students

* Practice considered central to school's approach to improving math learning.

Source: Authors' compilation based on primary documents gathered at the school, classroom observations, and interviews with teachers and administrators; see appendix A for details.

TABLE 13
Student demographics at Aspen Elementary School, 2006/07

Characteristic	Value
Grade span	K–4
Number of students enrolled	380
Average class size (students)	20
Percentage of students with disabilities (percent with Individualized Education Programs)	14
Percentage of students from low-income families[a]	17
Percentage of students of races other than White	4
Percentage of students with limited English proficiency	4
Percentage of students whose first language is not English	4
Attendance rate (percent)	96

a. The Massachusetts Department of Education defines a low-income student as one who is eligible for free or reduced-price lunch, receives Transitional Aid to Families benefits, or is eligible for food stamps.

Source: Massachusetts Department of Education (2008) and interviews with the principal; see appendix A for details.

TABLE 14
Staff and administration at Aspen Elementary School, 2006/07

Characteristic	Value
Staff	
Number of teachers	28
Student–teacher ratio	12.9: 1
Percentage of teachers licensed in teaching assignment	100
Percentage of core academic teachers identified as highly qualified[a]	100
Percentage of teachers at school five years or more	75
Percentage of teachers at school less than five years	18
Number of special educators	2
Number of teaching assistants and paraprofessionals	17
Administration	
Number of years principal has been at school	14
Number of assistant principals	0
Number of years assistant principal has been at school	1

a. To be considered highly qualified, Massachusetts teachers must possess a valid Massachusetts teaching license at either the preliminary, initial, or professional level (formally known as the provisional, provisional with advanced standing, and standard level) and demonstrate subject matter competency in the areas they teach.

Source: Authors' compilation based on school profile data from the Massachusetts Department of Education (2008), primary documents gathered at the school, and interviews with the principal; see appendix A for details.

Classroom placement of students with disabilities

Almost all students with disabilities at Aspen Elementary School received instruction with general education students. Students with disabilities were placed in one of four classroom settings:

- *A language-based classroom,* in which a third to half of all students had language-related learning disabilities (every grade except kindergarten had such a classroom). These classes were staffed by general educators, special educators, and paraprofessionals.
- *A general education classroom,* taught by a general educator, with in-class or pull-out support as necessary from the Title I math teacher or a special educator.
- *A combination setting of an intensive resource room and general education classroom,* where students with low cognitive skills (IQs of 60–75) from throughout the district are served in an intensive resource room for half the day and in a general education classroom for the other half.
- *The specific instructional program,* taught by a special educator and paraprofessionals, provided individualized instruction to students with IQs of about 30. This program served students from throughout the district. Each student also had a second home in a general education classroom, where they participated daily in activities with general education students.

Highlighted practices at Aspen Elementary School

Aspen staff highlighted several strengths during interviews:

Provision of a variety of math support services. Aspen's active approach to educating students with disabilities and other struggling learners was evident in its variety of math supports. As one teacher noted, "We have a lot of programs and we have a lot of different strategies. We use a lot of hands-on [activities]. Title I and special ed [work] very closely. . . . In this school, we work hand in hand, which is very good."

An array of teachers—including a math Title I teacher, special educators, and paraprofessionals—provided a flexible combination of in-class and pull-out support services: Title I support for math, tutoring to prepare for the MCAS, an intensive resource room, a Response to Intervention program, and language-based classrooms. The district's inclusion facilitator provided additional support for some students with disabilities who were placed in general education classrooms. She worked with their teachers to plan accommodations to meet the students' needs. And the school's instructional support team played an instrumental role in planning services to support students who were at risk academically or behaviorally. The team first used general education services and then made decisions about whether students required special education evaluations.

Title I services. The Title I teacher, the district's former elementary math coordinator, had a strong background in teaching math. Her room—filled with manipulatives, curriculum materials, and math books for all elementary grades—was a resource for teachers and students. At the beginning of every year, she helped classroom teachers identify students who needed extra math support (based on end-of-year assessments). Working with a paraprofessional, she provided students with at least two and a half hours of support each week through in-class and pull-out services. She was extremely flexible in accommodating teacher and student needs. While some teachers preferred to have her work regularly with students in their classrooms, others preferred to send students to the Title I math room to work with her.

Aspen's active approach to educating students with disabilities and other struggling learners was evident in its variety of math supports

Working with small groups in the math room, the Title I teacher tailored instruction to student needs. She adapted math lessons, tried different approaches, reinforced concepts and skills, and previewed material that students would encounter in class—returning students to their homerooms with greater confidence in their abilities. She also used teachers' pacing calendars and lesson plans to coordinate her services with classroom instruction.

In 2004 the Title I teacher started teaching highly interactive math mini-lessons in the language-based and general education classrooms. (These lessons were in addition to regular classroom math instruction.) The lessons previewed material coming later in the year and often addressed such topics as measurement, that teachers rarely covered in time for the MCAS. The Title I teacher also used the mini-lessons to demonstrate to teachers various ways to use manipulatives, which she believed were particularly helpful for student learning. The principal believed that the mini-lessons made a tremendous difference in student learning, leading to higher grade 3 scores on the MCAS.

Before-school tutoring for the Massachusetts Comprehensive Assessment System. In addition to receiving Title I math support during the school day, some students received before-school tutoring sessions from Aspen teachers to prepare them for the math MCAS. The twice a week 50-minute sessions ran 10 weeks and included about eight students. Funded by Title I and grant money, the tutoring was provided to 3rd graders considered at risk of failing and 4th graders who scored at the "needs improvement" or "warning" level on the test the previous year. Other students were also welcome to attend.

Intensive resource room. Students who had more significant disabilities received pull-out support from special educators and paraprofessionals in

the intensive resource room. This one-year-old program served students throughout the district with IQs of 60–75. The district's special education director started the resource room program to provide intensive, small-group instruction to the growing population of these students. (Aspen had a similar resource room many years ago.)

Ten students from grades 1–4 attended lessons in the intensive resource room: 1st and 2nd graders attended in the mornings, 3rd and 4th graders in the afternoon. These students spent the rest of the day in their homerooms with their general education peers. Resource room teachers provided highly individualized language arts and math instruction, reinforcement, and remediation. The special educator modified lessons from the regular grade-level math book and incorporated a variety of hands-on activities. According to her, many students responded well to multisensory approaches, such as the Touch Math program, which provided visual strategies to teach students how to add and subtract.

The Primary Prevention Response to Intervention program. In 2005/06 Aspen's special education director started a Response to Intervention initiative for grades K–2 to identify students with disabilities and other struggling learners, provide them with early intervention services in English language arts and math, and increase accuracy in identifying students with learning disabilities. The Individuals with Disabilities Education Act of 2004 recommends the Response to Intervention approach and allows the use of special education funds to provide these early intervention services in the primary grades.

In 2005/06 Aspen's special education director started a Response to Intervention initiative for grades K–2 to identify students with disabilities and other struggling learners, provide them with early intervention services in English language arts and math, and increase accuracy in identifying students with learning disabilities

Aspen's program was run by Ms. Teale, a primary preventionist with a special education background. She splits her time between two elementary schools in the district. Working with the district's other primary preventionist, she administered screening tests to identify struggling learners in grades K–2. She used the AIMSweb assessment system (http://aimsweb.com) to determine whether kindergartners could identify numbers, discriminate quantities, complete a missing number in a sequence, and count aloud. Students with very low scores received a 10-week intervention program. Those with Individualized Education Programs were generally not eligible for the Response to Intervention program, although exceptions were made if a student was at risk of developing a secondary learning disability.

During each 10-week intervention cycle Ms. Teale met with groups of four students four days a week. Sessions lasted 60 minutes for both math and literature, or 35 minutes for a single subject. Ms. Teale spent every afternoon at a different school. On Fridays she met with the other primary preventionist to plan lessons and analyze student data.

Ms. Teale provided her students with highly structured, individualized instruction, using a program developed by the other primary preventionist and the special education director based on their review of the research literature. The lessons involved many manipulatives, games, and hands-on activities for reinforcement and practice, as shown in the following vignette:

> *Four kindergartners enter the primary preventionist's classroom and sit together at a large table. The lesson begins with counting aloud. Students count forward, using simple rhymes to help them remember the sequence. Then, pretending to be in a spaceship ready for take-off, they count backwards.*
>
> *The teacher gives each student two number cards and asks, "Which number is bigger?" When a student is unsure, she asks the student to make the numbers with connecting cubes so that he or she can see which stack is larger.*
>
> *The next activity involves figuring out which number is missing from a sequence, such as 3, 4, _, 6. Students take turns identifying the missing numbers in the sequences on their cards. Afterwards, they*

work on number composition. "How many ways can you make 6?" the primary preventionist asks. Students explore this by building the addends with two colors of connecting cubes and then share their solutions.

After these warm-ups, the teacher moves to the focus of the day: number sentences. She says, "I had two cubes, and then Kevin gave me four more. Now I have six cubes." She models how to represent this by counting out two yellow connecting cubes and four red ones, and placing them in clear pockets on a chart. The corresponding number cards (2 and 4) are placed underneath to show how the numbers represent the concrete materials. To finish the math sentence, she includes cards with the symbols +, =, and 6 to show that 2 + 4 = 6. She then poses a new story for students to represent—by using cubes and writing number sentences on their whiteboard—and continues the lesson.

The preventionist consistently used the same warm-up sequence in her teaching, to help students build their skills and jump right in to familiar routines. She tried to create a lively, supportive atmosphere so that students felt happy to come to her room. She commented:

Kids themselves are different learners. Some are visual. Some are auditory. Some are kinesthetic. You need to approach it in different manners. I find that I've used [math] with literature even in the beginning with them. In math they didn't know their numbers. I brought in sand, and we were formulating numbers with sand, because they needed to touch it and they needed to feel it.

Ms. Teale used the AIMSweb system to monitor student progress during the intervention; she also administered a test at the end of the 10 weeks. Using these data she determined whether a student needed to be referred for a special education evaluation or for additional support services. Students still struggling could not repeat another 10-week cycle but instead received other support services from the school. The results of the intervention and the plans for each student were recorded in exit summaries and submitted to the classroom teacher, the school principal, and the director of special education.

Aspen's principal believed that students with disabilities and other struggling learners could succeed in a general education setting if instruction was strong, support was ample, and expectations were high

Aspen's Primary Prevention Response to Intervention program had evolved. In the first year one primary preventionist served four elementary schools. In the second, the program added another preventionist, Ms. Teale, to reach more students, and it began using the AIMSweb system to electronically collect and analyze data.

According to the director of special education, one indicator of the program's success was the decrease in the number of special education referrals. Before the Primary Prevention Response to Intervention, there were 81 referrals in the district's elementary schools; there were just 60 referrals the first year of Response to Intervention and 66 the second year. Teachers voiced appreciation for the program's services to struggling learners in the primary grades, particularly kindergartners, who do not receive Title I support.

Inclusive philosophy and practices. Aspen's principal believed that students with disabilities and other struggling learners could succeed in a general education setting if instruction was strong, support was ample, and expectations were high. These elements were evident in the school's four language-based classrooms, in which students with language-based learning disabilities learned with their general education peers. A general educator, special educator, and paraprofessional taught these classes. Because the classes included a range of students, teachers worked hard to differentiate instruction and create a culture of respect for learning differences. Both general and special educators had been trained in programs such as Lindamood Bell (http://www.lindamoodbell.com/) so that they could provide

instructional strategies specifically geared to students with these disabilities.

Several teachers at Aspen Elementary School described the benefits of having a special and general educator working together in an inclusive classroom, particularly because a student's language difficulties could affect learning in all subjects. As one noted:

> *At any given moment of any day—whether you're doing social studies, science, math, or reading—it is all involved [with language]. You have math in science; you have reading in science and social studies. . . . If these kids have a disability they don't just have it for English, they have it in math, they have it in all these other subjects, so having a special ed person there for all of these subjects is wonderful. [Students] can be helped throughout the curriculum, throughout the course of the day. That to me is ideal.*

Several staff members noted the advantages to staffing an inclusion class with a pair of coteachers rather than having different people providing in-class and pull-out services. The consistency in the classroom allowed more continuity in teaching, minimized transitions for students, and gave teachers a better grasp of their students' understanding.

Over the years Aspen's commitment to inclusive language-based classes remained strong. However, budget and policy changes in the district had affected these classes. Initially, each language-based class had three full-time staff members: the classroom teacher, a special educator, and a paraprofessional. Later, each special educator split time between two classes; after two years the paraprofessionals also had to split their time between a classroom and the resource room. Some teachers were concerned about the decrease in staffing, believing that the original model was instrumental in improving the math learning and performance of students with disabilities and other struggling learners.

Aspen's teachers used the same math curriculum for students in general education and language-based classrooms

In response to these changes three veteran staff members (a grade 4 teacher, a special educator, and the Title I teacher) proposed a way to maintain as much in-class math support as possible. The special educator and the Title I teacher coordinated their schedules so that one of them was in the class each day for the full math lesson (75 minutes). The general educator provided lesson plans a week in advance so that the other two teachers could anticipate potential barriers and plan ways to help struggling students.

Teaching math to a range of learners. Aspen's teachers used the same math curriculum for students in general education and language-based classrooms. The district aligned the curriculum with the Massachusetts State frameworks and put together a pacing calendar with designated dates for administering benchmark assessments.

Aspen's mission statement affirmed its commitment to providing differentiated learning instruction using multisensory approaches. Teachers embraced this philosophy, using a variety of instructional strategies to meet the needs of a range of learners, including those with disabilities. The following strategies were mentioned in interviews or noted in classroom observations:

- *Using hands-on activities, manipulatives, math games, and computer programs.* By seeing, touching, and working in different ways, students with varied learning styles and abilities built an understanding of math.

- *Using multiple representations to help students grasp math concepts.* For example, one teacher used visual and numeric representations to help students understand decimals.

- *Having students work in pairs or small groups.* Teachers often paired a struggling learner with a student who was stronger in a particular area.

- *Providing small group instruction.* Teachers believed that working with small groups of struggling students helped teachers gauge students' understanding and tailor instruction accordingly. If two teachers were in the room, the special educator could work with a small group while the other teacher helped other students.

- *Using math centers or work stations.* Teachers set up stations with different math activities and had students move from station to station. Teachers provided individual attention to students at particular stations.

- *Having students use math journals to reflect on a lesson or explain reasoning and strategies.* Teachers noted that using journals helped students learn math and improve their ability to solve the multistep, open-response math problems found on the MCAS test.

- *Connecting math to real-world contexts.* During one observation a kindergarten teacher invited the school's baseball coach to share stories about his team's last game. With baseball caps on, students enthusiastically tallied the team's record of strikes, runs, wins, and losses.

Inclusive culture. Teachers described Aspen as a welcoming place that embraced all students. One teacher noted that visitors would not easily be able to identify struggling learners in inclusion classrooms. Her colleague remarked, "Everyone is included. [Students with disabilities] are not isolated. They're not in the dungeon. They're not in the basement. Everyone's included. Everybody has a purpose and everybody is here. I think that's huge—just being included and having a homeroom and having friends."

Students at Aspen Elementary School seemed to feel comfortable receiving extra help from teachers. One teacher attributed this ease to the general education students who were welcoming and nurturing when students with severe disabilities from the specific instructional program classroom joined their classrooms.

Teachers described Aspen as a welcoming place that embraced all students

The principal helped build this positive culture through her example of warm and open interactions with all students, including those with severe disabilities. She instituted a practice of focusing each month on an attribute of good citizenship, such as respect, responsibility, fairness, patriotism, courage, self-discipline, honesty, or kindness. The principal conveyed the theme of the month, providing ideas on how teachers could inspire students to value such character traits. In addition, the school district instituted an antibully program, which begins in kindergarten. Thus, the message of respect and inclusion for all students was reinforced from the earliest grades at Aspen Elementary School.

Leadership that fosters a welcoming community. Having been a principal, reading coordinator, and special education team leader in another district, Aspen's principal understood what a school needs to foster learning for all students. She held strong beliefs about what organizational structures and practices best supported students with disabilities. She promoted child-centered and hands-on activities as well as multiple approaches to help students understand math. One special educator shared her appreciation for the principal's openness to teachers and students with disabilities:

> *She's very open-minded. Any time I've ever asked her for any type of materials, she's always said, "Let me look into it. I'll get right on it." And if I've had questions about things, I've been able to go to her and say, "Well, what do you think of this? What do you think of this?" And because she does have a special ed background, she's done it, been there, or tried it. And she's just very warm. Because she's had experience with special ed, she's not . . . timid around students [with severe disabilities].*

Teachers spoke highly of the principal, whom they described as offering teachers trust, autonomy,

and flexibility while expecting hard work and commitment. The principal, in describing her personal style, said, "I think [teachers] have to feel ownership of what they're going to do. . . . They definitely have to be empowered. We pretty much are a consensus building [organization]. I'm open to any suggestions." Teachers felt she encouraged collegiality and creativity and described her as understanding, positive, supportive, witty, warm, and community oriented.

The principal was also a forward thinker who enthusiastically piloted new ideas. Aspen was the first school in the district to set up language-based classrooms. Because the principal believed letter grades were not appropriate for primary-school students, she designed and piloted a new report card. Other initiatives included creating a student council and surveying parents each year for school improvement suggestions.

The student council was created to give students a voice in school decisions. Twice a month during recess, the principal met with grades 3 and 4 student council representatives. School council members gathered input from their classmates, planned fundraising activities, and decided how to spend the money. (One year they purchased a climbing wall for the school's gym.)

Receptive to parent input, the principal welcomed parents and built relations with the community through weekly newsletters, monthly coffee hours, and many school events for families. The school had an active parent-teacher organization and a school improvement council. Made up of three parents, two teachers, and the principal, the council developed the annual school improvement plan after conducting a survey on what parents would like to see improved or done differently.

Teachers could freely enter one another's classrooms to borrow materials and were comfortable turning to one another for help and sharing expertise

Highly experienced teaching staff. Aspen's teachers had many years of teaching experience and had worked together at Aspen for many years (21 of the school's 28 teachers had been at Aspen more than five years). The school had experienced special educators as well as several general educators with special education backgrounds. Teachers could also draw on the math expertise of the Title I math teacher.

Teachers described the Aspen staff as hardworking, dedicated, collegial, warm, and welcoming. Teachers could freely enter one another's classrooms to borrow materials. They were comfortable turning to one another for help and sharing expertise. As one teacher observed:

> *I feel like on the whole the staff gets along well with each other. . . . We work well together. We share well with each other. If you say, "The kids aren't getting such and such," someone will respond, "What I do with my class is" and the next thing you know, they're whipping out worksheets and everything. . . . Everyone is more than happy to help each other.*

Another teacher noted a desire to experiment—"This school was the first school where people were trying a lot of these new things on their own."

Many staff members attributed the positive staff culture to the principal's initiatives and leadership. She conveyed the message that "kids are first." She also encouraged the development of staff relationships beyond the classroom. During a staff meeting the principal asked the teachers, "Do you know each other? Do you know what the person sitting next to you likes to eat?" She wanted the staff to personally know and care for each other. Teachers felt empowered and were willing to help both students and colleagues. As one teacher commented, "We have a special group of people here who go above and beyond, maybe because it is such a comfortable atmosphere. I think that comes from the top down. It's a very helping atmosphere; people feel like they can do anything."

Several teachers commented that one reason why the staff was so collaborative was that they shared a long history of teaching at the same school. There was some concern about future turnover as

veteran teachers retired, but staff also recognized the potential for mentoring new teachers so that the experience of the veteran teachers could be passed on.

Remaining challenges

Math support services, inclusive practices, leadership, and collaboration among an experienced staff contributed to Aspen's success. Several challenges nevertheless remained:

- *Scheduling support services was difficult.* Although welcomed, the addition of the Response to Intervention and resource room programs exacerbated the problem of scheduling pull-out services so that students did not miss too much of their general education classes. Teachers were concerned that some students did not respond well to the transitions and would not feel like full members of their homerooms.

- *Common planning time was not provided.* Although teachers often collaborated informally (before school, by phone and email), they felt limited by the lack of a weekly common planning time with grade-level colleagues. Teachers were relieved of recess duties so that they could have an extended lunch period together, but many believed this small increase was not sufficient for planning with colleagues.

- *Staffing for language-based classrooms had been reduced.* Budget cuts, changes in the district's special education population, and new programs led to a decrease in special education staffing in language-based classrooms. To address this issue, teachers worked collaboratively and flexibly to meet student needs. Nevertheless, some teachers voiced frustration about the effect of these changes on the amount and kinds of support that could be provided.

- *Teachers found it difficult to implement many new initiatives simultaneously.* In recent years the district had launched many new initiatives, including a new math curriculum, an antibully curriculum, and a writing program. Teachers spoke positively about those programs but also cited the difficulties of implementing multiple initiatives in a short time. Teachers felt more comfortable with the math curriculum after two years but questioned how well the curriculum's spiral approach worked for students with disabilities and other struggling learners. Teachers also raised concerns with the pacing calendar and a new requirement to administer district benchmark math assessments at designated times. To help with these issues, in-house math curriculum support was available from the Title I teacher, a primary grade classroom teacher, and the district's elementary math coordinator.

Math support services, inclusive practices, leadership, and collaboration among an experienced staff contributed to Aspen's success

Looking forward

In considering ways to improve existing practices, Aspen's principal would like to see more professional development in teaching math—for teachers and herself. The teachers are working to get common planning time built into the school day so that they have a regularly scheduled opportunity to collaborate. To better coordinate services, the administration and staff are seeking ways to increase communication among the many educators who provide math instruction and support for students with disabilities and other struggling learners.

BEECH ELEMENTARY SCHOOL: SUPPORTING STUDENT LEARNING BEFORE, DURING, AND AFTER SCHOOL

At Beech Elementary School, a K–5 school in New York City, administrators and staff collaborated to improve math learning for a range of students.

Administrators and staff identified one practice as central to their school's approach:

- *Math supports and interventions provided during and outside the regular school day.* Every grade had a collaborative classroom in which students with disabilities and general education students were taught by full-time general and special education coteachers. A variety of programs also provided interventions for students who were struggling academically and who scored below designated performance levels on state assessments. These programs included services provided during the school day as well as before and after school, on Saturdays, and during the summer.

Other highlighted practices included:

- *Knowledgeable math coaches who supported classroom teachers.* Throughout the school year math coaches helped teachers implement the math curriculum and provided ideas and materials for classroom instruction. They modeled lessons in teachers' classrooms, trained new staff, provided professional development, and held family math events.

- *School-designed assessments.* Starting in 2005, a team of teachers and math coaches designed their own assessments for the primary grades, to create a formal way to identify struggling learners and measure student progress over time.

- *An administrative team that fostered leaders.* Beech's administrative team encouraged teachers to take advantage of professional development and to assume leadership positions. It also delegated administrative responsibilities to teachers.

Beech projected a sense of relaxed efficiency and safety: despite its large size, there was little noise or disruptive behavior in classrooms, hallways, or the lunchroom

These practices were just part of Beech's approach to math (table 15).

Overview of Beech Elementary School

Beech was one of the largest primary schools in its New York City borough in 2006/07, with some 1,240 students (table 16). Many students' families were immigrants from Guyana, the Caribbean, the Philippines, Haiti, and parts of South and Central America, and just 2 percent of the student body was White. About 10 percent of students (125 children) had identified disabilities. Most of the student body came from low-income families, with 81 percent eligible for free or reduced-price lunch. Classes were large, with an average size of 29 students.

Beech had a designated program for students with physical disabilities. The building had elevator access and provided trained paraprofessionals to assist students in wheelchairs. The school also offered adapted physical education and other services.

Beech projected a sense of relaxed efficiency and safety. Despite its large size, there was little noise or disruptive behavior in classrooms, hallways, or the lunchroom. A uniformed officer welcomed everyone at the door (a common practice in many urban schools) and had visitors sign in for passes. Student art adorned the walls. And a bulletin board displayed monthly attendance graphs for each classroom.

The Beech administration included a principal and three assistant principals, who oversaw a large teaching staff (table 17). Students with disabilities and other struggling learners received support from special educators, paraprofessionals, and special service providers. The school also had a general education teacher support services teacher, who coordinated and provided services for struggling students who did not have Individualized Education Programs or 504 plans.

Classroom placement for students with disabilities

Beech used a variety of classroom structures to serve its large student body:

TABLE 15
Snapshot of practices at Beech Elementary School, 2006/07

Practice	Description
Classroom math instruction	Math instruction time: 60 minutes a day (grades K–2); 90 minutes a day (grades 3–5)
	Curriculum: Everyday Mathematics, implemented for four years
	Placement of students with disabilities and other struggling learners: inclusion classrooms with full-time general and special education coteachers, general education classrooms taught by general educators (and paraprofessionals when the class includes students with severe disabilities), self-contained classrooms for students with severe disabilities, gifted and talented classrooms for students performing well above grade level, dual-language classrooms with instruction in Spanish and English on alternating days (participation by parental request)
	Accessible instruction: varied strategies include manipulatives, small groups, math journals, differentiated instruction
	Pacing calendar
Math supports and interventions	Wide variety of math support services, including:* • In-class and pull-out support, lesson accommodations, and progress monitoring by special educators • General education teacher support services teacher, who provides math instruction, coordinates intervention services, and monitors progress for struggling students who do not have Individualized Education Programs • Academic intervention services in an extended day program for students at risk and students who scored below proficient on the state assessment • Programs for academic help outside school hours: Project Sunrise, Project Sunset, Saturday academy, and summer school
	Math coaches help teachers implement the math curriculum and pacing calendar and work with teachers in the classroom*
Assessment	Team of teachers and math coaches developed assessments for grades K–2 as part of New York City's Design Your Own initiative*
	Daily observations, class work, and assessments are based on the math curriculum
	Five Princeton Review tests administered each year to students in grades 3–5
	Assessment results used to inform instruction and determine who receives academic intervention services
Collaboration among teachers	General and special educator teams coteach full time in inclusion classrooms
	Scheduled weekly common planning time available for grade-level teachers
	Math coaches frequently collaborate with literacy coaches
Professional development	Math coaches conduct professional development, train new teachers, and model lessons to demonstrate workshop model
	Principal attends and sends math leaders to professional conferences
	General education teacher support services teacher trains paraprofessionals
Leadership	School administrators: principal, three assistant principals, health services coordinator, and disciplinary dean, each assistant principal supervises teachers and paraprofessionals in two grades and oversees different curriculum areas
	Administration makes math a priority by overseeing the curriculum, hiring math coaches, fostering leadership, and attending math conferences with staff*
	Principal initiated development of Design Your Own assessments for grades K–2
School culture	Staff culture described as collegial, caring, warm, receptive, and supportive
	Numerous academic services show staff's commitment to helping students succeed
	Environment is disciplined, safe, and welcoming for students

* Practice considered central to school's approach to improving math learning.

Source: Authors' compilation based on primary documents gathered at the school, classroom observations, and interviews with teachers and administrators; see appendix A for details.

TABLE 16
Student demographics at Beech Elementary School, 2006/07

Characteristic	Value
Grade span	K–5
Number of students enrolled	1,240
Average class size (students)	29
Percentage of students with disabilities (percent with Individualized Education Programs)	10
Percentage of students eligible for free or reduced-price lunch	81
Percentage of students of races other than White	98
Percentage of students with limited English proficiency	10
Percentage of students whose first language is not English	—
Attendance rate (percent)	94

— is not available.

Source: Authors' compilation based on data from the New York State Education Department (2005a); see appendix A for details.

TABLE 17
Staff and administration at Beech Elementary School, 2006/07

Characteristic	Value
Staff	
Number of teachers	80
Student–teacher ratio	—
Percentage of core classes taught by highly qualified teachers[a]	98
Percentage of teachers with valid teaching certificates	100
Percentage teachers with master's degree plus 30 hours or doctorate	45
Percentage of teachers at school five or more years	64
Percentage of teachers at school less than five years	36
Number of special educators	12
Number of paraprofessionals	22
Administration	
Number of years principal has been at school	4
Number of assistant principals	3
Number of years assistant principals have been at school	1, 4, 5

— is not available.

a. To be considered highly qualified, New York State teachers must have at least a bachelor's degree, be certified to teach in their subject area, and demonstrate subject matter competency.

Source: Authors' compilation based on New York State Education Department (2005a), primary documents gathered at the school, and interviews with the principal; see appendix A for details.

- *Collaborative classrooms,* which were co-taught by one general educator and special educator, were available in all grades. Forty percent of the students in these classes had Individualized Education Programs or 504 plans.

- *General education classrooms* were taught by a classroom teacher and could include some students with disabilities. A paraprofessional could assist in the classroom if the class had students with more severe disabilities. Some general education classrooms had a second teacher to assist English language learner students.

- *Self-contained classrooms*—one for grades K–2 and for grades 3–5—were available for students with severe disabilities. The classes were taught by special educators, with support from paraprofessionals.

- *Gifted and talented classrooms* were for students performing well above grade level.

- *Dual-language classrooms* were offered in each grade level, with instruction in Spanish and English on alternating days. Participation was by parental request.

All students in grades K–2 received 60 minutes of math instruction daily; students in grades 3–5 received 90 minutes of daily instruction. All grades followed a pacing calendar for math that included New York State standards and suggestions for lessons. Each week objectives from Everyday Mathematics were listed, along with recommendations for supplementary work from *Math Steps*, a homework and test preparation book that promotes practicing skills and strategies. Assessments in Everyday Mathematics

address skills and concepts for each unit and identify the degree of mastery students are expected to achieve.

Highlighted practices at Beech Elementary School

Four strengths were consistently highlighted during interviews with Beech staff and administrators: math support and interventions during and beyond the school day, math coaches who support classroom teachers, design your own assessments, and an administrative team that fosters leaders. Each is discussed here.

Math support and interventions during and beyond the school day. Every grade level at Beech Elementary School had a collaborative classroom, in which about 40 percent of students had disabilities. The classes were cotaught by full-time pairs of general educators and special educators (called collaborative teams), sometimes assisted by a paraprofessional.

Teachers used manipulatives, math journals, and flexible grouping strategies in which one teacher worked closely with a small group of struggling students while the other led the rest of the class. Teachers used activity stations to work with small groups of students, as described below:

> *In the integrated 1st grade classroom teachers and students are seated on the rug. All students can see an easel that has chart paper with strategies on how to solve problems. A paraprofessional sits nearby at a table.*
>
> *The teachers explain what students will do at different math stations. The general educator begins by modeling a problem from one of the stations. She holds up a card that says 7 + __ = 14 while making up a story that corresponds to the mathematical notation. "Joshua has seven seeds. He wants 14. How many more does he need?" she says. The general educator holds up a 100 grid on which she shades in 7 and 14. She counts aloud how many places it takes to reach 14: "One, two, three, four, five, six, seven. I found out how many are missing."*
>
> *Next, she pulls out a card that reads 10 + __ = 16 and makes up another story. She asks the students to turn to a partner and describe what strategy they might use to solve the problem. A buzz of discussion breaks out. The paraprofessional leans forward and interacts with several students in front of her. They share different ideas on how to solve the problem.*
>
> *After a short time of sharing, the special educator introduces a skip-counting activity for another math station. "I'm going to choose a number," she says. She writes the number 32 (on a strip of paper with reusable laminated strips) and then rolls some dice. She rolls a six, so students will skip-count by six. Using her fingers and the number grid, she shows how she solves 32 + 6, and she writes, "32, 38." She then instructs students to turn to a partner and tell the partner another way to solve the problem. After some discussion, she pulls the class together and shows how an algorithm can help solve 32 + 6. She continues the sequence on the strip of paper, "32, 38, 44, 50."*
>
> *After the stations are fully explained, the children go to them in groups of four. The teachers and paraprofessional go to different stations, helping students solve problems and asking questions to check for understanding. After 20 minutes students make the transition to the next station.*
>
> *The teaching styles of the general educator and special educator appear to blend naturally. Each takes turns sharing parts of the lesson while emphasizing different aspects of the directions and concepts in the activities. When the class breaks into small groups, the teachers give personal attention to students who need more support, and they differentiate lessons to accommodate the range of learners. The lesson addresses important math content—strategies for solving addition problems—in ways that were accessible and engaging to struggling learners and general education students.*

Every grade level at Beech Elementary School had a collaborative classroom—in which about 40 percent of students had disabilities—cotaught by full-time pairs of general educators and special educators

Intervention services from the general education teacher support services teacher. Beech provided extensive services for general education students who struggle in math. Central to these services was the general education teacher support services (GETSS) teacher, who conducted screening tests, recommended appropriate programs, and coordinated all intervention services for general education students. During the school day she instructed struggling learners in her classroom, using skills-based, hands-on, and computer activities. She focused on helping grades 3–5 students who failed the New York State assessment. She also referred students to before- and after-school support services, which she coordinated, and scheduled and trained paraprofessionals in programs such as Great Leaps, designed to foster fluency in basic math facts and operations using one-minute oral and written activities.

When a classroom teacher referred a student, the GETSS teacher conducted a battery of assessments and created a detailed log of the student's skills and knowledge. She then chose the most appropriate intervention or academic support from among the school's programs, providing some interventions herself. She stressed the importance of understanding each child's learning style and communicating her findings to the classroom teacher.

The GETSS teacher worked with three to six students at a time, grouping students by grade and class at the beginning of the year. As the year progressed, she grouped them by academic need, sometimes mixing students from different grades:

> *I limit my group to six. To me, once you're past six, you've lost that one-on-one time. And sometimes I have to switch the groups. I have a 3rd grader who started out slightly below level for 3rd grade math and [then moved up], so I can put him with my slower 4th grade students now. So, that's where this program is kind of ideal.*

Students at Beech identified as at risk by the New York State exam, school assessments, or teacher observations received individual or small group instruction from their classroom teachers from 8:00 to 8:30 a.m., five days a week

The teacher viewed herself as a liaison between the student and the classroom teacher. She occasionally went into classrooms to observe and support lessons. She wrote personal intervention plans to communicate the learning styles of students to teachers. And she tracked individual student progress and led meetings to review and evaluate whether students had improved. If students did not show progress, they were referred to the special education team for possible testing.

Intervention programs outside the school day. Students struggling with math could take part in before- and after-school, Saturday, and summer school programs. Depending on the complexity of their needs, they could take part in several programs (table 18).

New York State mandates that schools provide academic intervention services to students who do not achieve proficiency on the state exam. In New York City the teachers' contract was changed so that teachers work an extra 37.5 minutes four days a week to provide academic intervention services. The Beech administration decided to redistribute the time allotted to provide academic intervention services five days a week instead of four.

Students at Beech received individual or small group instruction from their classroom teachers from 8:00 to 8:30 a.m., five days a week. Students who attended this extended day program had been identified as at risk by the New York State exam, school assessments, or teacher observations. By state mandate attendance was required for the entire school year, and each group could include no more than 10 students per teacher (5 for self-contained classrooms). Beech's principal tried to keep the groups even smaller (five to seven students per teacher). A specialist in an academic subject (such as music, technology, or science) or a special service provider assisted the classroom teacher during these before-school sessions.

TABLE 18
Math support and intervention programs provided outside the school day at Beech Elementary School, 2006/07

Program	Availability	Student grade level
Extended Day (academic intervention services)	8:00–8:30 a.m., Monday–Friday	K–5
Project Sunrise (before-school tutoring)	7:00–7:45 a.m., Monday–Friday	1 and 2
Project Sunset (after-school tutoring)	3:00–3:45 p.m., Tuesdays and Thursdays	2–5
Summer school	Summer	2–5
Separate summer school component (English as a second language)	Summer	3–5
Saturday Academy (tutoring)	Saturdays	2–5

Source: Authors' compilation based on primary documents gathered at the school and interviews with school staff.

Teachers viewed the current extended day structure as a great improvement over the previous year's program, in which students received academic intervention services after school from teachers other than the classroom teacher. The new program allowed teachers to build on relationships with their students and align the additional support with their classroom instruction. Teachers reported that most students concentrated better in the morning.

In addition to academic intervention services, the school's classes were held from 7:00–7:45 a.m., Monday through Friday, under the school's Project Sunrise program. It provided instruction and support to students in grades 1 and 2 in English language arts and math. Project Sunset, for grades 2–5, held classes from 3:00–4:45 p.m., on Tuesdays and Thursdays. This program focused on test preparation for the state assessment by teaching strategies and using practice tests. Both programs ran from October through April and were supported by city and Title I funds.

Summer school was a citywide mandate for all students in grades 3–5 who failed the state exam. Students from three city schools attended Beech summer classes. Beech also ran a Saturday Academy for students in grades 2–5. Both the Saturday Academy and English as a second language classes were staffed with classroom teachers who were compensated for this work.

Math coaches who supported classroom teachers. In 2003/04 New York City required that all elementary schools include a math coach to assist schools in implementing the new math curriculum, Everyday Mathematics. Beech's principal hired a second math coach in 2004/05, to better support the many teachers in this large school. One coach worked with K–2 teachers and the other supported teachers in grades 3–5. Although New York City no longer required a math coach at every elementary school in 2006/07, the Beech principal continued to believe that the coaches played an important role in the school's math program.

The math coaches worked with teachers to increase the quality and consistency of math teaching in all grades. They helped teachers implement the math curriculum and pacing calendar. They conducted periodic professional development sessions during staff meetings. And they were available to answer questions, provide resources, and order curriculum materials. Coaches did not evaluate teachers.

Coaches supported teachers by using the Teachers College workshop model for math. This instructional model, designed for writing, was mandated for all subject areas by the New York City Department of Education. The model consisted of a mini-lesson, small group or independent work, and whole-group discussion. One of the math coaches described the approach as follows:

The children are partners in the lesson. So, we allow them to turn and share instead of calling on 30 kids. . . . [Students] turn and talk to their partner; meanwhile, I'm circulating [and] listening . . . [and] at the end, I say, "You know, I've heard some great answers." And I ask the child, "Do you mind if I share that, or would you mind sharing that information?" In the beginning you introduce the lesson for about 10 minutes. [Then] you send them off on their own with their partner, or you pull aside the ones you feel could use extra assistance. And after that, you wrap up. We share. That's the workshop model.

At the start of the school year the coaches focused on helping new teachers. Later, they worked with different teachers for about a week at a time. (Because of the school's large staff, the coaches could not work with every teacher every year.) The coaches conducted model lessons and cotaught. One coach described how this helped teachers see ways to use different teaching strategies with their students:

We conduct demonstration lessons where the teachers are watching us implement the workshop model. We conduct team-teaching lessons [with the classroom teachers], where both of us are teaching, [sort of a] tag team [approach]. Everything that I do or say to the children is really there for the teacher to hopefully catch on to why I said it. At the end, I debrief and say to them, "I don't know if you noticed, but. . . ."

Modeling lessons was one of the ways the coaches supported the implementation of the math curriculum and the workshop model. Their approach was observed in the following lesson:

Modeling lessons was one of the ways Beech's math coaches supported the implementation of the math curriculum and the workshop model

The math coach arrives at a grade 2 classroom to model a lesson on decimals. The 28 students sit at desks that are arranged in groups to facilitate small group work.

The coach introduces the New York State learning standard for the day: learn how to enter money amounts into a calculator and understand the data display. Using the workshop model, she starts the mini-lesson. She connects to students' experiences by asking, "How many of your parents take a calculator to the grocery store?" She then displays a calculator on the overhead and asks students to talk to a partner in response to the question: "How would you input $3.58 into a calculator?" The room hums with conversation as students talk and use the calculators at their desks. The coach and teacher walk around to listen.

The coach brings the group together and asks, "How can we enter the 58¢ when we don't have a cents sign on the calculator?" Students are eager to propose strategies. Then she asks students to work with partners to "add 65¢ to $3.58." After the problem is solved, she asks, "How many of you feel comfortable with entering money amounts in the calculator? Put your thumbs up." She reassures the class, "It's OK not to be comfortable. There are things that I'm not comfortable with."

The next part of the lesson involves problems from the math books. As students work with partners, the coach and teacher circulate to provide help as needed and ask questions to check for understanding. Students appear to be comfortable keying in amounts such as $1.50, but are surprised that when they press the equal sign, it shows 1.5. When a student raises questions about this, the coach encourages him to figure it out himself.

At the end of class the students gather on the rug to hear the coach read a math-related picture book. In the story a girl is trying to save 50¢ in a penny pot to have her face painted at a fair. Each time someone added money to her pot, the coach asks, "How much money does the girl have? How much money does she need?" She calls on individual students as well as the whole class to count with her. Students are eager to participate in the counting and all show thumbs up when she asks if they enjoyed the story. Throughout the lesson the coach's expert use of questioning, partner work, and careful attention

to individual needs provides a helpful instructional model.

The role of the math coaches evolved. At first some teachers were reluctant to work with them, fearing that the coaches were there to "spy" on them. This posed a challenge because New York City Teachers' Union regulations state that coaches could not go into classrooms unless invited by teachers. To help teachers feel more comfortable, the principal communicated that he wanted the coaches to lead model lessons but not conduct observations.

With persistence and patience the coaches were able to establish trust. The coaches said that they strived to establish a nonthreatening partnership with teachers. Teachers regarded them as math leaders to whom they could go for support and resources. One teacher shared how the primary math coach helped her during her first year of teaching:

> *I can always go to the two math coaches and ask them for support and ideas. When I was a new teacher, [the coach] came in for a week and we worked as a team. We set up the workshop model to get on pace. If I have trouble, I always can go to them. . . . [T]hey're more than willing to come in and help.*

In addition to helping teachers, coaches communicated with parents about the math program. They provided suggestions and helped parents understand the curriculum's approach. As one math coach explained, parents "come to us, and we suggest . . . materials that they can use or certain web sites that they could use to assist [their children]. We help with their knowledge of the curriculum because it's a new math, so some parents are very confused about it."

Each year the school organized two math game nights—one for grades K–2 and one for grades 3–5—to help parents understand the components of the curriculum. Parents learned about the educational value behind Everyday Mathematics games and how assessments were scored. Game nights were popular with families, with more than 700 people attending the two events one year.

At all grade levels Beech teachers used informal and formal math assessments—daily observations, in-class work, and end-of-unit assessments from the curriculum—to evaluate students' understanding and guide instruction

The two math coaches collaborated regularly and worked closely with the school's two literacy coaches. The four coaches shared office space, held monthly meetings, attended grade-level meetings with teachers, and shared common preparation times. They also met weekly with the principal and assistant principals.

School-designed assessments. At all grade levels teachers used informal and formal math assessments—daily observations, in-class work, and end-of-unit assessments from the curriculum—to evaluate students' understanding and guide instruction. Students in grades 3–5 also took the New York State exam and five Princeton Review tests each year. Test preparation was conducted through out-of-class programs, academic intervention services, and in-class assignments from Math Steps.

In the past grades K–2 lacked formal indicators for evaluating student progress. To change this, the principal applied to New York City's Design Your Own assessment program.

Beech began implementing the Design Your Own assessment program in 2006/07. Following the guidelines of the New York City Department of Education, math lead teachers for grades K–2 and math coaches worked with a consultant to develop five assessments for each grade. The principal found time, funding, and coverage for Design Your Own assessment team members, who met for 15 days during the summer and continued meeting during the school year. They began by carefully comparing the state standards with those of Everyday Mathematics and discovered gaps in the curriculum and other places where the curriculum went beyond state frameworks. Teachers

developed their own assessments to measure students' progress on the state standards and to ensure that those standards were taught. As one teacher said, "Before this, you would grade them on Everyday Mathematics standards, but now you know there are state standards. . . . It changed expectations." The team worked closely with the consultant to develop the test items for each grade level. Having an outside consultant (a New York City Department of Education requirement) helped to facilitate the process and brought in expertise in assessment design and math content.

During the first year the Design Your Own assessment team administered and hand-scored tests for all classes. This was a time-consuming process, because the assessments needed to be administered individually to kindergartners and read aloud to 1st graders. The team spent about two hours a day for five weeks implementing the assessments. Based on their experience with the pilot, the team made changes to clarify test questions and help teachers administer the tests. The results of the assessment were shared with classroom teachers. In the future classroom teachers will administer the assessments themselves, in order to benefit from the process firsthand.

Although the process took considerable planning and effort, team members agreed that the benefits were worthwhile. Team members gained in-depth knowledge of the standards and the assessments helped them identify weak content areas. One team member said, "I wish we had more people on the team; [team members] benefited from it so much that I wish everybody could have benefited from it. But I don't think it would have been as productive." Another team member stated, "We use the tests to distinguish which children are struggling. But we also use the tests to [perfect] our own teaching." As planned, the assessments were guiding instruction. In addition, teachers were using the assessment results to identify students at risk and make referrals to academic intervention services.

Beech's administration created a supportive and welcoming environment for new and veteran teachers

An administrative team that fostered leaders. Beech's administration created a supportive and welcoming environment for new and veteran teachers. As one special educator stated, the culture "comes down from the administration, because the administration is always [available]. If you want to go and speak to anyone, they're more than receptive to it. It trickles down and makes it such a warm environment. It really does."

Principal. Previously a math teacher, middle school dean, and assistant principal (for 15 years) at another New York City school, the principal had been at Beech Elementary School for four years. In his leadership role he set clear expectations and trusted his staff to fulfill them.

The principal built leaders and delegated responsibilities to individuals he believed would do a job well. He made an effort to learn the strengths of his teaching staff and develop potential leaders:

> *I don't believe in micromanaging things, but I do believe in laying out my expectations. I tend to give people little jobs and then see how they accomplish them before I give them bigger jobs. I try to scaffold them into taking responsibility and becoming leaders in their own right.*

Teachers considered the administration to be well organized and supportive. One teacher identified the principal (and his background as a math teacher) as one of the reasons the school's math program was so strong.

For math coaches the principal selected staff members who were excellent teachers. He also promoted the development of math teaching knowledge. When opportunities to attend math conferences arose, he sent a math leader from each grade level. He and the math coaches also attended the National Council of Teachers of Mathematics conference every year to learn about the latest research and teaching practices that support math learning.

When he saw a need, the principal created new roles that would address the specific issues in his

school—such as the general education teacher support services teacher position and the second math coach. He preferred to fill these roles with experienced, well respected teachers from the school rather than with outsiders, whom staff tended to view less positively.

The principal also helped new teachers adjust to Beech. At the beginning of the year, he held after-school meetings so that new and old staff members could become familiar with each other. A special educator said that in her first year these meetings gave her the chance to meet other new teachers going through similar experiences; she felt supported by the principal's initiative.

Assistant principals. Because of Beech's large size, the principal shared leadership responsibilities with three assistant principals. Each supervised teachers at different grade levels and had specific responsibilities, such as math and literacy. One special educator voiced his appreciation for the assistant principal who oversaw special education: "We actually have an assistant principal who used to be a special ed teacher, so she's extremely involved with special ed children. . . . I think she knows every child with a disability. I think she knows everybody's name."

In addition to the assistant principals, the school had a dean who oversaw behavioral issues. The school's disciplined environment was evident in the classroom observations and in the orderly way in which students walked through the hallways.

Health coordinator. One of the ways Beech fostered an inclusive culture was through its health coordinator. As described by one of the assistant principals, she was the "meeter and greeter" who welcomed students with physical disabilities. She made sure that the school was meeting the medical, physical, and health needs of all children, especially students with Individualized Education Programs and students who needed physical accommodations. She trained paraprofessionals, ensured that state regulations were met, and was the critical link among administrators, teachers, parents, and students with disabilities and other struggling learners.

Beech Elementary School's disciplined environment was evident in the classroom observations and in the orderly way in which students walked through the hallways

Remaining challenges

Beech Elementary School addressed the diverse needs of its students, including those with disabilities, with a variety of services. But school staff and administrators reported remaining challenges:

- *Physical space was limited.* The student population continued to grow, causing a lack of space and large class sizes (some exceeding 30 students). During one whole-class instruction, students were supposed to gather on the rug, but there was insufficient room, forcing many to sit in chairs around the rug's perimeter.

- *Pairing coteachers posed some challenges.* Collaborative classrooms cotaught by a full-time general educator and a special educator had many benefits, but finding the right teaching partners could be challenging. Although most teams worked well, some had difficulties. The personalities and teaching styles of the teachers must be complementary.

- *Too little communication took place between out-of-class and classroom teachers.* One teacher noted the need for more communication between general educators and the teachers for Project Sunrise and Project Sunset. With more feedback from general educators, the Project Sunrise and Project Sunset teachers could direct their instruction more effectively to a student's specific areas of weakness.

- *The workshop model was not always applicable to the math curriculum.* A few teachers noted that the workshop model—intended for writing—was challenging to apply to some math lessons. They also felt that the mini-lesson format did not provide enough instruction for some students.

Looking forward

In looking toward the 2007/08 school year, Beech's principal intended to decrease class size and create more classrooms. "As of next year . . . I'm closing down a computer room, having a new room built, and opening up another 2nd grade class, so we'll go to nine 2nd grade classes rather than eight." He also planned to provide more staff support in classrooms, reducing the student–teacher ratio.

Beech also planned to refine its use of design your own assessments in 2007/08, administering them in grades K–2 at the same time that the upper elementary grades take the Princeton Review tests. Classroom teachers would administer the tests, collect and analyze the data, and use the data to gain a better sense of students' academic mastery, and how to focus instruction. Math coaches would be integrally involved in this effort. They would also help Beech implement a new edition of its current math curriculum.

WILLOW SCHOOL: VERTICAL COLLABORATION SUPPORTS LEARNING FOR ALL

Once considered the worst school in the area, Willow School had created a respectful learning environment that provided differentiated instruction and increased support for math teaching in grades K–8

Willow School was in a small, isolated seasonal resort community in rural Massachusetts. Once considered the worst school in the area, Willow had created a respectful learning environment that provided differentiated instruction and increased support for math teaching in this K–8 school. Administrators and staff identified the following practice as central to their school's approach to improving the math learning of all students:

- *Paired middle and lower school math teachers.* Within this K–8 school, middle school math teachers provided regular classroom support to grades 3–5 general educators. Middle school math teachers served as content experts and assumed varied roles in the lower school classrooms, from working with small groups of students to modeling lessons.

Other practices highlighted by school staff included:

- *The Responsive Classroom approach.* Adopted in 1997/98, this approach helped to create a respectful culture that was inclusive of students with disabilities.
- *Small group instruction and differentiation.* Teachers used small group instruction and differentiation to informally assess students' math understanding and tailor instruction to the needs of a range of learners.
- *Leadership that gives teachers a voice.* Leadership empowered teachers to initiate programs, form committees, and take on additional roles to make teaching and learning more effective.

These practices were just part of Willow's approach to math education (table 19).

Overview of Willow School

Willow School is the largest nonsecondary school in its area, with an enrollment of about 420 students (table 20). It had a higher proportion of students with disabilities (22 percent) than the state average (17 percent). The school also had a growing number of Brazilian immigrants, almost all of whom were English language learners.

The school played a central role in its small, tight-knit community. Because many teachers lived and worked in the same area, they had close personal and working relationships.

The principal had a background in special education and had been at the helm of Willow School for 11 years. Working with an assistant principal, he led a staff of 49 teachers and 24 teaching assistants (table 21).

TABLE 19
Snapshot of practices at Willow School, 2006/07

Practice	Description
Classroom math instruction	Math instruction time: varies
	Curriculum: Everyday Mathematics, implemented for more than five years
	Placement of students with disabilities and other struggling learners: inclusion classrooms taught by general educators, with in-class support from teaching assistants and pull-out support from special educators
	Accessible instruction: varied strategies include small-group work and differentiated instruction emphasized throughout school*
Math supports and interventions	Class sizes kept below 20 students
	Math support in grades 3–5 provided twice a week by middle school teacher
	In-class support provided by special education teaching assistants
	Pull-out services provided by special educators in resource room
	Informal help provided by teachers after school
Assessment	Informal assessments are conducted through observation of students working in small groups, based on these assessments, teachers adjusted math tasks, and the school provides additional support as needed
	Classroom teachers use assessments from the math curriculum
	Administration analyzes results of statewide assessment
Collaboration among teachers	Middle school math teachers provide twice-weekly classroom support to classroom teachers of grades 3–5*
	General educators have weekly grade-level common planning time and hold monthly staff meetings
	Teachers and teaching assistants collaborate to provide instruction and support to students
Professional development	Two teachers are trained leaders of the Responsive Classroom approach[a] and provide professional development to teachers at Willow School and other district schools
	Administrators and teachers are encouraged to attend workshops and conferences; outside consultants provide professional development at the school
	Each teacher creates an individual professional development plan with goals that are tied to the school improvement plan; progress is reviewed monthly with principal or administrators
Leadership	School administrators: principal and assistant principal
	Administration's leadership style emphasizes empowering teachers and giving them a voice in running the school*
	Principal has special education background and is strong proponent of inclusion and the Responsive Classroom approach
	Principal and assistant principal visit classrooms daily and hold supervision meetings with each teacher monthly
School culture	Responsive Classroom approach emphasizes setting up an environment conducive to learning, with consistent routines, respect, and collaboration among both students and teachers*
	School maintains inclusive culture for students with disabilities
	Staff culture is described as supportive, passionate, friendly, collaborative, and hardworking, with a strong sense of community

* Practice considered central to school's approach to improving math learning.

a. In the Responsive Classroom approach classroom and schoolwide practices help children build academic and social-emotional competencies through methods that emphasize social, emotional, and academic growth.

Source: Authors' compilation based on primary documents gathered at the school, classroom observations, and interviews with teachers and administrators; see appendix A for details.

TABLE 20
Student demographics at Willow School, 2006/07

Characteristic	Value
Grade span	PreK–8
Number of students enrolled	420
Average class size (students)	16
Percentage of students with disabilities (percent with Individualized Education Programs)	22
Percentage of students from low-income families[a]	14
Percentage of students of races other than White	31
Percentage of students with limited English proficiency	6
Percentage of students whose first language is not English	11
Attendance rate (percent)	94

a. The Massachusetts Department of Education defines a low-income student as one who is eligible for free or reduced-price lunch, receives Transitional Aid to Families benefits, or is eligible for food stamps.

Source: Authors' compilation based on data from Massachusetts Department of Education (2008) and interviews with the principal.

TABLE 21
Staff and administration at Willow School, 2006/07

Characteristic	Value
Staff	
Number of teachers (grades K–8)	49
Student–teacher ratio	8.6 : 1
Percentage of teachers licensed in teaching assignment	96
Percentage of core academic teachers identified as highly qualified[a]	90
Percentage of teachers at school five or more years	82
Percentage of teachers at school less than five years	18
Number of special educators	5
Number of teaching assistants and paraprofessionals	24
Administration	
Number of years principal has been at school	11
Number of assistant principals	1
Number of years assistant principal has been at school	6

a. To be considered highly qualified, Massachusetts teachers must possess a valid Massachusetts teaching license at either the preliminary, initial, or professional level (formally known as the provisional, provisional with advanced standing, and standard level) and demonstrate subject matter competency in the areas they teach.

Source: Authors' compilation based on data from Massachusetts Department of Education (2008), primary documents gathered at the school, and interviews with the principal.

Classroom placement for students with disabilities

All students with disabilities at Willow School were educated in inclusive classrooms. Special educators, and the teaching assistants they supervised, provided special education support to classroom teachers. Special educators typically provided pull-out services, and teaching assistants worked with students in the classroom.

Highlighted practices at Willow School

Four strengths were consistently highlighted during interviews with Willow staff: paired middle and lower school math teachers, the Responsive Classroom approach, small-group instruction and differentiation, and leadership that gave teachers a voice. Each is discussed here.

Paired middle and lower school math teachers. The pairing of middle and lower school math teachers at Willow School was started by two middle school math teachers in 2004 when the middle school was undergoing staff changes, including the retirement of the remedial math teacher for grades 4–8. The change prompted the teachers to think about new ways to help struggling learners. With the administration's consent, they redefined their roles. Following their recommendations, rather than assign one math teacher for grades 6 and 7, another for grades 7 and 8, and another for remedial students, Willow assigned one math teacher to each grade and increased the amount of time devoted to learning math in middle school. And the two teachers became math support teachers for grades 3–5. Their aim was to close gaps so that students struggling in math would not need support past grade 5.

Collaboration in the classroom. The math support teachers were assigned to individual lower school

classrooms, in which they spent one hour twice a week. To establish a nonthreatening, collaborative partnership, they made clear to the classroom teachers that they were open to their requests. One elementary school teacher described her experience with the math support teachers as follows:

> *The math support teacher . . . brings a richness of math experience and knowledge, so I'm able to utilize her in some shared teaching, some coteaching. Sometimes she'll work with individuals; sometimes she'll take a small group and I'll take a small group. Sometimes she does some remedial work, and sometimes she does some extension work for some kids who are really grasping concepts and able to do a little bit more. Sometimes she will even model a lesson that I can observe.*

This in-class collaboration also benefited the middle school math teachers. As one explained:

> *I have learned a lot about teaching practice from the people I'm working with. It's very rare that you get to observe somebody else teaching, so for me, I might be helping them with the math, but they're certainly helping me—and I've been a teacher for 13 years. I've learned some stuff about teaching practice that I've used in 8th grade that they do in their class.*

Many lower school teachers volunteered to become part of this program and welcomed the help in their classrooms. Because the math support teachers did not evaluate them, teachers felt comfortable sharing their successes and struggles and reaching out to them for help whenever a need arose. As one lower school classroom teacher remarked:

> *There is a freedom to try new things; there is a freedom to share your strengths and your weaknesses. You can say to someone whom you have an established relationship with, "I don't really understand this 3rd grade something-or-other." . . . There is a sense of "we're all in this experience together."*

Pairing middle and lower school teachers at Willow gave them the opportunity to gather new insights into their teaching

Middle school math teachers not only played support roles, they also served as informal math leaders. They were viewed as great resources of knowledge on math content and teaching practices. The grade 8 math teacher played a central role in selecting math curricula for the school and participated in the school's math committee. Lower school teachers valued not just the math knowledge and practical classroom help the middle school math teachers provided but also their enthusiasm. One teacher described how her relationship with the math support teacher helped her grow professionally:

> *As a general practitioner I am asked to be knowledgeable in many areas. And I think I find myself drawn to language arts and doing things related to reading and writing. And going to a math conference might not be my first draw; but having the relationship [with the middle school math teacher] and working with someone who has such a passion for this subject really opened my eyes to the possibilities of what my instruction could look like. And so I can't stress enough that the relationship we share really benefits the children.*

Sharing a common language. Pairing middle and lower school teachers gave them the opportunity to gather new insights into their teaching. Middle school teachers gained a better understanding of how math was taught in the lower grades; meanwhile, lower school teachers gained a better sense of the kind of math foundation they needed to build so that their students would do well later. In the words of one lower school teacher:

> *The math support teacher brings an energy and an enthusiasm that really benefits my professionalism. She reminds me that many of these students could do many great things with math and how important it is to lay the foundation of having a love of not just learning but of math.*

Working across grades helped teachers establish a consistent vocabulary for teaching math. Use of a common language built connections between lower and middle school math. A math support teacher described helping lower school teachers adopt the same math vocabulary terms that students used in middle school:

> *I'll point out the vocabulary you might use in middle school; [lower school teachers] keep saying "whole number" and I keep stressing "integer." And so I have noticed them trying to incorporate that. . . . In third grade they used to always say "top heavy fraction," and I'm saying if they have to learn that, why not just learn that it's an improper fraction?*

This focus on using common math terms in all grades was evident in the following observation:

> *When the grade 7 math teacher, Ms. Washington, enters the grade 3 classroom, the students seem eager to see her. Their teacher, Ms. Martin, has worked with them to prepare a surprise for Ms. Washington—a song about a moose in a cookie jar. The class sings enthusiastically about the number of cookies the moose eats, counting the cookies using multiples of two, three, and four. After thanking the class for the song, Ms. Washington asks questions about the counting to help students come up with the terms "multiple" and "factor." She then discusses the definitions of each term and points out that these are terms her seventh graders also use. Ms. Washington asks students to come up with examples of different multiples she writes on the board.*
>
> *After this warm-up, Ms. Martin introduces the main part of the lesson, which is an open response problem from a past MCAS test. This multistep problem focuses on multiples and involves determining where to place different numbers in a Venn diagram. Ms. Martin divides the class of 18 students into three groups. Each group works with one of the two teachers or the teaching assistant. During her twice a week visits Ms. Washington usually works with the same small group, which includes several struggling learners. The teaching assistant, Mr. Lapa, who speaks Portuguese, tends to work with the English language learners. He has created a large visual of the Venn diagram to help the students at his table.*
>
> *Seated with their small groups, the students work individually on the problem. The teachers observe the students, provide help as needed, and ask questions to check for understanding. Some students take their papers up to the board to look at the examples and then return to their seats. The groups are moving at different paces. When a group is ready, a teacher asks students to share their answers and strategies. The teachers and teaching assistant ask similar questions of the three groups: "How did you solve it?" "How do you know you are right?" "Can you tell me in your own words?" "What would be another example of a multiple that would go in that part of the diagram?" In response students explain their math thinking to the other group members.*

Teachers at Willow believed that they would benefit even more if the lower and middle school teachers had common planning time

The opportunity to use small group instruction was one of the main benefits of these cross grade partnerships. After the first year of program implementation, teachers had a better sense of how to use their time together and what roles they wanted to play. They established a rapport that allowed them to collaborate more effectively and to explore new ways of working together.

Teachers believed that they would benefit even more if the lower and middle school teachers had common planning time. At the time of the study planning was done informally—outside the classroom during whatever time the teachers could spare during their busy days. As one math support teacher put it, "The biggest concerns that are still sort of an issue—it's not a perfect system—are the facts that neither of those teachers nor I have the time to meet with one another ahead of time."

Responsive Classroom approach. In 1996/97, when the principal joined Willow School, the school had a reputation as the worst school in the area. The principal decided to adopt the Responsive

Classroom approach, which he had implemented in another school. The Responsive Classroom approach is "a way of teaching that emphasizes social, emotional, and academic growth in a strong and safe environment. . . . [It] consists of classroom and schoolwide practices for deliberately helping children build academic and social-emotional competencies" (Northeast Foundation for Children n.d.). The central teaching practices include morning meetings, rules and logical consequences, guided discovery, and academic choice. The principal brought in consultants to provide training in the model. The approach was integrated into school and classroom practices, from having rules posted to classroom grouping to how students and teachers greet one another.

The principal believed this approach supported struggling math learners in several ways. First, differentiating instruction provided students with greater academic choice. When structuring time in the classroom, teachers were able to provide students with learning opportunities that were appropriate to varied individual needs. One teacher described how she provided additional challenges for some students:

> *Kids who easily grasp the concepts can go on and do some independent challenge work. . . . And the rule is that if you're up for the challenge, the biggest part of the challenge is solving it independently. You can't come back to the group and ask the teacher. So, they've been doing that when they kind of get their wings on the concept that we're dealing with.*

Second, significant attention was devoted to how students got along with one another and collaborated. Students routinely worked in groups. According to Willow's principal, "You want them problem solving in groups; you want them bouncing ideas off of one another. But you want them to do it in a respectful fashion. So, I think that this kind of model really nurtures that kind of learning for kids."

In 2001/02 two of the school's strongest lower and middle school teachers were trained to become leaders in the Responsive Classroom approach. The principal believed that in-house capacity was essential to the continuation of the program. These teacher leaders provided professional development not only to teachers at Willow School but also to teachers from other schools. The principal continued to promote the program, providing new teachers with training and support to help them implement these practices in their classrooms.

Willow adopted the Responsive Classroom approach, which included morning meetings, rules and logical consequences, guided discovery, and academic choice

Small-group instruction and differentiation. Teachers noted the benefits of using small-group instruction to reach a range of learners. The principal made an effort to keep class sizes below 18 students, a staff–student ratio that allowed students to work in small groups. When classes used small groups, each group typically worked with one adult—the classroom teacher, the teaching assistant, or the math support teacher when she was present. A lower school teacher described how small-group instruction helped her ensure that all her students learned the material:

> *The beauty of it is that if I have a group of eight, and there are four kids who get it right away and four kids who are struggling, then I can work with the four until there are two that still don't get it. And then I can work with the two until everyone has gotten it. So, really, the kids are getting the objectives we're teaching. And we're assessing it right there as they work so that we can easily see if they don't get it; they don't get to just hide somewhere.*

Teachers valued the opportunity to conduct informal assessments through observation as students worked in small groups. Using information from the observations, they could adjust the difficulty of a math task and provide additional support. One middle school teacher described how she supported struggling learners in building

understanding of math concepts: "They may not know their math facts, but I'm going to get them to get the concepts. . . . I let them use calculators. But I made sure that they understood the math and did not get hung up on the fact that they couldn't add fractions."

A lesson in which the teacher explained the math concept to the whole class usually preceded small-group instruction. During this lesson the special educator would provide pull-out support to some students with disabilities, who usually rejoined the class for small-group work. One lower school teacher described the way it worked in her class:

> *Our math program is pretty rigorous, and we like to keep that pace up. So, I do a lot of whole-group instruction initially. And then we're so fortunate that we are able to use our assistants in a small-group instruction situation. So, we do a math small group, I would say, probably three times a week. And it's interesting to plan for that, because I look at the ability. . . . I probably do assessment every day, when I look at the kids [to decide] who needs what and which teacher is going to best provide that for them.*

Math ability was just one consideration when assigning groups. Depending on the lesson and student understanding level, students could work in mixed groups, gaining opportunities to learn from one another.

Throughout the week the teaching assistants at Willow helped the classroom teacher, providing additional instruction in math concepts, help in staying on task, language support for English language learners, and instruction for students with disabilities who missed material when they were pulled out of class by the special educator

In-class support from teaching assistants. Teaching assistants were members of the special education staff and were supervised by special educators. They worked full time in general education classrooms, where they provided support to all students. The decision to place the teaching assistants full time in these classrooms was made in 2004 to provide students with access to more in-class support from adults. In the primary grades K–2 there was one full-time special education teaching assistant in each general education classroom. In the upper elementary grades 3–5 each classroom had a teaching assistant at least half the time.

Throughout the week the teaching assistants helped the classroom teacher, particularly with small-group instruction. They provided additional instruction in math concepts, help in staying on task, language support for English language learners, and instruction for students with disabilities who missed material when they were pulled out of class by the special educator. In the principal's view teaching assistants were far more than mere aides:

> *I made very clear to the assistants in our school a long time ago that their job mirrors what a teacher does. In other words, their job is to work with kids. . . . If you're in a classroom, you're essentially working alongside the teacher, so you'll do reading groups and you'll do math groups. Sometimes you take over the class. . . . They're totally engaged in helping the teacher develop instruction. . . . And so when we hire them, we put a high value on not so much have they taught or where did they work before [but] on the potential they have for wanting to become a teacher.*

Math support in the resource room. In addition to in-class support, some students with disabilities received pull-out services from special educators in the resource room. Students viewed the resource room positively. As one special educator said, "They want to be in the resource room because they want the assistance. They want the help. Even kids that don't need to go to the resource room want to go to there." Students with disabilities in K–2 received daily instruction from a special educator, while students in grades 3–5 received less frequent but more concentrated instruction.

Special educators provided small-group and individualized instruction to support the curriculum

taught in the general education classroom. They tailored curriculum lessons to student needs and used supplementary materials to build number sense and basic skills. Because the curriculum did not provide intervention materials, teachers used a variety of resources and designed their own. In the words of one special educator: "I just put things together. I see where the kids really are falling down, and [I] find things [in books], or we make things. Sometimes I make up games about money and other topics." Special educators also assessed students to determine where they were having difficulties in math. Some teachers lamented the fact that fewer diagnostic tools were available for math than for reading.

Homework support. Middle school students could receive additional small-group help from teachers after school. The homework club, which ran from 2:40 to 4:00 p.m., was staffed by middle school teacher volunteers. Six to 20 students attended this program (the number could increase to 40 at exam time). One teacher described how the homework club helped all students succeed:

> *Because they come, they are able to participate in the next day's class. They have their homework in front of them. They're not like—oh, I didn't get it. That's not even an option for them, because it's right there in front of them. And therefore they can be successful. So, I really push that. We're there every day after school. We make ourselves available; if you need to come at recess, you can come at recess.*

Leadership that gives teachers a voice. Staff members credited the principal's leadership in turning Willow School around. According to one teacher, the principal let people "take initiative to lead things," empowering them to effect change. When middle school math teachers wanted to redefine their roles and provide math support to lower school classroom teachers, for example, the principal gave them the freedom to figure out how to structure the arrangement—and then followed their recommendations. He also supported teachers' decisions to bring new math curricula to the lower school and middle grades. As one teacher said, "If you figure out something you're really interested in, like literacy, you could be on the literacy committee. He'll make time for you to be part of that group and to really make decisions for the school, as long as it's a well represented group."

Staff members credited the principal's leadership in turning Willow School around

The principal was also highly visible and accessible to teachers and students. He visited classrooms daily. He also met with middle school teams, ran faculty meetings, and planned Friday community meetings.

Because of his background in special education, the principal believed strongly in creating a school culture that welcomed everyone. He believed that fostering inclusive practices was vital to his role:

> *I think that our job as administrators is to make sure that there is an inclusive tone and a differentiated approach to how kids are worked with. We want every kid in the classroom as much as possible. I think that is where learning takes place, and I think that kids inherently want to be with their peers in the mainstream; they don't want to be singled out and told that they're different. So, anything we can do to try to break that down [is good].*

The assistant principal also worked hard to foster a caring and supportive school environment. "If a teacher needs something, if a child needs something, if a parent needs something, it's my job to get it done," he commented.

One of his responsibilities was student discipline. Like the principal, the assistant principal made himself visible by frequently visiting classrooms:

> *I think it's important for these kids to see me and know me. And the more they see me, the*

more they're going to trust me and the more they're going to think: "He's all right. He's not a screamer or a yeller. I don't have to be afraid of him. If I have a problem, I can go to him."

Both the principal and the assistant principal held supervision meetings with every teacher once a month. For the first meeting, teachers were asked to create an individual professional development plan with goals tied to the school improvement plan. Succeeding meetings addressed what the teachers were doing to implement their plans. Teachers found these meetings helpful:

I think we have a great administration. I have supervision once a month with the principal, and it's just half an hour meeting time. . . . I feel like I can talk to him about anything. He knows my kids. He knows the kids that struggle. We always talk about the progress they're making.

Staff dedication. The administration's efforts were complemented by the staff's dedication and hard work. Staff members spoke about the school's strong sense of community, which enabled teachers to feel comfortable asking one another for help. One teacher commented:

I think in great part, it's the relationship that the staff members have with each other. . . . It's a really hard-working staff. I think everyone is very committed to what they do and have a passion for doing what they do. And I think it's through the relationships that we have with each other that really supports the achievement.

In ongoing efforts to be more inclusive, Willow School joined with others in the area in a program that emphasizes identifying each student's strengths and difficulties and using instructional strategies to address learner differences

Remaining challenges

Administrators and staff were proud of the many positive changes at Willow School but also talked frankly about the challenges they faced in improving math learning and teaching. These challenges included:

- *Paired lower and middle school teachers lacked shared planning time.*
- *School priorities had shifted.* The math committee and the focus on math vocabulary that teachers found so helpful were not continued the following year because priorities in English language arts took precedence. While recognizing the need to address all subject areas, some teachers expressed frustration with this change.
- *Math assessment tools and programs were inadequate.* Special educators had an array of tools for diagnosing difficulties in reading but lacked comparable assessments for math. They also faced challenges providing interventions for math, because they lacked the kinds of programs that were available for reading.
- *The amount of time devoted to math instruction varied across classrooms.* One teacher mentioned that the amount of time spent on math instruction in the lower grades depended on the classroom teachers' preferences. Some staff members suggested that establishing a consistent amount of time for math would improve student learning.

Looking forward

Willow School placed heavy emphasis on increasing literacy and providing a strong English language arts program. The school had a literacy committee and a Response to Intervention program for reading. Teachers believed that similar efforts would benefit the school's math program. They also saw a need to increase the amount of time spent teaching math and to have a more formal after-school math program.

In ongoing efforts to be more inclusive, Willow School joined with others in the area in a major professional development initiative, the Schools Attuned program. This program emphasizes

identifying each student's strengths and difficulties and using instructional strategies to address learner differences. The principal believed that this approach would help Willow School provide increased support to all struggling learners.

QUESTIONS FOR FUTURE RESEARCH

The common practices displayed by the six schools raise several questions for further research and investigation:

- In the Northeast and Islands Region how widespread is the practice of supporting teachers and students with an in-house math expert, such as a math leader or coach?

- How many districts across the Northeast and Islands Region regularly administer benchmark assessments to students—with what frequency and for what uses?

- What do teachers across the region cite most frequently as practices they believe hold the most potential for improving the teaching and learning of math among students with disabilities and other struggling learners?

These questions can be explored through school and teacher surveys. Case studies, interviews, and ethnographic research projects could address the following exploratory research questions:

- How do in-house math leaders in different schools provide support to teachers and students? What types of support do they believe lead to the greatest achievement gains for students?

- How might different school leadership styles and practices lead to higher student achievement? Does allowing greater teacher creativity in the classroom lead to stronger student performance? How do attracting and retaining higher quality teaching staff affect student outcomes?

- How might high levels of teacher collaboration across schools and districts lead to higher student achievement? What are the relative benefits of formal and informal types of teacher collaboration? Is increased sharing of expertise and resources important? Does collaboration raise levels of teacher satisfaction and thus help spur more energetic classroom instruction? Do different school structures and roles for special educators affect their collaboration with general educators?

- How do schools select and implement math intervention programs for a Response to Intervention initiative? How do different implementation approaches affect a program's integration into schools and its acceptance by special educators and general educators? What are the subsequent effects on student learning?

The common practices displayed by the six schools raise several questions for further research and investigation that can be explored through school and teacher surveys, case studies, interviews, and ethnographic research

An experimental study comparing pre- and post-assessment outcomes of students randomly assigned to a control group and a treatment group might ask:

- Do students with disabilities and other struggling learners who receive an intensive math intervention program in addition to their primary classroom math instruction demonstrate higher math performance levels than similar students who receive classroom math instruction only?

These and many other questions emerge from the practices described in this report. Pursuing these questions is important if researchers and education leaders wish to expand knowledge of the school practices that hold greatest potential for improving math learning among all struggling learners.

APPENDIX A
METHODOLOGY

Case studies offer rich information about how schools implement practices in different contexts. This section describes how the six case study schools were selected, the procedures and instruments used to collect data, and the steps taken to analyze the data.

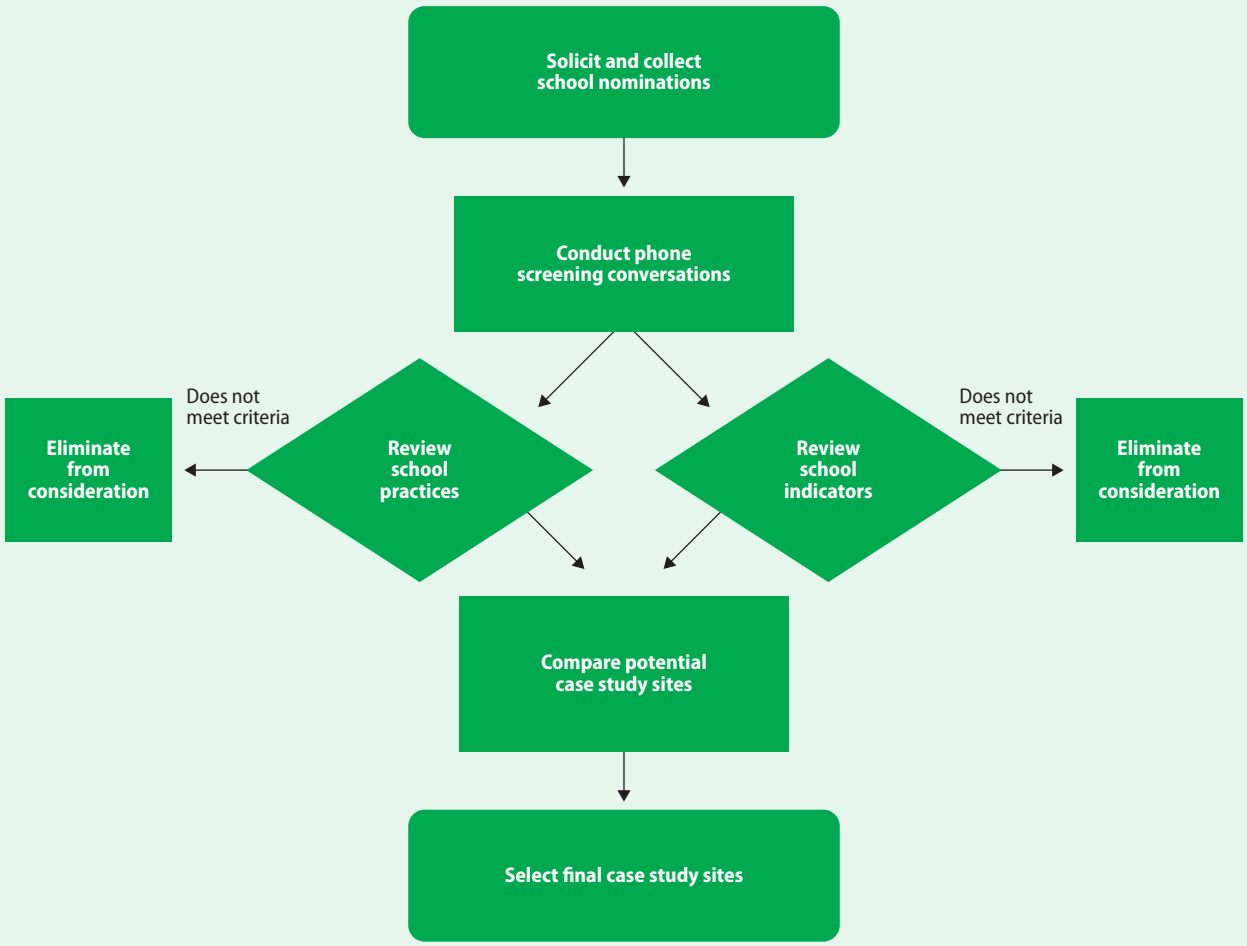
School selection process

Nomination, screening, review, and selection of case study sites were carried out during the 2006/07 school year. The process is described below (figure A1).

Soliciting nominations. Researchers solicited nominations for case study schools from the following types of education leaders:

- State education leaders in special education.
- Leaders of special education district collaboratives in Massachusetts and Boards of Cooperative Educational Services in New York. Both types of bodies provide special education services for schools in many districts.
- District leaders, including superintendents, special education directors, and math coordinators.

FIGURE A1
Process for selecting case study schools



Source: Authors' schematization based on process described in text.

- University professors in math and special education.

- Leaders of projects by nonprofit research institutions that focus on both math education and students with disabilities.

To identify the most appropriate leaders to target for school nominations, researchers drew on the contacts and knowledge gained from three Education Development Center, Inc. projects: the Urban Special Education Leadership Collaborative, Addressing Accessibility in Mathematics (funded by the National Science Foundation; NSF), and Mathematics for All (funded by NSF). These leaders were asked to use their knowledge of district or school initiatives to nominate schools they believed were making strong, targeted efforts to improve the math learning of students with disabilities and other struggling learners. To help provide a common set of nomination criteria, the research team provided them with a list of suggested practices (drawn from the research literature [described at the beginning of this report; table A1]) and asked them to identify the school's strengths in one or more areas. They could also cite practices not on the list to support their reasons for nominating a school.

All communications during the nomination and screening process were carried out under task 1.1 of the Northeast and Islands Regional Educational Laboratory: need-sensing work in the areas of special education and math education. This process ultimately yielded 38 nominations, 19 each from Massachusetts and New York.

Screening the nominations. Reviews of publicly available data on each school's demographics, annual yearly progress status, and grade 4 math state assessment results were used to screen the nominated schools. Project staff determined each school's need-level category and then compared its assessment results with the averages for that need level (see appendix C). Conversations with contacts at the nominated schools were used to verify and learn more about specific practices.

The project staff then determined whether the identified practices met the following criteria:

- *The school serves general and special education students.* Schools that serve only students with disabilities or a special subgroup within that population were eliminated from consideration because such schools are often more highly specialized and do not reflect the types of student populations that most schools in the region face.

- *The school includes a grade 4.* Because it was important to have a standardized measure of student math performance in the case study schools—and grade 4 was the only elementary grade tested in math before 2005/06 in both Massachusetts and New York—only elementary schools with a grade 4 and publicly available state math assessment results for both general and special education students were considered.

- *The school serves a medium- to high-need population.* Medium- to high-need schools were preferred because lessons learned from these schools are likely to be of greater interest across the region than those from schools with less challenging populations, greater resources, or both.

- *The school has been using its math curriculum for more than one year.* Because implementing a new curriculum often involves particular challenges for teachers, schools in their first year of implementation were eliminated.

- *The school made adequate yearly progress in math during 2005/06.* Schools that did not meet adequate yearly progress were eliminated because their status could raise questions about the school and its practices. This standard was based on the No Child Left Behind report cards for 2005/06 for Massachusetts and 2004/05 for New York. Many elementary schools (including all of the ones selected) did not have adequate yearly progress determinations for students with disabilities because fewer than 40 grade 4 students had disabilities.

TABLE A1

School practices suggested by the research team to guide nomination of schools

Category	Practice
Classroom math instruction	
Instructional strategies and time	Uses instructional strategies such as peer tutoring, graphic organizers, differentiated instruction, and multisensory approaches, to make math accessible to students with disabilities and other struggling learners
	Uses computers or other technologies to support math learning among students with disabilities and other struggling learners
	Allocates additional time for math instruction and uses that time effectively to meet the needs of a range of learners
Staffing arrangements	Has math specialists who provide coaching, resources, or support to teachers
	Places additional staff, such as special educators, in general education classes
Math supports and interventions	
Services for students with disabilities and other struggling learners	Provides math support services (math tutoring programs, additional math classes, other programs during or outside the school day) to help all struggling learners
Intervention programs for students without Individualized Education Programs	Has Response to Intervention program in place to identify struggling learners in math and provide them with interventions.
	Has program that focuses on grades K–3 in order to provide early intervening services for struggling math learners
Assessment	
Assessment strategies for math	Uses variety of assessment strategies, including formative and benchmark assessments, and uses assessment data to inform instruction
Support for students who perform poorly on state assessments	Provides classes or other kinds of support for students who perform poorly on standardized math assessments
Collaboration	
Collaboration between general educators and special educators	Implements strong collaborative practices, such as coteaching
	Provides coplanning time during the day, when general and special educators can work together to plan lessons, assessments, accommodations, and interventions
Professional development	
Professional development	Has a professional development program (study groups, professional learning communities, coaching, workshops, institutes) geared toward improving one or more of the following: math teaching practices for students with disabilities, math content, inclusive practices, differentiated instruction, and collaborative teaching
Leadership	
Leadership	Leaders (math coordinators, special education coordinators, principals, and others) engage in practices that focus on improving math learning for all struggling learners and spearhead initiatives to improve math learning for all struggling learners or practices in other relevant areas, such as math teaching, special education services, and collaboration

Note: These practices are from six of the seven practice categories. The school culture category was not used in the school selection process; however, it was incorporated into the site visits and data analysis.

Source: Authors' compilation based on research data described in the beginning of the report.

- *The school met the project's criteria for the performance of students with disabilities on the grade 4 state math assessment.* Project staff used datasets from Massachusetts and New York and the data analysis reports in this series to compare each school's performance with the averages for schools in the same need-level category to determine whether the school met or exceeded that average for at least two of the three years examined. (See appendix C for assessment data on the six schools and explanation of need-level categories.)

Schools that did not meet the screening criteria were eliminated from consideration, reducing the pool from 38 schools to 10.

Selecting the case study schools. For the remaining 10 schools phone conversations with principals or math specialists at the schools were used to gather more detail about the school's nominated practices and to learn about other practices the schools believed were benefiting the math learning of students with disabilities or other struggling learners. Gathering additional information on schools and their practices after the nomination phase was an essential part of the site selection process. The education leaders who nominated schools helped direct the project team to a pool of potential case study candidates, but because these leaders (most often state or district leaders) tended to be removed from the day-to-day workings of the schools, they typically did not have in-depth knowledge of individual school practices.

The data on schools' characteristics and detailed practices gathered by the project team from publicly available sources, principals, math leaders, and designated school contacts was the most important determinant in the selection of the case study schools. The project team discussed the information for each school, first individually and then in comparison with the other candidates. A matrix was created to organize the 10 schools' practices.

Because the project's goal was to describe a wide variety of math education practices for students with disabilities and other struggling learners in diverse settings, sites were selected to maximize the variety of practices across major categories. In comparing schools, the team gave more weight to schools whose practices appeared more closely aligned with research and policy recommendations and those whose approaches had been in place longer. For schools with similar practices the team assigned greater weight to schools with higher need levels and more diverse student populations. In considering these different factors, the project team discussed different combinations of sites before selecting the six schools (tables A2 and A3).

Data collection

Two-day site visits were conducted between March and June 2007. During these visits researchers observed classrooms, interviewed teachers and administrators, and gathered primary documents. The primary contacts were the principal at Cedar Elementary School, an assistant principal at Redwood Elementary School, a Title I math leader at Aspen Elementary School, the informal math leader at Maple Elementary School, a math coach at Beech Elementary School, and a school administrator at Willow School.

All site visits were conducted by at least one of the two project leaders and at least one of the two research associates. This arrangement helped the researchers maintain consistent observation and interview procedures across the six schools. The researchers worked in pairs, with the pairings rotating both within and across schools to ensure quality control and provide multiple perspectives for data corroboration of classroom observations.

The project targeted the following staff members for interviews and observations at each school:

- Administrator (principal, assistant principal).
- Math coach or leader.
- Grade 4 general education teacher.

TABLE A2
Similar math practices at the six case study schools, 2006/07

Math practice	Cedar Elementary School: math lead teacher who works with students and teachers	Redwood Elementary School: integrated classrooms, multiple support services	Maple Elementary School: professional learning communities	Aspen Elementary School: Primary Prevention Response to Intervention program	Beech Elementary School: math coaches, multiple support services	Willow School: pairing of elementary and middle school teachers
Classroom math instruction		✔				✔
Math supports and interventions	✔			✔	✔	
Assessment				✔		
Collaboration		✔	✔			✔
Professional development	✔		✔		✔	
Leadership[a]						
School culture[b]						

a. No school was nominated specifically for the leadership category, perhaps because nominators identified practices that provide direct services to students with disabilities rather than practices such as leadership that have more indirect relations with student learning.

b. School culture was not used in the screening process, but was incorporated into site visits and data analyses.

Source: Authors' compilation based on interviews with staff at case study schools and primary documents described in this appendix.

- Grade 3 general education teacher.
- Grades K–2 general education teacher.
- Special education teacher providing in-class or resource room services.
- Teaching assistant and paraprofessional.
- Other key informants suggested by the school's primary contact, including special educators in integrated or inclusion classrooms, special educators in separate special education classrooms, early interventionists, a special education service coordinator, and teachers who worked together to design a schoolwide assessment for the early grades.

In preparation for the site visits the project team provided each school's primary contact with a list of the staff positions noted above and requested that the primary contact recruit participants in each role for interviews and classroom observations. The team asked the primary contacts to select staff members knowledgeable about the school's math education or special education practices. To gain different perspectives at each school, the team also asked the primary contact to schedule at least one new general or special educator for an interview, a classroom observation, or both. The primary contacts made recruitment and selection decisions and scheduled site visits.

Classroom observation procedures. At each school the research team observed math lessons in a variety of classrooms, including general education, inclusion, and separate special education settings. After each observation, team members interviewed the teachers. Classroom observations (typically lasting one class period) were conducted by pairs of researchers who followed a common observation protocol. (This protocol was guided by a project leader's work on the Addressing Accessibility in Mathematics project, funded by the

TABLE A3
Characteristics of case study schools, 2006/07

Characteristic	Cedar Elementary School	Redwood Elementary School	Maple Elementary School	Aspen Elementary School	Beech Elementary School	Willow School
Geographic setting	Urban Massachusetts	Urban New York	Rural New York	Suburban Massachusetts	Urban New York	Rural Massachusetts
Number of students	430	970	230	380	1,240	420
Grade span	1–4	PreK–6	K–4	K–4	K–5	PreK–8
Need level	High[a]	High (N/RC 2[b])	Average (N/RC 5[b])	Medium[a]	High (N/RC 1[b])	Medium[a]
Title I school[c]	Yes	Yes	Yes	Yes	Yes	Yes
Percentage of students of races other than White	88	95	2	4	98	31
Percentage of students eligible for free or reduced-price lunch	91	84	37	17	81	14
Percentage of students with disabilities (percent with Individualized Education Programs)	12	21	12	14	10	22
Percentage of students who are English language learners	18	11	0	4	10	6

a. For Massachusetts this report used the methodology of the New York City public schools, calculating need level by weighing three separate school measures: the percentage of students who receive free or reduced-price lunches, the percentage of students with disabilities, and the percentage of students with limited English proficiency. As part of the data analysis for the companion Massachusetts report in this series, schools were assigned need-level categories of low, medium, or high. (For more details see appendix C.)

b. For New York schools need level was determined by a need-to-resource-capacity (N/RC) index developed by the New York State Education Department. This index has two components: a district's level of need (defined by the percentage of students eligible for free or reduced-price lunch) and its level of resources (defined by the combined wealth ratio). There are seven need-to-resource-capacity index categories. (For more details see appendix C.)

c. Indicates that the school has a schoolwide or targeted Title I assistance program. Maple has Title I funding for reading but not for math.

Source: Authors' compilation based on interviews with staff at case study schools and primary documents described in this appendix.

National Science Foundation.) Fifty-two classroom observations were conducted across the six schools.

The goal of the classroom observations was to gather descriptive information on teachers' practices to guide conversations with teachers afterwards, provide evidence of the use of practices, and collect concrete examples that could illustrate the school's practices in vignettes in the case study report. During interviews the researchers asked teachers to provide more information about specific practices used during the observation. The researchers then compared the strategies teachers described in interviews with practices observed in the classroom to identify areas of data consistency and inconsistency.

During each observation the researchers took detailed notes on what the teachers and students said and did throughout the math lesson. The researchers took a purely descriptive approach and did not evaluate or rate the practices. The project built consistency across researchers by having researchers conduct frequent discussions of the observations and review their field notes together.

During an observation of either a general or special education math class, the researchers took notes on the following areas:

- Teacher's instructional practices for making math accessible to all students
    - Type of instruction (whole classroom, small group, pairing of students, one-on-one attention to particular students).
    - Method of instruction (lecturing, giving examples orally or on the board, having students perform examples on the board).
    - Time given to slow and fast workers to complete problems.
    - Grouping of students (homogenous or heterogeneous).
    - Use of different materials (manipulatives, overheads, individual wipe boards, sheets for following along, other hands-on materials).
    - Teacher's role when students are working individually (help getting individual students started, waiting for students to ask for help).
- Teacher's interaction with students
    - Does the teacher wait for the student to ask for help or focus on students who are struggling?
    - What does the teacher do while students are working in small groups or individually?
    - What is the teacher's procedure for answering questions (do students come up to her desk, raise their hand)?
- Teacher's strategies for engaging all students
    - Strategies used to ensure that all students are on task (calling on students, standing next to them, moving students around).
    - Grouping of students.
- Teacher's approaches to helping struggling students, including types of accommodations and interventions used
    - Are students given different or modified assignments?
    - Are students given additional directions?
    - Do students receive additional help to start the assignment?
    - Are students working separately with a resource room teacher or aide?
    - Are students sent to the resource room during math time?
- Use of different types of materials, including computer technology, in the classroom
    - What types of materials are used?
    - Are they available to all students or only to struggling learners?
    - Are the materials freely available to students or kept in a cabinet controlled by the teacher?
    - Is there a space dedicated to using special materials, or do students bring the materials back to their desks?
    - Is computer work directed, or are computers used only during students' free time? Do struggling learners get an opportunity to use the computer?
- Seating arrangement for students
    - How are the desks arranged (grouped together or in rows)?
    - Do all students face the board?

    - How do students seem to be grouped? Are fast and slow learners grouped together or taught in their own groups?
    - Do the students move around during class?
    - How is the space in the room used?
- Roles of and communication and collaboration among classroom staff
    - Do teaching assistants or special educators focus on particular students, or are they available for general help?
    - Do teaching assistants and special educators work with an assigned group?
    - What do teaching assistants and special educators do while the lead teacher is giving whole class instruction?

Interview procedures. All interviews were conducted based on agendas tailored to the school and the roles of the staff at the school. The choice of school-specific topics was based on information gathered from phone conversations with the principals or math lead teachers during the site selection process (tables A4 and A5). Across the six schools, researchers conducted 55 interviews, which were recorded and transcribed. Interviews lasted 40–75 minutes.

Training and staffing procedures for the six site visits. To prepare for each site visit, the four researchers reviewed the preliminary information gathered on the school through the nomination and screening process. The team identified and discussed topics on which to focus to find out more about the school's practices. Through these discussions researchers established a common understanding of the goals for each site visit. During each visit researchers met at the end of the first day to discuss information from the interviews. They identified

TABLE A4
Issues examined at each school, 2006/07

School and setting	Topic
Cedar Elementary School, urban Massachusetts	Math lead teacher Use of assessments and data Multiple support services
Redwood Elementary School, urban New York	Integrated classrooms Continuum of services America's choice model Administrative structure
Maple Elementary School, rural New York	Professional learning communities Use of math software programs School-based intervention team Inclusion classrooms
Aspen Elementary School, suburban Massachusetts	Language-based inclusion classrooms Response to Intervention program Title I math services Special education resource room
Beech Elementary School, urban New York	Math coaches Workshop model Design of assessments Multiple support services
Willow School, rural Massachusetts	Pairing of elementary and middle school teachers Inclusion classrooms Responsive classroom model

Source: Authors' compilation based on interviews with school principals, math leaders, and designated contacts at the six case study schools.

TABLE A5
Role-specific focus, number of staff observations, and number of interviews, 2006/07

Role	Focus	Number of observations	Number of interviews
School leaders			
Administrators	Role and leadership style, vision and programs for math and special education, support for teachers	0	9
Math leaders, including math lead teachers, coaches, and specialists	Role and work with teachers and students	8	7
General education teachers			
Grades K–2 teachers	Early intervention strategies	9	3
Grade 3 teachers	Strategies for accessibility, differentiation, and classroom assessment	8	6
Grade 4 teachers	Areas of difficulty for students, math teaching methods, and state test preparation	9	6
Special education teachers			
Resource room teachers	Supports and interventions for students with disabilities	6	9
Inclusion and collaborative classroom teachers	Experiences with coteaching and coplanning	3	3
Separate special education classroom teachers	Instructional approaches, particularly for multigrade classrooms	2	3
Intervention specialists	Role and intervention program	1	2
Service coordinators	Role and availability of special education services	0	1
Teaching assistants	Role, experience, and collaboration with general and special education teachers	6	2
Assessment design team	Experience creating, administering, and analyzing assessments	0	4
Total		52	55

Source: Authors' compilation based on interviews with school principals and math lead teachers at the six case study schools.

information that was contradictory, unclear, or missing and planned ways to obtain clarification and additional information on the second day. At the end of each visit the project team met again to discuss and consolidate information.

The four members of the research team reviewed and discussed the project's research questions and data collection instruments (the classroom observation protocol and specific topic agendas for individual interviews) before each site visit. All four members of the team participated in the first site visit (at the Maple Elementary School), to ensure that all team members were following similar data collection procedures and to have a shared experience on which to base discussions and reconcile different data observations and interpretations. Both for training and quality control purposes, each of the project's two team leaders was paired to work with one of the research associates for each classroom observation and interview during the first site visit.

Primary documents collected from each school included school improvement plans, school mission or vision statements, grade 4 report cards, and examples of pre-referral forms for special education services. At some schools researchers also collected other materials, such as districtwide math scoring rubrics, math curriculum pacing calendars, school technology plans, and school newsletters.

Data analysis

Several steps were followed to conduct the individual- and cross-case analyses. These procedures are described below.

Individual case analysis. A detailed set of codes was developed to categorize the data obtained from teachers and administrators. These codes classified the following information:

- Descriptions of how the school organized and implemented math education practices in classroom math instruction, math supports and interventions, student assessment, staff collaboration, professional development, leadership, and school culture.
- Opinions about the school's strongest practices for improving the math learning of all struggling learners.
- Opinions about the greatest challenges involved in raising the math achievement of all struggling learners.

Coded data were used to assemble preliminary descriptive narratives that answered each of the three primary research questions for each school. Transcript data from interviewees, data from classroom observations, and primary documents were used to corroborate or identify inconsistencies in the preliminary narratives. When interviewees gave different accounts of school practices and field observation notes and other primary documents could not resolve discrepancies, the project team contacted school staff members to verify information. For each school data from all the interviewed administrators and staff were examined to determine which practices were most consistently identified as the school's strongest. Consistently identified strengths were practices identified by two or more interviewees and not identified by any interviewees as a challenge. The most consistently identified strengths were those identified by the greatest number of interviewees. When different practices were cited as strengths by the same number of people, opinions of staff members and administrators with more years of experience at the school were weighted more heavily.

These practices were used to organize the main narratives in the individual case study reports. After the project staff completed the reports, copies were sent to the schools for review. Principals and other key staff members were asked to confirm the accuracy of the descriptions of their practices. The reports were then revised based on their corrections.

Cross-case analysis. Data analysis across cases began by compiling large master matrices containing detailed information from the interview transcripts about the practices in each of the seven practice categories in the six schools. Master matrices were also created to array the strengths and challenges described by interviewees from each school.

Within each of the matrices containing one of the seven practice categories, data were organized along key dimensions that the research literature had identified as important and that describe how practices were executed in schools. The master matrix for classroom math instruction, for example, identified how much time schools designated for classroom math instruction; the types of classrooms in which students with disabilities were placed (general, inclusion, separate special education classrooms); and the types of instructional strategies used to make math accessible to students.

The project team examined the master matrices to identify common themes and patterns within practice dimensions and across schools. This was an iterative process that involved many cycles of returning to the transcript data for additional information and then further refining the matrices. To identify patterns, the team compared and contrasted practices and counted instances of evidence, such as descriptors for a particular practice, within and across schools. The team also searched for outlier practices within schools that

diverged from more common practices among the six schools. When team members disagreed over findings, the researchers reexamined transcript data, observation notes, and primary documents to provide further evidence or refine cross-case generalizations.

Summary tables for each practice category and for school strengths and challenges were created by taking the master matrices, devising overarching descriptions of practices and their constituent dimensions within each school, and organizing practice dimensions to highlight patterns across schools. Final summary tables were created through successive iterations of data consolidation and table review among project team members to verify that identified patterns were valid and consistent with the original data.

The primary goal of the case studies was to describe current school practices, but the identification of common strengths and challenges (as well as outlier practices) across schools allowed the project team to generate tentative hypotheses about how certain practices might lead to different teacher or student outcomes. Whenever rival theories could be discounted through collected data, this evidence was reported. Whenever rival theories could not be invalidated by existing data, this fact was noted to qualify proposed hypotheses as highly preliminary.

Study limitations and ideas for future research

Several limitations of the data and the methodology need to be taken into account. First, the data do not provide evidence that specific school practices are effective or ineffective; the methods do not allow valid causal inferences to be made.

Second, because of small sample sizes and the sample selection methods used, school characteristics and opinions of teachers and administrators cannot be considered representative of all personnel within each school or of broader populations of schools or school personnel. The possibility of selection bias must be taken into account in interpreting the findings. Although not all staff interviewed spoke in consistently positive terms about their work experiences, staff members interviewed may have had more positive views of the school than other staff.

Third, the process used for nominating the schools has some limitations. Because many leaders are removed from the day-to-day workings of schools, they may have nominated schools that have strong reputations, overlooking other schools that also have noteworthy practices. In addition, the education leaders targeted for school nominations tended to be extremely busy. Thus, leaders who responded to the call for nominations may have worked in jurisdictions with more resources or readily available information to participate in the project. If so, the sample of nominated schools may be biased toward those in jurisdictions with more resources or other characteristics.

Fourth, because of time constraints, the study did not solicit the views of students, parents, and district administrators. Case studies of students with disabilities and other struggling learners would shed light on how well different school practices may be meeting student needs and affecting math learning. Longer site visits would allow researchers to gather information about the broader context of each school by interviewing district administrators and parents.

Fifth, the visits to each site were limited in scope. Additional visits would allow researchers to observe school practices, such as child study team meetings, that do not occur daily. Future studies could observe professional development activities as well as classroom practices.

Sixth, there are limitations to the cross-case analysis. Most of the data for this project came from interviews that covered topics tailored to specific schools and personnel playing specific roles. Because of the constraints of this fast-response project, the researchers were unable to administer a systematic survey of standardized questions

to school personnel across all sites. Thus, variations in interview questions across personnel and schools may have resulted in different information on particular practices for specific schools. Findings about commonalities and differences across the schools, therefore, cannot be viewed as definitive. Because many similar themes were voiced by study participants, despite different topic agendas and interview conditions, the common descriptions of school practices and characteristics should be viewed as provocative and worthy of further study.

APPENDIX B
SIDE BY SIDE SUMMARIES OF CHARACTERISTICS AND PRACTICES AT THE SIX CASE STUDY SCHOOLS

TABLE B1

In-class math services for students with disabilities at the six case study schools by classroom type, 2006/07

Classroom type	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
General education classroom						none
Student composition						
General education students	Majority	Majority	Majority	Majority	Majority	
Students with disabilities	Very few	A few	A few	A few	A few	
Staff						
General educator	Full-time	Full-time	Full-time	Full-time	Full-time	
Special educator, in-class math support	None	Hours vary[a]	Hours vary[a]	Hours vary[a]	Hours vary[a]	
Teaching assistant and paraprofessional[b]	None	None	Part-time	Part-time	Part-time	
Other in-class math support	None	Occasional[c]	—	Hours vary[d]		
Integrated or inclusion classroom						
Classroom name	None	Integrated	Inclusion	Language-based	Collaborative	Inclusion[e]
Student composition						
General education students		Half or more	Half or more	Half or more	60 percent	Three-fourths
Students with disabilities		Up to half	Up to half	Up to half	40 percent	A fourth
Staff						
General educator		Full-time	Full-time	Full-time	Full-time	Full-time
Special educator		Full-time	Hours vary[a]	Hours vary[f]	Full-time	Hours vary[g]
Teaching assistant and paraprofessional[b]		none	Hours vary[a]	Part-time	Full-time	Part-time
Other in-class math support		On request[c]	—	Hours vary[d]	—	Two periods per week (middle school math teachers)
Separate special education classroom[h]						
Classroom name	Substantially separate	Self-contained	None	None	Self-contained	None

(CONTINUED)

TABLE B1 (CONTINUED)

In-class math services for students with disabilities at the six case study schools by classroom type, 2006/07

Classroom type	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Student composition						
General education students	na	na			na	
Students with disabilities	10–15 students	8 or 12 students			8 or 12 students	
Staff						
General educator	na	na			na	
Special educator	Full-time	Full-time			Full-time	
Teaching assistant and paraprofessional[b]	Full-time	Full-time			Full-time	
Other in-class math support	Part-time[i]	Occasional[c]				

na is not applicable.

— is not available.

a. Services depend on students' needs according to their Individualized Education Programs. At Redwood these services cannot exceed five hours a week per student.

b. Teaching assistants and paraprofessionals are assigned to classrooms, not individual students.

c. The math specialist supports teachers with lesson plans, demonstrations, student assessments, and occasionally in-class support.

d. The Title I teacher or one of her two teaching assistants provide in-class math support whenever possible based on student needs and teacher schedules.

e. All general education classrooms are defined as inclusion classrooms.

f. The Title I math teacher and the special education resource room teacher together provide full-time in-class math support to one classroom of students with language-based disabilities.

g. The special educator serving students below grade 5 provides only pull-out services, while the special educator for the upper grades provides in-class services.

h. Does not include districtwide programs serving students with severe cognitive, emotional, behavioral, or physical disabilities.

i. The special education resource room teacher provides support for grades 3 and 4 during classroom math instruction time.

Source: Authors' compilation based on primary documents gathered at schools and interviews with administrators and staff, as described in appendix A.

TABLE B2

Staff teaching experience and background at the six case study schools, 2006/07

Staff	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Principal						
Years at school	1	8	7	14	4	11
Years in education	33	More than 25	30	36	More than 38	About 25
Other information	Prior experience as assistant principal at another school Former special educator	Prior experience as assistant principal at another school Taught grades 4, 5, and 6 for eight years	Served as assistant principal during first year at school	Prior experience as assistant principal at another school Former special educator	Prior experience as assistant principal at three other schools Former district math coordinator and math teacher	Prior experience as a principal at another school Former special educator
Math leader						
Years at school	18	7	24	14	More than 10	11
Years in education	18	More than 34	24	More than 14	—	13
Other information	Previous math lead teacher for the district	Taught grades 2, 4, 5, and 6	Also the inclusion classroom general educator for grade 4	Title I math teacher Previous district math coordinator	A school math coach Taught grades 3–5 Lead coach for the region	Grade 8 math teacher and informal lead math teacher
General educator[a]						
Years at school	8	8	24	8	4	20
Years in education	14	8	24	14	More than 6	20
Other information	Grade 4 general educator Teaches grade 4 struggling learners in the after-school program	Grade 4 integrated classroom general educator	Grade 4 inclusion classroom general educator	Grade 4 language-based classroom general educator Has served as a special educator	Grade 2 collaborative classroom general educator	Grade 3 general educator paired with middle school math teacher Served on district math committee Assistant principal at another school during two-year leave
Special educator[b]						
Years at school	11	More than 7	31	8	19	7

(CONTINUED)

TABLE B2 (CONTINUED)

Staff teaching experience and background at the six case study schools, 2006/07

Staff	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Years in education	20	20	—	More than 20	27	More than 7
Other information	Grades 1 and 2 special educator	Grade 4 integrated classroom special educator	Grades 3 and 4 previous special educator Currently an administrator at another school	Special educator, resource room director	General education teacher support services (GETSS) teacher	Grades K–2 special educator

— is not available.

a. The noted general educator at each school participated in this project and taught math to students with disabilities or struggling learners.

b. The noted special educator at each school served as an informal special education expert and resource for other staff members.

Source: Authors' compilation based on primary documents gathered at schools and interviews with administrators and staff, as described in appendix A.

TABLE B3

Reported and observed accessibility strategies used for math instruction at the six case study schools, 2006/07

Practice	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Differentiated instruction	✔*	✔*	✔*	✔*	✔*	✔*
Provide small, flexible groups						
Provide one-on-one assistance						
Teach individualized curriculum						
Multi-sensory methods	✔*	✔*	✔*	✔*	✔*	✔*
Use manipulatives and hands-on materials						
Encourage visual and audio activities						
Select kinesthetic and interactive activities						
Math-specific strategies	✔*	✔*	✔*	✔*	✔*	✔*
Use math games						
Model multiple problem-solving approaches						
Teach math language						
Break down problems						
Increase math instruction time	✔*	✔*	✔*	✔*	✔*	✔*
Repeat, reinforce, review						
Integrate math into other subjects						
Peer instruction	✔*	✔*	✔*	✔*	✔*	✔*
Encourage paired tutoring						
Use students to teach class						
Other						
Use computers	✔	✔	✔*	✔	✔	
Apply schoolwide instruction model		✔*			✔*	✔*
Highlight success to build student confidence	✔*	*	✔*	*	✔*	✔*
Simplify or rephrase language	*	✔*	✔*	*	✔*	*
Relate lessons to real life	✔*	✔	✔	*	*	

✔ indicates that three or more interviewees mentioned the practice as a strategy at the school.

✔ indicates that one or two interviewees mentioned the practice as a strategy at the school.

* The practice was observed in at least one classroom.

Source: Authors' compilation based on primary documents gathered at schools, staff interviews, and classroom observations, as described in appendix A.

TABLE B4

Math curricula, curriculum support, and instruction time at the six case study schools, 2006/07

Category	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Math program	Scott Foresman/ Addison-Wesley (grades 1–4)	Investigations (grades K–5); Connected Math (grade 6)	Scott Foresman/ Addison-Wesley (grades K–4)	Scott Foresman/ Addison-Wesley (grades K–4)	Everyday Mathematics (grades K–5)	Everyday Mathematics (grades K–5); Impact Math (grades 6–8)
Current year of implementation	2nd	2nd	5th	2nd	4th	7th
Curriculum aligned with state standards	Yes	Yes	Yes	Yes	Yes	Yes
Staff available for curriculum implementation	School math lead teacher	School math specialist	School professional learning communities	District math coordinator[a]	School math coaches	District curriculum coordinator
Time spent on math instruction per day (minutes)	60	60	60	60	60 (grades K–2); 90 (grades 3–5)	60
Schoolwide instructional model	None	America's Choice	None	None	Teacher's College workshop model	Responsive Classroom
Current year of implementation	na	6th	na	na	4th	10th

na is not applicable

a. In Aspen teachers can also get curriculum support from the Title I math teacher and a kindergarten teacher, who are trained to provide this support.

Source: Authors' compilation based on primary documents gathered at schools and interviews with administrators and staff, as described in appendix A.

TABLE B5

Out-of-class math services and programs at the six case study schools, 2006/07

Math services	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Math resource room	✔			✔		
Special education resource room	✔	✔	✔	✔	✔	✔
Before-school program	✔				✔	
After-school program	✔				✔	
Saturday program		✔			✔	
Summer school (districtwide)	✔	✔			✔	
Vacation program (districtwide)	✔					
Response to Intervention program			✔	✔	✔	
Short-term test preparation course	✔			✔		
Other services	✔					

Note: See table B13 for further detail.

Source: Authors' compilation based on primary documents gathered at schools and interviews with administrators and staff, as described in appendix A.

TABLE B6

Summary of math assessment practices at the six case study schools, 2006/07

Assessment	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
State math assessment						
Name	Massachusetts Comprehensive Assessment System	New York State Testing Program	New York State Testing Program	Massachusetts Comprehensive Assessment System	New York State Testing Program	Massachusetts Comprehensive Assessment System
When given	Once a year in May	Once a year in March	Once a year in May	Once a year in March	Once a year in May	Once a year in March
Who analyzes data	Math lead teacher	Assistant principal and math specialist	Principal and teachers in professional learning communities	Principal, elementary school math specialist, Title I teacher, and grade 3 and 4 teachers	Math coaches and principal	Administrators
How data are used	Identify student curriculum difficulties, guide instruction, and identify students needing support	Identify student curriculum difficulties, guide instruction, identify students needing support, and set targets	Identify student curriculum difficulties, guide instruction, and identify students needing support	Identify student curriculum difficulties, guide instruction, and identity students needing support	Identify student curriculum difficulties, guide instruction, and identify students needing support	Identify student curriculum difficulties and guide instruction
Districtwide math assessments						
Name	District math exam[a]	District foundational assessment	District exam (forthcoming)[b]	District benchmark tests (new)	Princeton Review	None
When given	Four times a year	Once (start of year)	Goal: four times a year	Every two chapters and mid- and end-year	Five times a year	
Grades assessed	1–4	3–6	K–4	K–4	3–5	
Who analyzes data	Math lead teacher	Math specialist with classroom teachers	Teachers in professional learning communities	District math coordinator	District	
How data are used	Identify student curriculum difficulties, guide instruction, identify students needing support, and monitor progress	Identify student curriculum difficulties, guide instruction, identify students needing support, and set targets	Identify student curriculum difficulties, guide instruction, identify students needing support, and monitor progress[c]	Not reported	Identify student curriculum difficulties, guide instruction, identify students needing support, and monitor progress[d]	

(CONTINUED)

TABLE B6 (CONTINUED)

Summary of math assessment practices at the six case study schools, 2006/07

Assessment	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
School-based assessments						
Name	None	TerraNova	None	None	Design your Own (DYO) assessment	None
When given		Once (start of year)			Five times a year, grades 1 and 2 Four times a year, kindergarten	
Grades assessed		K–2			K–2	
Who analyzes data		TerraNova and classroom teachers			DYO team and classroom teachers	
How data are used		Identify student curriculum difficulties, guide instruction, identify students needing support, and set targets			Identify student curriculum difficulties, guide instruction, identify students needing support, monitor progress[d]	
Classroom assessments						
Name	Curriculum unit tests; other teacher measures	Curriculum unit tests; other teacher measures	Teacher-designed or textbook assessments	Curriculum unit tests; other teacher measures	Curriculum unit tests; other teacher measures	Curriculum unit tests; other teacher measures
When given	Throughout year	Throughout year	Throughout year	Throughout year	Throughout year	Throughout year
Grades assessed	1–4	K–6	K–4	K–4	K–5	K–5
Who analyzes data	Classroom teachers	Classroom teachers	Classroom teachers	Classroom teachers	Classroom teachers	Classroom teachers
How data are used	Identify student curriculum difficulties, guide instruction, identify students needing support, and monitor progress	Identify student curriculum difficulties, guide instruction, identify students needing support, and monitor progress	Identify student curriculum difficulties, guide instruction, identify students needing support, and monitor progress	Identify student curriculum difficulties, guide instruction, identify students needing support, and monitor progress	Identify student curriculum difficulties, guide instruction, identify students needing support, and monitor progress	Identify student curriculum difficulties, guide instruction, identify students needing support,[e] and monitor progress

a. The district math exam is developed by the four district math lead teachers.

b. The district assessments are at varying stages of implementation in different grades.

c. The principal holds teachers accountable for raising student achievement levels on the districtwide assessments based on student scores.

d. Teachers factor student performance on district and design your own assessments into student report card grades.

e. Teachers use unit tests and other classroom assessments to determine student placement in small groups.

Source: Authors' compilation based on primary documents gathered at schools and interviews with administrators and staff, as described in appendix A.

TABLE B7

Formal collaboration practices among staff at the six case study schools, 2006/07

Collaboration	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Between general educators and						
Within school						
General educators in same grade						
Common planning time	Daily	Daily	Weekly	None	Weekly	Weekly
Grade-level meetings	Semi-weekly	Monthly	Weekly	Occasional	Monthly	Weekly
Math leader						
Grade-level meetings	Weekly	Occasional	—	—	Occasional	None
In-class math support	Upon request	Upon request	None	Arranged with teachers	Upon request	Twice a week
Special educators						
Grade-level meetings	Monthly	Weekly	Weekly	None	None	Weekly
Co-teaching (in inclusion-type classrooms)	None	Daily	Daily	Daily	Daily	None
General educators, multiple grades						
School staff meetings	Semi-monthly	Semi-monthly	—	—	—	Monthly
Vertical grade meetings	—	—	—	Yearly	Yearly	—
Across district						
General educators, multiple grades						
Districtwide meetings	—	Monthly	Monthly	Monthly	Twice a year	—
Between special educators and						
Within school						
Math leader						
Regular meetings	Weekly	Occasional	—	—	Occasional	None
In-class math support	Upon request	Upon request	—	Arranged with teachers	Upon request	None
Special educators, multiple grades						
Regular meetings	Every other week	None	—	—	—	—
Across district						
Special educators						
Regular meetings	Monthly	—	Monthly	1–2 times per month	—	—

(CONTINUED)

TABLE B7 (CONTINUED)

Formal collaboration practices among staff at the six case study schools, 2006/07

Collaboration	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Between in-school math leader and						
Across district						
Math leaders						
Regular meetings	Monthly	Biweekly	Monthly	—	—	—

— is not available.

Note: For further detail see table B14.

Source: Authors' compilation based on primary documents gathered at schools and interviews with administrators and staff, as described in appendix A.

TABLE B8A

Math professional development providers for the six case study schools, 2006/07

Provider	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
In-house providers	Math lead teacher	Math specialist Collegial learning circles	Informal math leader Professional learning communities	Title I math teacher Kindergarten teacher	Math coaches	Middle school math teachers Math committee[a] Study groups
Outside providers	District University partner Curriculum publishers Conferences	District Curriculum publishers Program trainers[b] Conferences	District Curriculum publishers Conferences	Varies[c] Curriculum publishers Conferences	District Local university Curriculum publishers Conferences	District Curriculum publishers Program trainers[d] Conferences

Note: For further detail see table B15.

a. Not active during the year of the study.

b. When the program was introduced, Redwood staff received training in math instruction and the workshop model from America's Choice.

c. The district allows Aspen staff to attend two conferences or other training sessions a year from any outside provider.

d. Willow teachers were trained in Responsive Classroom instructional techniques when the program was introduced. Although Responsive Classroom is not a math program, training for this program is included here because interviews with teachers linked it to positive benefits for math instruction.

Source: Authors' compilation based on primary documents gathered at schools and interviews with administrators and staff, as described in appendix A.

TABLE B8B

Types of professional development provided by the in-house math leaders in the six case study schools, 2006/07

Professional development	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School,[a] Rural Mass., K–8
Schoolwide staff presentations	✔	✔	✔		✔	
Schoolwide staff workshops	✔					
Presentations or support at grade-level meetings	✔	✔			✔	
In-class lesson modeling	✔	✔			✔	✔
Informal support to individual teachers	✔	✔	✔	✔	✔	✔
Support or mentoring for new teachers	✔		✔		✔	

a. In the prior year to the study Willow School had a math committee that made occasional presentations during schoolwide staff meetings; however, during the year of the study the committee was inactive.

Note: For further detail see table B15. The in-house math leaders at each school are the staff members in row 1 of table B8a.

Source: Authors' compilation based on interviews with administrators and staff as described in appendix A.

TABLE B9

Leadership characteristics at the six case study schools, 2006/07

Characteristic	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Empowers teachers						
Encourages leadership development	—	"[The principal] does give opportunity. You have the freedom, but you also have responsibility. . . . [For] teachers, [he is trying to] develop the leadership in them." —Assistant principal	—	—	"I tend to give people little jobs, and then see how they accomplish them before I give them bigger jobs. I try to scaffold them into taking responsibility and becoming leaders in their own right." —Principal	"[The principal] really looks at teachers that want to take on roles, so he doesn't hold on to power. . . . That has been totally refreshing for me. . . . I've just been empowered here more so than other places." —Administrator
Grants autonomy	—	"[The principal is] laissez-faire. He lets us do our jobs." —Special education teacher "He doesn't micromanage." —Special education teacher	"[The administrators] don't micromanage; they basically put out the information and allow the professionals, because teachers are professionals, to do the job." —General education teacher	"I think that [teachers] have to feel ownership of what they're going to do. . . . They definitely have to be empowered." —Principal	"Everybody is free to make it their own within some parameters. They're respected as professionals and therefore give respect to their colleagues and to their students." —Math coach	—
Encourages risk-taking, creativity, initiative	"[The principal] welcomes ideas. So, I mean, that's going to help to make the staff more trusting and willing to work together and to take risks." —Special education teacher	"People can be as creative as they want. . . . People are able to try things and know that we're going to support them and [the fact that] they're trying something." —Assistant principal	—	"I'm looking for enthusiasm, creativity, somebody who has got a lot of ideas and they're so excited that they can't wait to share." —Principal	—	"I said, I have [had] this really great experience, and I found it to be really helpful to my instruction. . . . I would love to have an opportunity to share. And so [the principal] said: Would you like to lead a staff meeting? I said sure." —General education teacher

(CONTINUED)

TABLE B9 (CONTINUED)

Leadership characteristics at the six case study schools, 2006/07

Characteristic	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Respects teachers						
Listens to opinions	—	"[The principal] is always saying: you are the educational leaders of the classroom. . . . He puts that respect and faith in us. . . . You know that he's willing to listen." —Special education teacher	—	"Our principal listens to us and is great." —General education teacher "I feel that she respects us as professionals." —General education teacher	"Anybody in the school can tell me: 'You're going the wrong way with this.' I'll listen." —Principal	"[The principal] takes advice from the teachers during staff meetings. We have a brainstorming session and everything is written down. . . . There is no questioning anything." —Assistant principal
Treats as equals or treats equally	—	"So the goal here . . . was [to] walk the talk and show staff through my actions . . . that I would not ask them to do anything that I wouldn't do myself." —Principal	"Every one of us is equal, we are all the same, and we all just have a job to do. We're all in the same boat." —General education teacher	"We're here as a group . . . We all have the same vote. We're all here for the same reason so I don't get a bigger vote than anyone else." —Principal	—	—
Supports teachers						
Provides resources and training	—	"[The administration has] helped with resources . . . making professional development available . . . It's been astronomical." —Special education teacher	—	—	—	"[The] teachers and the administration are open to any idea. They don't shut you down or they try to help you get the resources in order to do something different." —Special education teacher

(CONTINUED)

TABLE B9 (CONTINUED)

Leadership characteristics at the six case study schools, 2006/07

Characteristic	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Is nurturing and receptive	"I have felt like it's a very nurturing place to work. . . . I have felt welcomed here from day one. The support that I get . . . if I have a question that they don't know the answer to, they find the answer." —Special education teacher	"[The principal] is receptive. He's a good listener. . . . He's going to give you that chance to always sit down with him and discuss what your concerns are. . . . So, he always gives you that respect of not feeling like he is this super administrator that is untouchable." —Special education teacher	—	"As far as the principal, I feel she is very warm. She's very supportive. If there's an issue I feel like I could definitely approach her with it, run it off of her." —General education teacher	—	—

— No quotations were available for this category.

Source: Authors' compilation based on staff interviews.

TABLE B10
Staff culture at the six case study schools, 2006/07

Characterization	Some descriptions from staff
Warm, inclusive community	"The teachers, the quality of teachers, and the community: we're like one big family on personal levels and school levels, which help[s] us build that collaboration for the kids." —Special education teacher at Maple Elementary School
Positive relationships	"Everyone including special ed—we're a team. We all can share resources and ideas and work together." —Special education teacher at Cedar Elementary School
Supportive colleagues	"We have a lot of great teachers here that will bend over backwards and do anything for anybody to really help out." —Special education teacher at Maple Elementary School
Noncompetitive, nonjudgmental peers	"There is a freedom to try new things . . . to share your strengths and your weaknesses. . . . There is a level of comfort. There is just a sense of 'we're all in this experience together.'" —General education teacher at Willow School
Mutual respect and admiration	"We've appreciated our co-workers' efforts. . . . And there is a lot of respect for people because of this, a lot of admiration for this kind of effort. . . . Overall, it's just a nice staff. We have a nice group of people here." —General education teacher at Redwood Elementary School
Flexibility and dedication	"[T]he thing that struck me here is the teachers are very willing to change. . . . We have teachers that are willing to go above and beyond." —General education teacher at Aspen Elementary School
Enjoyable workplace	"It's a very happy place to work; it's very positive. . . . I truly believe that because of [the principal's] aura in this school, it's carried out through the teachers and the children and the assistants. . . . Everyone seems to get along, and I look forward to coming to work everyday." —General education teacher at Aspen Elementary School
Stable staff	"We have longevity here. And longevity says a lot." —Math coach at Beech Elementary School

Note: For further detail see table B19.

Source: Authors' compilation based on staff interviews.

TABLE B11

Staff attitudes toward students at the six case study schools, 2006/07

Attitudes	Some comments from staff
Shared ownership of kids	"I don't think anybody has the thought that their class . . . that those are their only kids. All of the teachers here view every child here as one of their kids." —Special educator at Maple Elementary School
Inclusive of students with disabilities	"[E]veryone is included. Even those learning disabled kids, they're not isolated. They're not in the dungeon, they're not in the basement. Everyone's included, everybody has a purpose and everybody is here." —Primary preventionist at Aspen Elementary School
Know the students	"And what's also good is that we actually have an assistant principal who used to be a special ed teacher, so she's extremely involved with special ed children, and she knows every kid. I think she knows every child with a disability . . . knows everybody's name." —Special educator at Beech Elementary School
Believe in kids	"These kids are great kids. And they know I believe in them. . . . They've given it their all. They've tried their hardest. They work to the best of their ability." —Math leader at Cedar Elementary School
High expectations	"I think we all have high expectations for them. Just because they have disabilities, we don't [give] them any more. . . . We still hold them up to the same standard as everybody else." —Special educator at Redwood Elementary School
Nurturing staff	"There is a lot of nurturing going on. Many of our students are very needy and really are seeking out attention and love and guidance up and beyond just the academic piece. And I think our teachers really try to provide that." —Special education administrator at Redwood

Note: For further detail see table B20.

Source: Authors' compilation based on staff interviews.

TABLE B12

Teacher qualifications and longevity at the six case study schools and in Massachusetts and New York, 2004/05–2006/07

Teacher qualification and longevity	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8	Massachusetts (total), 2005/06	New York (total), 2004/05
State-reported data								
Number of teachers	34	99	18	29	81	49	73,176	221,204
Teachers certified in teaching assignment (percent)[a]	100	90	94	100	97	96	95	93
Total teachers in core classes[b]	31	na	na	27	na	44	60,604	na
Highly qualified teachers in core classes (percent)[c]	100	na	na	100	na	90	95	na
Total core classes[b]	na	260	66	na	260	na	na	763,211
Highly qualified teachers in core classes (percent)[d]	na	97	92	na	98	na	na	95
School-reported data[a]								
Total teachers	35	91	18	28	81	49	na	na
Veteran teachers (five or more years at school)	16	80	9	21	29	34	na	na

na is not applicable.

a. For Massachusetts schools, designates the percentage of teachers who are "licensed with Provisional, Initial or Professional licensure to teach in the area(s) in which they are teaching" (Massachusetts Department of Education 2008). For New York schools, designates the percentage of teachers teaching for five or fewer periods per week outside their certification.

b. Defined by the No Child Left Behind Act as English, reading or language arts, math, science, foreign languages, civics and government, economics, arts, history, and geography.

c. In Massachusetts teachers are considered highly qualified if they hold a valid Massachusetts license and demonstrate subject matter competency in the areas they teach (Massachusetts Department of Education 2008).

d. In New York teachers are considered highly qualified if they have at least a bachelor's degree, are certified to teach in their subject area, and show subject matter competency (http://www.emsc.nysed.gov/irts/reportcard/).

Source: Authors' analysis based on data from Massachusetts Department of Education (2006a); New York Education Department (2005a); and interviews with administrators at each school for 2006/07.

TABLE B13

Out-of-class math services for students with disabilities and other struggling learners at the six schools, 2006/07

Service	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Math resource room						
Staff	Math lead teacher			Title I teacher and teaching assistant		
Students served	Students with Individualized Education Programs and struggling learners (grades 2–4)[a]			Title I students and struggling learners (grades 2–4)		
Special education resource room						
Staff	Special educator	Special educator	Special educators (one each for grades K–2 and 3–4)	Special educator (only grades 1 and 2 for math) and teaching assistants	Special educator	Special educator
Students served	Students with Individualized Education Programs, all grades	Students with Individualized Education Programs, all grades[b]	Students with Individualized Education Programs, all grades[c]	Students with Individualized Education Programs, all grades	Students with Individualized Education Programs, all grades	Students with Individualized Education Programs, all grades
Before-school program						
Name	Before-school				Extended day	
Staff	Math lead teacher and general educators				General educators (grouped by administrators)	
Students served	Struggling learners, teacher-identified (grades 2–4)				Struggling learners from own classroom, teacher-identified, those who scored low 2s on state exam, mandatory	
Frequency and duration	Math leader: every morning (at least 30 minutes per session, twice a week)				Daily (8:00–8:30 a.m.)	
Name					Project Sunrise	
Staff					General educators and special educators	

(CONTINUED)

TABLE B13 (CONTINUED)

Out-of-class math services for students with disabilities and other struggling learners at the six schools, 2006/07

Service	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Students served					Struggling learners, teacher-identified (grades 1 and 2)	
Frequency and duration					Daily (45 minutes, 7:00–7:45 a.m.)	
After-school program						
Name	After-school				Project Sunset	
Staff	General educators				General educators and special educators	
Students served	Students with Individualized Education Programs Struggling learners, teacher-identified (grade 4)				An early intervention program for struggling learners, grades 2–5, academic intervention services (AIS) students, focus on New York State test preparation, based on teacher recommendations and test scores	
Frequency and duration	At least one day a week devoted to math, 40 minutes				Two days per week (one hour and 45 minutes; 3:00–4:45 p.m.)	
Saturday program						
Staff		General educators			General educators	
		Special educators				
Students served		Students with Individualized Education Programs, struggling learners			Grades 3–5, struggling learners	
Frequency and duration		Weekly (three hours per session)			Weekly (three hours and 30 minutes per session, November–May)	

(CONTINUED)

TABLE B13 (CONTINUED)

Out-of-class math services for students with disabilities and other struggling learners at the six schools, 2006/07

Service	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Summer school (districtwide)						
Staff	Math leader teacher and general educators	AIS staff			Principal and general educators	
Students served	Students with Individualized Education Programs, struggling learners	Grades K–6 (not all grades; in the past was only for upper grades), struggling learners who have shown substantial regression without summer services, measured by general education teachers			Grades 3–5, struggling learners (students who have failed the state exam)	
Frequency and duration	Monday–Thursday (half days with math block)				Monday–Thursday (five hours a day, six weeks)	
Vacation program (districtwide)						
Staff	Math leader teacher and general educators				General educators	
Students served	Students with Individualized Education Programs, struggling learners whose scores were close to passing on the Massachusetts Comprehensive Assessment System (MCAS)				Struggling learners	
Frequency and duration	February and April vacations (focus is on MCAS); Monday–Thursday mornings					

(CONTINUED)

TABLE B13 (CONTINUED)

Out-of-class math services for students with disabilities and other struggling learners at the six schools, 2006/07

Service	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Response-to-intervention (RtI) program						
Name			School based intervention team (SBIT)	Primary prevention RtI	General education teacher support services (GETSS) program	
Staff			SBIT coordinator All staff	Primary preventionist	GETSS teacher	
Students served			Struggling learners (all grades)	Struggling learners (grades K–2)	Struggling learners (grade 2: teacher identified; grades 3–5: AIS students)	
Other programs and services						
Name	Lunch group	Extended Day			AIS support	Informal time before and after school, during recess for extra help
Staff	Math lead teacher				General education teacher	General educators and special education teachers; grade 6 teachers have a schedule among them to cover the days of the week
Students served	Struggling learners, grade 4 (any who wish to participate)					General education students and students with disabilities
Frequency and duration	When math leader has time and throughout the year				8:00–8:30 a.m. everyday	Middle school teachers stay until about 4:00 p.m. everyday
Name	MCAS camp (districtwide)			MCAS preparation (districtwide)		
Staff	General educators			Staffed by teachers who apply		

(CONTINUED)

TABLE B13 (CONTINUED)

Out-of-class math services for students with disabilities and other struggling learners at the six schools, 2006/07

Service	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Students served	Grades 2–4 (districtwide)			For MCAS students at risk and those recommended by teachers		
Frequency and duration	Starts in June, lasts for five weeks, 8:15 a.m.–12:30 p.m.			Held twice a week for 10 weeks just before the math MCAS before school, 8:00–8:50 a.m.		

a. In January the math lead teacher stops serving grade 2 students and focuses on MCAS preparation for grades 3 and 4 students whose scores were on the border between passing or failing the test.

b. Students eligible for AIS services in math are typically served by general educators in general education classrooms.

c. Students eligible for AIS services in math are served by teachers whom the staff consider most appropriate to help the student with his/her specific needs.

Source: Authors' compilation based on interviews and personal communication with staff and primary documents gathered at schools, as described in appendix A.

TABLE B14
Formal collaboration practices in the six case study schools, 2006/07

Collaboration	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Between general educators and						
Within school						
General educators from same grade level						
Common planning time	Daily common planning time.	Daily common planning time (for most teachers within grade levels).	Weekly common planning time.	No weekly common planning time	Weekly common planning time.	Weekly common planning time.
Regular meetings	Two grade-level meetings each week, during common planning time: teachers meet twice a week (once for literacy, once for math).	Monthly grade-level meetings during one staff meeting each month. Agendas set by administration (may include lesson planning or analysis of student data).	Weekly grade-level professional learning community (PLC) meetings. Teachers can meet during common planning time or at another time, but must meet weekly. Agendas for monthly (full-day) PLC's set by administrators; teachers can add to it. Topics include math standards, student assessment data and writing assessments.	Occasional grade-level meetings occur a few times a year to every month, for one hour before school. Teachers examine topics (such as Massachusetts Comprehensive Assessment System, math, and school culture) assigned by the principal.	Monthly grade-level (40–50 minute) meetings during common planning time in which teachers discuss upcoming assessments, the curriculum, and so on.	Weekly grade-level meetings during common planning time. Teachers discuss curriculum and share ideas.
Math leaders						
Regular meetings	Weekly meetings in which grade-level teams meet with the math lead teacher every Thursday or Friday to plan lessons for support.	Occasional meetings during the year in which the math specialist may attend monthly grade-level meeting if requested.	—	—[a]	Occasional meetings during the year in which math coaches may attend grade-level meetings to illustrate new curriculum components and distribute materials.	—

(CONTINUED)

TABLE B14 (CONTINUED)

Formal collaboration practices in the six case study schools, 2006/07

Collaboration	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
In-class math support	Individual lesson modeling and in-class support sessions in which math leader will model lessons and provide other in-class support to teachers upon request.	Individual lesson modeling and in-class support sessions in which math specialist will model lessons and provide other in-class support to teachers upon request.	—	—	Individual coaching or coteaching sessions in which math coaches work with teachers in their classrooms for one week, upon request, to model lessons, provide feedback, and confer about students. Math coaches worked with Design Your Own team to develop and analyze grades K–2.	Individual math support sessions in which middle-school teachers provide in-class support to elementary-school teachers in paired arrangements two to three times a week (for two hours total), each semester.
Special educators						
Regular meetings	Goal is to meet once a month (not yet fully in place).	Special educators invited to weekly grade-level meetings.	Special educators invited to weekly PLC meetings. They receive minutes when they cannot attend.	—	General education teacher support services (GETSS) teacher works closely with general educators who have referred students to her.	Middle school special educators participate in grade-level weekly meetings.
In-class math support	—	General and special educators collaborate daily in integrated classrooms.	General and special educators collaborate daily in inclusion classrooms.	General and special educators collaborate daily in language-based classrooms.	General and special educators collaborate daily in collaborative classrooms.	—
Across district						
General educators from same grade level						
Regular meetings	—	Monthly districtwide meetings for teachers of all grades: for 1 hour and 50 minutes after school for professional development.	Monthly districtwide grade-level PLC meetings for a full day.	Monthly districtwide meetings for kindergarten teachers for two hours each. Teachers share best practices, have guest speakers, and discuss curriculum focal points.	Districtwide meetings for teachers of all grades each year for a couple days at the beginning and end of each year. Teachers discuss plans for upcoming year.	—

(CONTINUED)

TABLE B14 (CONTINUED)

Formal collaboration practices in the six case study schools, 2006/07

Collaboration	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Between special educators and						
Within school						
Math support staff						
Regular meetings	Math leader meets once a week with new special educator for curriculum planning and guidance.	Math specialist can provide support to special educators in their classrooms and meet during grade-level meetings.	—	Title I math teacher has worked out an arrangement with the special educator and a general educator to provide full-time math support in a language-based classroom.	Math coaches can provide support to special educators in collaborative teams. Math coaches occasionally meet with the GETSS teacher.	—
Special educators						
Regular meetings	Team meetings every other week include all special educators, principal, and assistant principal(s), and occupational therapist. Staff discuss support needs and topics raised by district.	No regular special education team meetings. Instead, special educators can meet weekly with general educators during grade-level meetings.	—	—	—	—
Across district						
Special educators						
Regular meetings	Monthly special educator meetings for professional development on writing Individualized Education Programs and other topics.	—	Monthly special educator meetings. Monthly districtwide grade-level PLC meetings, including special educators.	Monthly or semi-monthly meetings between district primary preventionists and director of special education to plan Response to Intervention instruction.	—	—

(CONTINUED)

TABLE B14 (CONTINUED)

Formal collaboration practices in the six case study schools, 2006/07

Collaboration	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Between in-school math support staff and						
Across district						
Math leaders						
Regular meetings	The math committee consisting of the four math leaders and math teachers from each school meet at least once a month	Every other Friday for a full day district math specialists and leaders meet to review standards, lessons, and curriculum focal points.	Monthly districtwide grade-level PLC meetings.	None reported between Title I math teacher and district math coordinator.	None reported across the district, although math coaches meet regularly with the school administration.	—[b]

— is not available or was not reported.

a. A district math coordinator meets with each grade level at the beginning of the year and is available to answer questions about the curriculum and assessment. She met with grade-level representatives from each school in the district to decide on math assessment tools.

b. A math committee (consisting of middle school math teachers, grade-level representatives, a special educator, and the administration) met monthly the previous year to examine math support and professional development needs across the school. The committee was disbanded during the year of the study because of changing priorities.

Note: Formal collaboration practices excludes collaboration between school administrators, special educators, and general educators during the Individualized Education Program referral process.

Source: Authors' compilation based on primary documents gathered at schools and interviews with administrators and staff, as described in appendix A.

TABLE B15

A summary of math professional development at the six schools, 2006/07

	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
In-house training						
Provider	Math lead teacher	Math specialist	Math expert teacher	Title I teacher kindergarten teacher	Math coaches	Middle school math teachers
Type	Staff presentations and workshops	Staff presentations	Staff presentations	—	Staff presentations	—
Details	For all teachers, held on occasion during staff meetings, and includes lesson demonstrations, curriculum training, Massachusetts Comprehensive Assessment System (MCAS) data analysis.	For all teachers, held on occasion during staff meetings, includes strategies for standardized test preparation, and addresses state math standards.	For all teachers, held on occasion during staff meetings, and includes lesson demonstrations and instructional strategies.	—	For all teachers, held on occasion during staff meetings, and includes lesson modeling and training in the curriculum for new teachers.	—
Type	In-class lesson modeling	In-class lesson modeling	na	na	In-class lesson modeling	In-class lesson modeling
Details	For all teachers, by request, throughout the year.	For all teachers, by request, throughout the year.	na	na	For all teachers, by request, for one-week sessions (with focus on new teachers).	For paired teachers from grades 3–5, twice a week (two hours total) for semester or year.
Type	Additional formal and informal math support.	Additional formal and informal math support.	Informal math support.	Informal math support.	Additional formal and informal math support.	Informal math support.
Details	For all teachers available all year and includes developing lesson plans, curriculum support, and instructional strategies. Formal consultations during grade-level meetings.	For all teachers available all year includes developing lesson plans, curriculum support, and state standards. Formal consultations during grade-level meetings.	For all teachers available all year and includes instructional strategies.	For all teachers available all year and includes curriculum support and instructional strategies.	For all teachers available all year, formal consultations during grade-level meetings.	For all teachers available all year.
Provider	na	Staff colleagues through Collegial Learning Circles	Grade-level colleagues through professional learning communities (PLCs)	Staff colleagues through grade-level committees	na	Math committee,[a] staff colleagues through informal study groups

(CONTINUED)

TABLE B15 (CONTINUED)

A summary of math professional development at the six schools

	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Type	na	Study groups	Group meetings	Study groups	na	Staff presentations (math committee)
Details	na	For all teachers (voluntary), available all year; frequency depends on teachers' initiative; topics chosen by teachers (not necessarily math).	For all teachers, weekly PLC meetings (districtwide once a month); topics include analysis of New York State Assessment results and designing benchmark exam.	For all teachers (voluntary), available all year; frequency depends on teachers' initiative; topics chosen by teachers (not necessarily math).	na	For all teachers, one half-day a year (math committee)[b]; math committee's focus last year was teaching and learning math vocabulary. Study group topics were chosen by teachers (not necessarily math).
Outside training						
Provider	District and university partner	District	District	Varies	District and local university	District
Type	Courses, workshops	Courses (including online), workshops	Workshops, conferences	Courses, workshops, conferences	Courses, workshops, conferences	Workshops, conferences
Details	For all teachers, but special training for math lead teachers[c] all summer and all year on a variety of topics (time and money; probability and statistics; hands-on activities).	For all teachers, but special training for math specialist[d] all year on a variety of topics (such as curriculum training and online math tools).	For all teachers and teachers assistants, but special training for math expert[e] once or twice a month on a variety of topics.	For all teachers. Staff can attend two sessions a year on a variety of topics.	For all teachers, but special training for math coaches.[f] Staff have five half-days of professional development per year on a variety of topics (such as curriculum training and math assessment scoring).	For all teachers special training for middle school math teachers[g] every other week on a variety of topics (such as math open response writing).
Provider	Curriculum publishers	Curriculum publishers; program trainers	na	Curriculum publishers	Curriculum publishers	Curriculum publishers; program trainers
Type	Scott Foresman	Investigations and America's Choice	na	Scott Foresman	Everyday Mathematics	Everyday Mathematics and Responsive Classroom

(CONTINUED)

TABLE B15 (CONTINUED)

A summary of math professional development at the six schools

	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Details	Training in the Scott Foresman curriculum for all teachers when it was introduced	Training in the Investigations curriculum and America's Choice program when they were introduced for all teachers.	na	Training in the Scott Foresman curriculum when it was introduced for all teachers.[h]	Training in the Everyday Mathematics curriculum when it was introduced for all teachers.	Training in the Everyday Mathematics curriculum and the Responsive Classroom program[i] when they were introduced for all teachers.

— is not available or was not reported.

na is not applicable.

a. The math committee, alive in the previous year, was disbanded the year of the study. Members included administrators and middle school math teachers.

b. Two half days per year were designated for professional development, with one half day focusing on local school topics, including math instruction.

c. The math leader was trained by university partner professors. She met with other district math leaders each month.

d. The math specialist met each month with other district math specialists to review state standards, the curriculum, and information for teachers.

e. The principal sent the school's informal math expert to national and international math conferences so that she could share the information with staff.

f. The district provided training for the math coaches to serve as math and workshop model coaches. The principal sent the math coaches to math conferences.

g. The principal sent the middle school math teachers and a few other teachers to math conferences.

h. The Title I math teacher and a kindergarten teacher were trained by curriculum publishers to be in-school consultants for the curriculum.

i. Teachers received training in Responsive Classroom instructional techniques when the program was introduced. Although Responsive Classroom is not a math program, training was included because interviews with teachers linked this program to positive benefits for math instruction.

Source: Authors' compilation based on primary documents gathered at schools and interviews with administrators and staff, as described in appendix A.

TABLE B16

Governing approaches—words from administrators at the six case study schools, 2006/07

Governing approach	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Staff input		"If you want to make a change go to your best teachers first. . . . People may not always agree [with each other], but I think they at least feel like they were heard." —Assistant principal	—	"We pretty much are a consensus building. I'm open to any suggestions." —Principal	"Anybody in the school can tell me: 'You're going the wrong way with this.' I'll listen." —Principal	"During staff meetings . . . we have a brainstorming session and everything is written down. . . . There is no questioning anything. It's just: what are your concerns?" —Assistant principal
Decisionmaking		"Rather than top-down, call it the bottom-up and side-to-side [approach] that is a collective effort." —Principal	—	"We're here as a group. . . . We all have the same vote. We're all here for the same reason, so I don't get a bigger vote than anyone else." —Principal	"In most cases, I do hold the final veto. Because let's face it . . . if something goes wrong, it's my head on the chopping block, not anybody else's." —Principal	"The decision ultimately rests with the principal . . . [but] normally it's the teachers [who] decide what's going to happen." —Assistant principal
Management style	"I'm giving them a little more freedom to make decisions in their classroom. . . . But I'm also making them more accountable by being in there [as an observer]." —Principal	"Equip people adequately to do the job . . . equip them in a manner where they're going to feel very competent . . . [then] provide incentives along the way, recognition for the work that they do." —Principal	"Always remember we're here for kids, because every time there's an issue . . . it's because they're thinking of adults. They've missed the kids and as soon as you bring the problem back down to kids, we can solve it and move on." —Principal	"I think that they have to feel ownership of what they're going to do. You can't come and mandate them to do something when . . . they're going to say, 'How do you know what we do?' They're right. They definitely have to be empowered." —Principal	"Hire good people, tell them what to do, and let them do it. . . . I don't believe in micromanaging things. But I do believe in laying out my expectations. Also . . . I try to scaffold [people] into taking responsibility and becoming leaders in their own right." —Principal	—

— No quotations were available for this category.

Source: Authors' compilation based on interviews with administrators.

TABLE B17

Roles of school administrators: summary of the six case study schools, 2006/07

	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Administrative structure	Principal Assistant principal	Principal Three assistant principals One senior program administrator	Principal	Principal	Principal Three assistant principals	Principal Assistant principal
Described roles and activities						
Principal	• Helps serve as school's instructional leader. • Provides teacher support. Oversees teacher hiring. • Oversees student discipline.	• Oversees school improvement efforts. • Tracks school achievement data, sets school vision, and communicates it to staff. • Oversees accountability monitoring. • Works to upgrade the physical plant. • Seeks resources to support teachers. • Oversees teacher hiring.	• Sets schoolwide expectations for teaching and learning. • Provides support to teachers. • Oversees teacher hiring. • Introduced and continues to monitor the work of school professional learning communities (PLCs).	• Seeks resources to support teachers. • Oversees teacher hiring. • Established language-based classrooms at the school. • Initiated and directs the work of school committees that focus on promoting a different social value each month (collegiality, respect). • Initiated formation of a student council and meets with grades 3 and 4 student representatives twice a month. • Organizes community outreach events.	• Oversees use of the physical plant. • Provides training to coaches and teacher leaders by sending them to conferences. • Decides how to deploy teachers for different roles (in collaborative team, in resource room). • Oversees teacher hiring.	• Attends grade-level meetings. Runs faculty meetings. • Plans Friday community meetings. • Attends and brings back information from national educator conferences. • Helps analyze Massachusetts Comprehensive Assessment System (MCAS) data and reports with staff. • Examines student progress.

(CONTINUED)

TABLE B17 (CONTINUED)

Roles of school administrators: summary of the six case study schools, 2006/07

	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Assistant principal	• Assists the principal as school instructional leader. • Provides teacher support. Chairs the special education team.	na	na	na	na	• Helps examine student progress. • Helps set learning priorities. • Visits classrooms daily.
Assistant principal 1	na	• Chairs the Educational Support Services team, which evaluates teacher requests for student referrals to special education.	na	na	• Oversees literacy instruction and special education.	na
Assistant principal 2	na	• Oversees all assessment and test data analysis for the school.	na	na	• Oversees the science curriculum.	na
Assistant principal 3	na	• Oversees all special programs (such as, art or music).	na	na	• Oversees the social studies curriculum. • Assistant principals also help set up staff trainings after school.	na
Senior program administrator	na	• Oversees PreK and kindergarten programs.	na	na		na

(CONTINUED)

TABLE B17 (CONTINUED)

Roles of school administrators: summary of the six case study schools, 2006/07

	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Teacher supervision practices						
Principal	• Observes and evaluates all first-year, third-year, and professional-status teachers (latter shared with assistant principal). • After observations converses with teachers and provides instructional advice.	• Has no direct observation or evaluation duties.	• Holds teachers accountable for student performance. • Examines students' assessments administered every 10 weeks. Teachers with struggling students must show improvement at the end of 5 weeks.	—	• Makes very few observations. • Receives information about teachers from his assistant principals and writes up evaluations.	• Conducts monthly, half-hour meetings with every teacher in the building to check for support needs. • Accompanied by regular classroom observations.
Assistant principal	• Observes and evaluates all second-year and professional-status teachers (latter shared with principal).	na	na	na	• Oversees the teachers' paraprofessionals and teaching assistants.	• Shares monthly teacher meetings and observations with principal.
Assistant principal 1	na	• Supervises grades 1 and 2 teachers.	na	na	• Supervises grades 1 and 4 teachers; library, nursing, special services, and health coordinator staff; makes observations and gives evaluations of teachers.	na

(CONTINUED)

TABLE B17 (CONTINUED)

Roles of school administrators: summary of the six case study schools, 2006/07

	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Assistant principal 2	na	• Supervises grades 3 and 4 teachers.	na	na	• Oversees K and grade 3 teachers; computer, music, art, and substitute teachers.	na
Assistant principal 3	na	• Supervises grades 5 and 6 teachers.	na	na	• Oversees grades 2 and 5, English language learner teachers, guidance counselor, behavior modifications dean, and attendance coordinator.	na
Senior program administrator	na	• Supervises PreK and kindergarten teachers.	na	na	na	na

— is not available.

na is not applicable.

Source: Authors' compilation based on interviews with administrators and staff, as described in appendix A.

TABLE B18

Goals for the school, staff, and students at the six case study schools—words from administrators, 2006/07

Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
"That's the bottom line . . . it's what the kids need. We're here for them. And I think that's really the motto of the school . . . learning takes place for students." —Principal	"For me, it was . . . getting people to feel good about who they may be . . . [so] that it will transfer to students, and students will feel good about being here, and it would translate to whatever we ask of them, that hopefully we would get the results that we were seeking." —Principal	"I said our whole goal of why we're here is to answer these three questions: One, what is it we want children to know and be able to do? Which means we all have to start talking to each other. . . . The second thing is how do we know what kids know? So we have to talk to each other again. . . . And the third thing is how do we respond to those kids who don't learn? And those three questions have really truly been our guiding force." —Principal	"I think what I want the kids to leave here with [is] that they're going to be a good member of the community and they're going to get along and be able to work with other people." —Principal	"And this is perhaps the core of my philosophy: I have three grandsons. I'm not going to accept anything in my building where I would not put my grandsons in that situation." —Principal	"Look at the whole child . . . put him in a classroom. Let him get along with his peers. Let him have friends; let him have fun. Teach him new things. Find his affinity. Find a passion for him or her, you know, and let him run with it. . . . Create a life-long learner. . . . That's what we shoot for, is we want to produce good citizens." —Assistant principal

Note: This study did not set out to examine administrators' overall school goals and visions; thus, systematic information about these ideas was not collected. The statements in this table were made in various contexts and are unlikely to represent administrators' full views. They are presented to suggest the spirit that these leaders bring to their schools.

Source: Authors' compilation based on interviews with school administrators.

TABLE B19
Staff culture at the six case study schools, 2006/07

Characteristic	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Sense of home	"We always think it's like our second home." —General education teacher	"I think we have a family. That's really how it feels here. . . . [It] really is a family-oriented kind of situation. I mean we all know each other well." —General education teacher	"The teachers, the quality of teachers, and the community: we're like one big family on personal levels and school levels which help[s] us build that collaboration for the kids." —Special education teacher	"For the most part, [the parents] are very happy. They like the school. We call ourselves a family, which is the way I want it to be." —Principal	"[It's] a fantastic staff. I think that it's a family. . . . We have longevity here." —Math coach	—
Sense of community	"We work as a community. We care about the children. We care about the parents. We want to make them feel like they're part of a community." —Special education teacher	—	—	"I do think . . . [we are] very community-centered." —Special education teacher	—	"Because it is a small school, I think, people feel a connection. . . . The parents work together for fundraising, and there's a large population of the kids that are involved in sports . . . drama and music and so all of those parents kind of know each other." —General education teacher
Everyone is equal	—	—	"Every one of us is equal, we are all the same, and we all just have a job to do. We're all in the same boat." —General education teacher	"Everyone is included. . . . We're in this together, and I don't think anyone is above anyone else. . . . We all have the same vote; we're all here for the same reason so I don't get a bigger vote than anyone else." —Principal	—	"There is a real sense of community. . . . Everybody is on the same page; nobody is excluded." —Special education teacher

(CONTINUED)

TABLE B19 (CONTINUED)

Staff culture at the six case study schools, 2006/07

Characteristic	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Good relationships, rapport, friendship	"For a lot of people, it's comforting because we do deal with kids coming from a rough home life or . . . stressful situations, and it's nice to have that collaboration . . . [and] friendship of colleagues." —General education teacher	"I think the teachers get along fine with each other. . . . If I go to somebody or ask somebody something, everybody is willing to share." —General education teacher	—	"Besides being great friends, we have a wonderful working relationship." —Special education teacher	"You really have to form a bond with them. . . . It's very rare that I can't collaborate with them. . . . I think I have a pretty good rapport with most teachers." —General education teacher	"I really think that people really care about one another. . . . We hang out. And people go out all the time and socialize as well." —General education teacher
Positive relations between general and special educators	"Everyone including special ed . . . we're a team. We all can share resources and ideas and work together." —Special education teacher	"And I think it's key that we're not looked at as self-contained [teachers]. . . . We are looked at as grade-level [teachers]. . . . We are not addressed as a secluded-type special education department. . . . They throw us right in there. We love it." —Special education teacher	"They love each other. We don't separate, we really don't. . . . The special ed teachers are right in the classroom. They would meet and talk with the classroom teacher and say OK these are the kids who need a small group." —Principal	"[T]he teachers here have been absolutely wonderful about loaning me things. They've let me come in, peek and go around." —Special education teacher	—	"I'm able to go into a lot of the classes, and the teachers are willing to let me go in and help them rather than just go in and sit in the back of class and pull my guys to the back. They're open to anything. . . . And even I'll teach a lesson." —Special education teacher

(CONTINUED)

TABLE B19 (CONTINUED)

Staff culture at the six case study schools, 2006/07

Characteristic	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Teachers help and support each other	"As a new teacher, I think the support is really amazing here. . . . We meet as a team every week for literacy, every week for math. We have the literacy coach checking. We have the math lead checking in. New teachers have mentors. So, there's a lot of collaboration here and support." —General education teacher	"We have a very cohesive kind of relationship. It's supportive. If you need help with anything, you can ask. I mean there is no holding back on whether it's materials or advice or help with something." —Special education teacher	"I think overall it's the teamwork. We have a lot of great teachers here that will bend over backwards and do anything for anybody to really help out." —Special education teacher	"I think it's a warm, very warm environment here. . . . I think the staff is a fairly warm staff. I feel like on the whole the staff gets along well with each other . . . We work well together. We share. . . . Everyone is more than happy to help each other." —General education teacher	"[As a new teacher, the culture for the staff was] very supportive. . . . The teachers all were very friendly. Anybody I needed help from was more than willing to answer questions to help." —Special education teacher	"Everybody tries to help. . . . Everybody is on the same page. Everybody is part of everybody's classes. . . . Everybody works together; it's really a team here." —Special education teacher
Able to learn from peers, share ideas, strategies	"We try to share ideas that worked. . . . If something works, we say I tried this and it worked really great and the kids are really into it." —General education teacher	"And when we get together for our professional development, this is what we're allowed to do . . . is bounce ideas off of each other, and it's invaluable. . . . You get your best ideas from your colleagues." —Special education teacher	"They'll go to the person next door; they'll go to somebody on their team. They will talk with each other. They'll talk in the staff room and say 'I'm just stumped.' And automatically the other teacher will say: 'Try this, I have this in my class you can borrow' or 'Gee I'm free on Tuesday at one and I'll come observe." —Principal	"I think a lot of teachers here . . . this staff, veteran teachers, new teachers, any teacher that is here seems more willing to learn new things. . . . We share a lot." —General education teacher	—	"[T]here is a very nice collaborative piece that comes when you work with someone who is at an entirely different grade level. . . . Having the relationship and going with someone who has such a passion for this subject really opened my eyes to the possibilities of what my instruction could look like." —General education teacher

(CONTINUED)

TABLE B19 (CONTINUED)

Staff culture at the six case study schools, 2006/07

Characteristic	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Team orientation, work together	"I think it's important that the first and second grade teachers see what's expected of the [4th grade] children because they're setting the foundation. . . . A fourth grade teacher actually sat at each table and went over the question with them.. I think we work very well together." —Math lead teacher	"[W]hy is this school differentiating itself from the others—especially in math—for students with disabilities? . . . I think because of the community of our building. I think our staff is outstanding. I think our administration, like I said, is excellent and, therefore, those two things working together, your really need them. You need teachers to fight." —Special education teacher	"I think overall it's the teamwork. We have a lot of great teachers here that will bend over backwards and do anything for anybody to really help out." —Special education teacher	"From the day I walked into this building, I just felt a part of it. . . . I just felt that everybody worked very well together. Yes, there are occasional conflicts, but I think people are reasonable and they just try to work together and solve the issue." —General education teacher	"[The coaches] come in and help the teachers at any time. For example, as a new teacher, [the coach] came in for a week. And we worked as a team. . . ." —Special education teacher	"[A]ll of us are a team and we all work together. And whatever I do affects everybody else. . . . I think that's the philosophy." —General education teacher
Nonjudgmental, can share weaknesses, can take risks, be creative	"I'm a colleague, and I do no evaluation, and I think that they can come to me and really genuinely ask for advice, and they know it's not going to go any further than that. I'm very non-threatening with them." —Math lead teacher	"It's not a competitive environment here. . . . Everybody says if I have it, you can borrow it." —Special education teacher	"I think a large piece of it comes from the trust factor. Teachers working together and being able to trust each other . . . they really feel that they could go to each other and that it was going to be kept in a professional fashion." —Special education teacher	—	"We also watch the teachers, but we have to be very careful how we phrase it. It is not an observation because we don't put any opinion to it. It doesn't matter whether it was good or bad; it is my job to make it better." —Math coach	"There is a freedom to try new things . . . to share your strengths and your weaknesses. . . . There is a level of comfort. There is just a sense of 'we're all in this experience together'." —General education teacher

(CONTINUED)

TABLE B19 (CONTINUED)

Staff culture at the six case study schools, 2006/07

Characteristic	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Respect, admiration for fellow staff	"What has led to that great working relationship? I think the respect we have for each other." —Math lead teacher	"We've appreciated our co-workers' efforts. We see the hardworking [efforts]. . . . And there is a lot of respect for people because of this, a lot of admiration for this kind of effort. . . . Overall, it's just a nice staff. We have a nice group of people here." —General education teacher	—	"And I feel that [the principal] respects us as professionals. And so the atmosphere in the building and the way we work with each other I think is at a very high level." —General education teacher	". . . the coaches were respected by the staff, and the staff listened to what the coaches said. . . . All the coaches were from the school so the teachers knew that these were excellent teachers." —Principal	—
Dedicated, hard workers	"I do think the teachers really love the kids here. I mean like really work hard for these kids." —General education teacher	"We work hard (chuckling). We work really hard here. I can't possibly tell you how fortunate we all are to be here onboard. . . . It's a great school." —Special education teacher	—	". . . the thing that struck me here is the teachers are very willing to change. . . . We have teachers that are willing to go above and beyond." —General education teacher	"I think our staff knows the expectation and they take pride in their work. . . . I was the one that provided it but by no means you can lead a horse to water but they all take the drink. They do that in and of themselves. It is a very dedicated staff." —Math coach	"I think it's the relationship that the adult community has and the value that they place on the learning that happens here that really makes for the greatest gains with student achievement." —General education teacher

(CONTINUED)

TABLE B19 (CONTINUED)

Staff culture at the six case study schools, 2006/07

Characteristic	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Flexible, open to change	"They let us do what we as teachers think that's best for our students. . . . [As] teachers we feel like we're flexible" —General education teacher	"Whatever the teachers are given, they really just do it. . . . The teachers here, I think, always come up to the plate. They know what they have to do. And they do it. There's not a lot of complaining." —Math specialist	"[There is] big time flexibility [here]. . . . If I had a couple of minutes to spare and you had a child come into the room you could do that, by all means you could do that." —General education teacher	"We're both very flexible, so I have no problem taking a child that is not special needs because I feel by having this kind of group, it boosts everybody's morale." —Special education teacher	—	"Our special education staff and program really every year sort of reinvents itself based on the needs of the kids and the places that they're at." —General education teacher
Enjoy, happy with work	"I have felt like it's a very nurturing place to work, both in terms of what I see happening with my students and my own personal experience. I have to say that I felt welcomed here from day one." —Special education teacher	"We work hard (chuckling). We work really hard here. I can't possibly tell you how fortunate we all are to be here onboard at. . . . It's a great school" —Special education teacher	—	"It's a very happy place to work; it's very positive. . . . I truly believe that because of [the principal's] aura in this school, it's carried out through the teachers and the children and the assistants. . . . Everyone seems to get along and I look forward to coming to work everyday." —General education teacher	—	"They're excited about their job; they love their job and they want to help the kids. And they've been doing it for years." —Assistant principal
Stable staff	—	"We've been stable. And I think you need to be stable." —General education teacher	—	"I think it is more of a community and the teachers have more of a drive to stay . . . and [they] do. . . . [A] lot of the teachers have been here for a long time." —Special education teacher	"We have longevity here. And longevity says a lot." —Math coach	—

— No relevant quotations were available.

Source: Authors' compilation based on interviews with school staff and administrators.

TABLE B20
Staff attitudes toward students at the six case study schools, 2006/07

Characteristic	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Shared ownership of kids	—	"But at the grade level, they're taking stuff, beginning to really discuss the children and treating the children as everybody's children or all of our students." —Assistant principal	"I don't think anybody has the thought that their class . . . that those are their only kids. All of the teachers here view every child here as one of their kids." —Special education teacher	—	—	". . . everybody has all the kids. . . . And so it's just a huge team rather than these are just my homeroom; you don't know my guys. It's everybody knows everybody so it's a real team effort." —Special education teacher
Inclusive of students with disabilities	"This administration cares about special ed. No doubt about it. I mean she's really concerned . . . that they have the same opportunities to learn as every other child in this school." —Special education teacher	—	"We don't separate. . . . Whether the small group is with the classroom teacher or special ed, whether the children are identified or not, it doesn't matter . . . [It's] whatever the kids need." —Principal	"Everyone is included. Even those learning disabled kids, they're not isolated. They're not in the dungeon, they're not in the basement. Everyone's included, everybody has a purpose and everybody is here." —Primary preventionist	"A lot of the teachers care for them from what I've seen. . . . Teachers call parents here. They want their kids to learn. They want their kids to strive . . . will do the extra work to get the kid whatever services they need." —Special education teacher	—

(CONTINUED)

TABLE B20 (CONTINUED)

Staff attitudes toward students at the six case study schools, 2006/07

Characteristic	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Know the students	". . . the advantage I have is that I know these kids. I mean I see them from first grade on. So, I probably know 85 percent of the kids. I know their strengths and weaknesses, which is great." —Math lead teacher	"In this school, there's a really tight bond between educators and the students. . . . There's a strong connection between home and school and parents as partners with the students and the teachers. They must work together." —General education teacher	—	—	"And what's also good is that we actually have an assistant principal who used to be a special ed teacher, so she's extremely involved with special ed children, and she knows every kid. I think she knows every child with a disability . . . knows everybody's name." —Special education teacher	"I get into the classroom a lot; and I think it's important for these kids to see me and know me. And the more they see me the more they're going to trust me. . . ." —Assistant principal
Believe in students	"These kids are great kids. And they know I believe in them. . . . They've given it their all. They've tried their hardest. They work to the best of their ability." —Math lead teacher	". . . I think [the teachers and administrators] really believe in the students. We really believe in teaching." —Special education administrator	—	—	—	"And then you're going to look at what your strengths are and be able to use those strengths to compensate for whatever that issue is in your learning. . . . So we're trying to use that kind of philosophy here to work with our special needs kids." —Principal

(CONTINUED)

TABLE B20 (CONTINUED)

Staff attitudes toward students at the six case study schools, 2006/07

Characteristic	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Have high expectations		"I think we all have high expectations for them. Just because they have disabilities, we don't [give] them any more. . . . We still hold them up to the same standard as everybody else." —Special education teacher	"And we hold the same rules for all kids. . . . No one is allowed to hurt other people . . . and it has been a very consistent message straight across the board." —Principal		"I expect them to behave. I expect them to be good kids. The teachers expect them. . . . Their actions indicate that they expect the same things from these children as they expect from their own. . . ." —Principal	". . . [The kids] know where the line is drawn with the teachers. [The middle school math teacher] is the toughest teacher, but the kids also respect her the most. . . . They know they love the class; they love the math because she keeps them working." —Assistant principal
Nurturing toward students	"I think a lot of it is the teachers. . . . You make them feel safe. You give them routines, your expectations. I think that in and of itself makes them feel safe. You're strict but yet nurturing." —General education teacher	"I see teachers as being really invested with the students. . . . There is a lot of nurturing going on. Many of our students are very needy and really are seeking out attention and love and guidance up and beyond just the academic piece. And I think our teachers really try to provide that." —Special education administrator	"[Flexible support] gives kids [the chance] to see that all the adults in this building are helpers. . . . It gives them one on one with an adult and they get mentorship going there, which has been really beneficial for a lot of our kids who are really struggling with all kinds of issues." —Principal	". . . it's a very helping atmosphere. People feel like we can do anything. . . . Some of it comes from the principal who is very child-oriented." —Title I math teacher	". . . The teachers from what I've seen here will do the extra work to get the kid whatever services they need. I've seen that." —Special education teacher	"I think we work really hard to help them and to find out really what their learning style is and what we can do for them to help them understand themselves better, advocate for themselves and get the stuff they need." —General education teacher

— No quotations were relevant for this category.

Source: Authors' compilation based on interviews with school staff and administrators.

TABLE B21

School environment for students with disabilities at the six case study schools, 2006/07

Characteristic	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
School is a safe place	"The time that they're here is their safest and happiest time of the day." —General education teacher	"The kids feel this is their safer place . . . much more than for a lot of them home is. And this is where there is some continuity and consistency, and I think our teachers are really good at showing them that they're loved and cared for and respected." —Special education teacher	"And our doors are always open. They're always opened. . . . So, it's also safe." —General education teacher	—	"It's a great place to learn. It's very welcoming. They like to come to school. Breakfast is provided. If [there is] anything the students need—any help or anything—[it] is always provided for them. It's a very warm and welcoming environment. It's a nice place to come to school." —Special education teacher	—
Good relations between students with disabilities and general education students	—	"The kids get along well in the classrooms. In the integrated rooms, I don't think that the Gen Ed kids know who the special kids are or vice versa. I think it's just one family." —School administrator	—	"There are so many different ways that students are getting help that the ones that are getting help I don't think feel different or isolated. . . . The children don't feel stigmatized in any way leaving the room to go for reading help or math help. It's just like, yes, I'm going, you know. It's very comfortable, very warm." —General education teacher	"It's a good place to come to school. They're included. No one teases them. No one picks on them. They're not made to feel like 'Oh, you can't do this.' It's a very supportive environment for the students. Even the other students are very supportive and helpful, which is nice." —Special education teacher	"The kids seem happy. They treat each other nicely. There's varying needs of kids in classrooms, and kids are so accommodating to that . . . like other kids. Like they treat each other so nicely because they've been in school with say an autistic kid since kindergarten, and they all love him in 6th grade." —Special education teacher

(CONTINUED)

TABLE B21 (CONTINUED)

School environment for students with disabilities at the six case study schools, 2006/07

Characteristic	Cedar Elementary School, Urban Mass., 1–4	Redwood Elementary School, Urban NY, PreK–6	Maple Elementary School, Rural NY, K–4	Aspen Elementary School, Suburban Mass., K–4	Beech Elementary School, Urban NY, K–5	Willow School, Rural Mass., K–8
Positive perceptions of student support	"They say: 'She's lucky; she gets to go see [the math lead teacher]. . . . She's a fun lady.' . . . It's not seen as, 'Little Johnny is really terrible at math. He has to go out and have these lessons.' [Instead, they think:] 'It's cool, they have their own special group.' And I think it's always been presented that way to kids." —Special education teacher	"I take the two groups where my kids fall in their reading, [and] anybody else who falls in that area as well. . . . I think that's really important so that the kids aren't teased for having that extra teacher in there. . . . They seem to think that my office is some special place." —Special education teacher	—	—	—	"The kids feel comfortable in this school; they feel comfortable with these teachers. And I think there is a lot of flexibility with these teachers. You don't have to call or make an appointment to see them. They want to help." —Assistant principal

— No quotations were relevant for this category.

Source: Authors' compilation based on interviews with school staff and administrators.

TABLE B22

Most commonly reported strongest math education practices for students with disabilities and other struggling learners at the six case study schools, 2006/07

Practice	Detailed areas
Staff collaboration, staff culture, and in-house professional development	**Common planning and regular meeting time** Increases communication Builds consistent instruction Promotes joint problem-solving Facilitates sharing of ideas and strategies Allows teachers to recognize their strengths and weaknesses **Coteaching in inclusion classrooms** Allows teacher learning from close collaborator Improves teacher lesson planning Promotes sharing and improving upon teaching strategies Allows teachers to gain greater mastery over fewer subjects **Collegial, supportive, and respectful staff culture** Builds trust Facilitates sharing of ideas and strategies Allows teachers to recognize their strengths and weaknesses Promotes initiative and risk-taking Supports dedication and hard work Accompanies positive staff relationships Accompanies high levels of teamwork Accompanies teacher job satisfaction Promotes shared ownership of all students **In-house expert math instruction support for teachers** Offers accessible and knowledgeable resource for teachers Offers regular in-house professional development through staff presentations and other meetings Provides nonevaluative coaching
Classroom math instruction	**High levels of individualized support for students** Through small class sizes Through small-group instruction **High quality teachers** **Use of peer teaching** **Strategies to increase math instruction time** By integrating math throughout the day By providing much practice in the mornings, through homework **Tailoring instruction to students' needs** By adjusting/supplementing curriculum **Full-time in-class support in inclusion classrooms** Provides support for students with disabilities in all subjects throughout the day Provides students with more one-on-one support Promotes more in-depth instruction for students Provides more stable environment for students when a teacher is absent Helps demonstrate that people have different strengths, can solve problems together

(CONTINUED)

TABLE B22 (CONTINUED)

Most commonly reported strongest math education practices for students with disabilities and other struggling learners at the six case study schools, 2006/07

Practice	Detailed areas
Multiple out-of-class math services and supports for students	**Availability of a wide range of additional math services** Through formal programs Through flexible support from willing teachers Through expert math leaders Through skilled special educators
Use of assessments	**Regular, ongoing assessment** **Use of assessments matched to state standards** **In-depth analysis and discussion among entire school staff of assessment results** **Use of assessment data to guide instruction**
Leadership	**Empowers teachers to take leadership in the classroom and beyond** **Encourages risk-taking** **Respects teachers' opinions** **Supports by providing professional development, resources, guidance, and encouragement**

Source: Authors' compilation based on interviews with school staff and administrators.

TABLE B23

Common challenges to math education for students with disabilities and other struggling learners at the six case study schools, 2006/07

Common challenge	Detailed areas
Insufficient staffing	**Classroom math instruction** Large class sizes **Out-of-class math support** Staffing reduced by district Hard to find trained support
Insufficient time for math instruction	**Classroom math instruction** Emphasis on reading over math Fast-paced calendar **Out-of-class math support** Difficult to find time Difficult to schedule
Teacher quality concerns	**Discomfort with weaker knowledge of math** Weaker teaching skills Need more professional development Resistance to more professional development Resistance to change in classroom practices
Insufficient teacher tools or supports	**Imperfect math curricula** Must be supplemented with other materials Not fully aligned with state standards Approach is difficult for students with disabilities and other struggling learners Insufficient practice and homework Lack of early intervention support Lack of early intervention tools Lack of math assessments for early grades and for measuring progress over the year Inconsistent leadership Shifting priorities, changing initiatives Not enough professional development available
Difficulties in communication and coordination among staff	**Scheduling difficulties** Coteaching pairing difficulties Teacher resistance to collaboration No common planning time
Difficult students to serve	**Classroom math instruction** Hard to meet every child's needs, even after creating smaller ability groups Hard to reach toughest kids, even after having tried everything Hard to get struggling learners to talk, present, participate, and not feel left out **Out-of-class math support** Difficult to maintain mandated pacing Difficult to support multiple grade levels simultaneously Students' needs change every year Some students need support but don't qualify for it **Student background conditions** Economically disadvantaged, with few opportunities for out-of-school learning High student mobility Many unmet basic needs Lack of parental involvement and support

Source: Authors' compilation based on interviews with staff and administrators.

APPENDIX C
STATE ASSESSMENT DATA FOR THE SIX CASE STUDY SCHOOLS

This section provides grade 4 state math assessment data for the six case study schools for three school years. These data were used as a secondary screening factor after schools were first identified for their practices through a nomination process (see appendix A). The assessment data are provided solely as background information on the schools. It would be invalid to infer from case study research that a school's practices have a causal relationship with a school's achievement results. Furthermore, there are many limitations to the data arising from the small numbers of students with disabilities and other factors (as described later in this appendix).

Use of assessment data in the screening process

In the screening process researchers reviewed each school's state assessment data using the datasets from the two companion reports in this series. These reports analyze achievement data for grade 4 students with disabilities on the state math assessments in Massachusetts and New York. To investigate how performance patterns vary by need level, schools were categorized by a need-to-resource-capacity (N/RC) index in New York and a need-level index based on student population characteristics in Massachusetts. Both reports found distinct differences in proficiency rates for students with disabilities by need level, with the lowest percentages of students with disabilities reaching proficiency at the highest need categories. Based on these results, the researchers compared the case study schools with averages for schools with the same need level rather than with the overall state average.

In the screening process researchers determined whether each school's results met or exceeded the average proficiency rate for students with disabilities for their similar-schools category for at least two of the three years examined. This criterion allowed for fluctuations in results because the schools had not only small numbers of students with disabilities but also considerable variations in numbers from year to year.

Data limitations

Tables C1 through C6 present data on the number of students and the percentage scoring proficient for the schools, organized alphabetically by state. There are several data limitations that need to be considered when interpreting these achievement results.

Causal inferences cannot be made between achievement results and school practices. A case study methodology can say nothing about causal relationships between a school's practices and its achievement results. Thus, it would be inaccurate to conclude that schools with higher performance results have more effective practices than other schools. Differences in performance may be related to differences in need levels of student populations, resources, geographic locales, or other factors.

The data are cross-sectional. The performance information for the schools is based on cross-sectional data for the school years 2002/03 to 2005/06, so each year's data came from a new cohort of students. Thus, a change in performance from one year to the next does not mean that a group of students improved or worsened over that period. Rather, variation from year to year might be due to changes in the composition of students. This issue is particularly important to consider for the students with disabilities subgroup, because it includes a small population of students with a wide range of disabilities.

The schools' students with disabilities subgroups have small numbers of students. At the case-study schools the numbers of grade 4 students with disabilities ranged from 5 to 30. The small numbers in each school are a major limitation of the data. In addition, some schools experienced large fluctuations in the size of this subgroup during the four years (2002/03–2005/06). For example,

the number of grade 4 students with disabilities at Maple Elementary School almost tripled from 2003 to 2005. Changes in performance from year to year could vary because of changes in student numbers and differences in the types and severity of disabilities between student cohorts. So, caution should be used in interpreting performance trends at each school.

Cross-state comparisons should not be made. Massachusetts and New York have different assessments and frameworks and different overall performance trends during this period, so cross-state comparisons are unreliable. (See the companion reports for a comprehensive analysis of grade 4 students with disabilities math performance patterns in each state.)

New York's math assessment and the need-to-resource-capacity index

This section provides background information on the state math assessment and the need-to-resource-capacity (N/RC) index. It also provides performance data for the New York State case study schools.

New York State Testing Program. The New York State Testing Program (NYSTP) has administered the grade 4 math test since 1997. Students take the test in three timed sessions. But testing accommodations, such as additional time, are available to students with disabilities based on specifications in their Individualized Education Program. Students with severe disabilities take the New York State Alternate Assessment. The NYSTP reports students' results using four performance levels. Reaching proficiency is defined as scoring at level 3 (meets standards) or 4 (meets standards with distinction).

Need-to-resource-capacity (N/RC) index. The need-to-resource-capacity index was developed by the New York State Education Department (NYSED) to categorize school districts. The index has three components: a district's level of need (defined by the percentage of students eligible for free or reduced-price lunch), its level of resources (defined by the combined wealth ratio), and to a lesser extent, a district's locale.[7] The index was created as a result of statistical research showing student performance is negatively related to a district's level of need and positively related to its level of resources (New York State Education Department 2005b).

There are seven need-to-resource-capacity categories. Each case study school was assigned the need-to-resource-capacity of its district:[8]

- Beech Elementary School N/RC 1: high need-to-resource-capacity, New York City.
- Maple Elementary School N/RC 5: average need-to-resource-capacity.
- Redwood Elementary School N/RC 2: high need-to-resource-capacity, four large city districts (Buffalo, Rochester, Syracuse, and Yonkers).

The companion New York data analysis report found that performance of students with disabilities varied by need-to-resource-capacity category, with the lowest percentage of students with disabilities reaching proficiency in high-need districts. For example, in 2005 there was a difference of more than 30 percentage points between the percentage reaching proficiency in N/RC 1 and N/RC 6 schools.

Performance data for the three New York case study schools. Tables C1 to C3 provide achievement data for the grade 4 NYSTP math assessment for 2002/03–2004/05.[9] Each table presents the data for the school and the average percentage of students with disabilities scoring proficient or above for schools in that need-to-resource-capacity category. For example, in 2004/05, 86 percent of students with disabilities at Maple Elementary School scored proficient compared with 65 percent of the students with disabilities in N/RC 5 schools across the state (see table C2).

TABLE C1
Grade 4 New York State Testing Program math performance for Beech Elementary School, 2002/03–2004/05

	Beech Elementary School		High index value (N/RC 1) New York City	
Year and student group	Number of students[a]	Percentage scoring proficient or above	Number of students	Percentage scoring proficient or above
2002/03				
General education students	240	76	67,520	73
Students with disabilities	30	34	8,913	37
2003/04				
General education students	190	75	67,754	73
Students with disabilities	15	40	8,068	37
2004/05				
General education students	190	82	64,058	83
Students with disabilities	20	50	8,878	49

a. The number of students has been rounded.

Source: Authors' analysis based on data from New York State Education Department (2005a) and Buckley et al. (2008), a companion report in this series.

TABLE C2
Grade 4 New York State Testing Program math performance for Maple Elementary School, 2002/03–2004/05

	Maple Elementary School		Average index value[a] (N/RC 5) New York	
Year and student group	Number of students[b]	Percentage scoring proficient or above	Number of students	Percentage scoring proficient or above
2002/03				
General education students	60	80	56,751	91
Students with disabilities	5	60	7,233	60
2003/04				
General education students	35	97	55,809	92
Students with disabilities	10	11	7,421	60
2004/05				
General education students	35	100	54,994	95
Students with disabilities	15	86	7,452	65

a. Districts with a need-to-resource-capacity index between the 20th and 70th percentiles.

b. The number of students has been rounded.

Source: Authors' analysis based on data from New York State Education Department (2005a) and Buckley et al. (2008), a companion report in this series.

Massachusetts' math assessment and school needs levels

This section provides information on the state math assessment and on the methods used to categorize schools by need levels. It also provides performance data for the Massachusetts case study school.

Massachusetts Comprehensive Assessment System. The Massachusetts performance data are from the Massachusetts Department of Education web site.[10] Since 1997 the state has been administering the Massachusetts Comprehensive Assessment System (MCAS) to grade 4 students. The math test is administered in May each year in two sessions, each

TABLE C3

Grade 4 New York State Testing Program Math Performance for Redwood Elementary School, 2002/03–2004/05

	Redwood Elementary School		High index value Large city districts[a] (N/RC 2) New York	
Year and student group	Number of students[b]	Percentage scoring proficient or above	Number of students	Percentage scoring proficient or above
2002/03				
General education students	110	77	7,351	68
Students with disabilities	30	55	1,596	43
2003/04				
General education students	100	89	6,900	70
Students with disabilities	20	57	1,603	45
2004/05				
General education students	100	91	6,635	79
Students with disabilities	20	44	1,512	51

a. Buffalo, Rochester, Syracuse, and Yonkers.

b. The number of students has been rounded.

Source: Authors' analysis based on data from New York State Education Department (2005a) and Buckley et al. (2008), a companion report in this series.

TABLE C4

Grade 4 Massachusetts Comprehensive Assessment System math performance for Aspen Elementary School, 2003/04–2005/06

	Aspen Elementary School		Medium need Massachusetts	
Year and student group	Number of students[a]	Percentage scoring proficient or above	Number of students	Percentage scoring proficient or above
2003/04				
General education students	60	71	18,800	50
Students with disabilities	20	41	3,780	17
2004/05				
General education students	80	44	18,674	48
Students with disabilities	20	27	3,868	14
2005/06				
General education students	65	33	18,452	47
Students with disabilities	15	23	4,272	18

a. The number of students has been rounded.

Source: Authors' analysis based on data from New York State Education Department (2005a) and Buckley et al. (2008), a companion report in this series.

designed to take 60 minutes (although all MCAS test administrations are untimed). The test consists of open response, short answer, and multiple choice questions. Testing accommodations are available to students with disabilities based on specifications in their Individualized Education Programs. If students with significant cognitive disabilities are unable to participate in the standard MCAS assessment even with accommodations, they take the MCAS Alternate Assessment (MCAS-Alt).

The Massachusetts Department of Education reports students' results on the standard MCAS assessment using four performance levels: advanced, proficient, needs improvement, and warning. Reaching proficiency is defined as scoring proficient or advanced.

Need-level categories. The case study schools were assigned need-level categories (low, medium, or high) as part of the data analysis for the companion Massachusetts report in this series.[11] The need level was established using a formula based on a school's student population: percentage of students with disabilities, students eligible for free or reduced-price lunch, and students with limited English proficiency. The companion Massachusetts report found that performance on the MCAS math test for grade 4 students with disabilities varied by need-level categories—proficiency rates were lowest among students with disabilities in high-need schools. In addition, the need level of a school had a stronger relation to the performance of students with disabilities than the locale of a school.

Performance data for Massachusetts case study schools. Tables C4 through C6 provide achievement data for the grade 4 MCAS math assessment for 2003/04–2005/06. Each table presents the data for the school and the average percentage scoring proficient for schools in that need level. For example, in 2005/06, 40 percent of students with disabilities scored proficient or above at Willow School compared with 17.5 percent of students with disabilities in medium-need schools across the state.

TABLE C5

Grade 4 Massachusetts Comprehensive Assessment System math performance for Cedar Elementary School 2003/04–2005/06

	Cedar Elementary School		High need Massachusetts	
Year and student group	Number of students[a]	Percentage scoring proficient or above	Number of students	Percentage scoring proficient or above
2003/04				
General education students	50	40	15,285	29
Students with disabilities	20	28	3443	9
2004/05				
General education students	60	51	14,792	26
Students with disabilities	30	17	3,636	7
2005/06				
General education students	60	56	14,118	28
Students with disabilities	10	8	3,652	8

a. The number of students has been rounded.

Source: Authors' analysis based on data from Massachusetts Department of Education (2008) and Ehrlich et al. (2008), a companion report in this series.

TABLE C6

Grade 4 Massachusetts Comprehensive Assessment System math performance for Willow School, 2003/04–2005/06

Year and student group	Willow School		Medium need Massachusetts	
	Number of students[a]	Percentage scoring proficient or above	Number of students	Percentage scoring proficient or above
2003/04				
General education students	30	67	18,800	50
Students with disabilities	20	14	3,780	17
2004/05				
General education students	30	58	18,674	48
Students with disabilities	15	28	3,868	14
2005/06				
General education students	35	56	18,452	47
Students with disabilities	10	40	4,272	18

a. The number of students has been rounded.

Source: Authors' analysis based on data from Massachusetts Department of Education (2008) and Ehrlich et al. (2008), a companion report in this series.

NOTES

The authors acknowledge the contributions of Katherine Culp Jane Donnelly, Teresa Duncan, Burt Granofsky, Denise Lamb, Michelle LaPointe, Allysen Palmer, and John Tapper. They also express their appreciation to the administrators and staff members at the six case study schools.

1. See www.ncee.org/acsd/index.jsp?setProtocol=true.

2. See http://www.tqnyc.com/NYC052376/resources_new.html.

3. See http://www.responsiveclassroom.org/.

4. Redwood also had a senior program administrator, who served as an unofficial assistant principal.

5. A separate special education classroom where students with disabilities receive their instruction. At Cedar Elementary School these students received all their instruction in this setting and were not integrated into general education classrooms.

6. For a student to qualify for special education summer school, teachers had to demonstrate that the student would suffer substantial regression without summer services. To do so, teachers assessed students before and after April vacation and measured how long it took them to return to their prevacation learning level.

7. The combined wealth ratio is derived from assessed property value and personal income, divided by the count of pupils and compared with a statewide average. See http://www.emsc.nysed.gov/repcrd2005/information/similar-schools/guide.shtml for more information.

8. Note that NYSED also categorizes schools into similar-schools groups. These were not used in the tables because the similar-schools data was not available for the students with disabilities subgroup.

9. Any inconsistencies between the data reported in the tables and those reported by the state are minor attributable mainly to missing data in the publicly available datasets. The 2006 results are excluded because they cannot be accurately compared with prior year results because of changes in state standards and testing dates.

10. Data were retrieved from Massachusetts Department of Education (various years).

11. The Massachusetts publicly available datasets do not have their own need-level variable. For the companion data analysis report researchers applied a needs-level formula developed by the New York City Department of Education as a way of grouping similar schools, known as the similar-schools achievement comparison.

REFERENCES

Access Center. (2005). *Strategies to improve access to the general education curriculum.* Washington, DC: American Institutes for Research. Retrieved from http://www.k8accesscenter.org/training_resources/teachingmatters.asp.

Access Center. (2008). *Teaching matters: the link between access to the general education curriculum and performance on state assessments*. Washington, DC: American Institutes for Research. Retrieved from http://www.k8accesscenter.org/training_resources/teachingmatters.asp.

Arnold, M. L., Gaddy, B. B., and Dean, C. B. (2004). *A look at the condition of rural education research: setting a direction for future research*. Aurora, CO: Mid-continent Research for Education and Learning.

Ashcraft, M., Krause, J., and Hopko, D. (2007). Is math anxiety a mathematical learning disability? In D. Berch and M. Mazzocco (Eds.), *Why is math so hard for some children?* (pp. 329–48). Baltimore, MD: Paul H. Brookes Publishing Co.

Ball, D. L. (2002). Knowing mathematics for teaching: relations between research and practice. *Mathematics and Education Reform Newsletter, 14*(3), 1–5.

Baker, S., Gersten, R., and Lee, D.-S. (2002). A Synthesis of Empirical Research on Teaching Mathematics to Low-Achieving Students. *Elementary School Journal, 103*(1), 51.

Ball, D. L., Hill, H. C., and Bass, H. (2005). Knowing mathematics for teaching: who knows mathematics well enough to teach third grade, and how can we decide? *American Educator, fall*(14–46).

Banilower, E. R., and Shimkus, E. S. (2004). *LSC professional development study: an analysis of data collected between 1997 and 2003.* Chapel Hill, NC: Horizon Research, Inc.

Barth, R. (1990). A personal vision of a good school. *Phi Delta Kappan*, *71*, 512–21.

Berends, M., Bodilly, S., and Kirby, S. N. (2002). Looking back over a decade of whole-school reform: the experience of new American schools. *Phi Delta Kappan*, *84*(2), 68–76.

Blackorby, J., Knokey, A. M., Wagner, M., Levine, P., Schiller, E., and Sumi, C. (2007). *What makes a difference? Influences on outcomes for students with disabilities* (Special Education Elementary Longitudinal Study, P10656). Washington, DC: Office of Special Education Programs, U.S. Department of Education. Retrieved February 1, 2007, from http://www.seels.net/designdocs/SEELS_W1W3_FINAL.pdf.

Borman, G. D., Hewes, G. M., Overman, L. T., and Brown, S. (2003). Comprehensive school reform and achievement: a meta-analysis. *Review of Educational Research*, *73*(2), 125.

Bouck, E. (2005). Service delivery and instructional programming in rural, suburban, and urban secondary special education: an exploratory study. *Rural Special Education Quarterly, 24*(4), 18–25.

Brigham, N., Morocco, C. C., Clay, K., and Zigmond, N. (2006). What makes a high school a good high school for students with disabilities. *Learning Disabilities Research and Practice, 21*(3), 184–90.

Brownell, M. T., Rosenberg, M. S., Sindelar, P. T., and Smith, D. D. (2004). Teacher education: toward a qualified teacher for every classroom. In A. M. Sorrell, H. J. Rieth, and P. T. Sindelar (Eds.), *Critical issues in special education: access, diversity, and accountability* (pp. 243–57). Boston, MA: Allyn and Bacon.

Bruner, D. Y., and Greenlee, B. J. (2000). Measures of work culture in high and low performance schools. *Research in the Schools, 7*(2), 71–6.

Buckley, K., Ehrlich, S., Midouhas, E., and Brodesky, A. (2008). *Performance patterns for students with disabilities in grade 4 mathematics education in New York State* (Issues and Answers Report, REL 2008–No. 050). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Northeast and Islands. Retrieved from http://ies.ed.gov/ncee/edlabs.

Butterworth, B., and Reigosa, V. (2007). Information processing deficits in dyscalculia. In D. Berch and M. Mazzocco (Eds.), *Why is math so hard for some children?* (pp. 65–82). Baltimore, MD: Paul H. Brookes Publishing Co.

Carpenter, R. (1985). Mathematics instruction in resource rooms: instruction time and teacher competence. *Learning Disability Quarterly, 8*(2), 95–100.

Cawley, J. (2002). Mathematics interventions and students with high incidence disabilities. *Remedial and Special Education, 23*(1), 2–6.

Cawley, J. F., and Miller, J. H. (1989). Cross-sectional comparisons of the mathematical performance of children with learning disabilities: are we on the right track toward comprehensive programming? *Journal of Learning Disabilities, 22*(4, April), 250–54, 259.

Clarke, D. (1997). The changing role of the mathematics teacher. *Journal for Research in Mathematics Education, 28*, 278–308.

Consortium on Inclusive Schooling Practices. (1996). *A framework for evaluating state and local policies for inclusion* (issue brief). Pittsburgh, PA: Consortium on Inclusive Schooling Practices.

Cotton, K. (2003). *Principals and student achievement.* Alexandria, VA: Association for Supervision and Curriculum Development.

Council for Exceptional Children. (2007). *Current practice alerts*. Retrieved February 1, 2007, from http://www.teachingld.org/ld_resources/alerts/default.htm.

D'Agostino, J. V., Borman, G. D., Hedges, L. V., and Wong, K. K. (1998). Longitudinal achievement and chapter 1 coordination in high poverty schools: a multi-level analysis of the prospects data. *Journal of Education for Students Placed at Risk, 3*(4).

Darling-Hammond, L. (2000). Teacher quality and student achievement: a review of state policy evidence. *Education Policy Analysis Archives*, *8*(1, January).

Darling-Hammond, L. (2001). *The right to learn: a blueprint for creating schools that work.* San Francisco, CA: Jossey-Bass.

Deno, S. L. (1985). Curriculum-based measurement: the emerging alternative. *Exceptional Children, 52,* 219–32.

Deno, S. L. (2003). Developments in curriculum-based measurement. *Journal of Special Education, 37,* 184–92.

Desimone, L. (2000). *Making comprehensive school reform work*. New York: ERIC Clearinghouse on Urban Education.

Driscoll, M. (1986). *Stories of excellence: ten case studies from a study of exemplary math programs.* Reston, VA: The National Council of Teachers of Mathematics.

Dufour, R., DuFour, R., Eaker, R., and Karhanek, G. (2004). *Whatever it takes.* Bloomington, IN: Solution Tree.

Dufour-Janvier, B., Bednarz, N., and Belanger, M. (1987). Pedagogical considerations concerning the problem of representation. In C. Janvier (Ed.) *Problems of Representation in the Teaching and Learning of Mathematics.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Education Development Center, Inc. (2002) *Impact Mathematics.* New York: Glencoe McGraw-Hill.

English, L., and Halford, G. (1995). *Mathematics education: models and processes*. Mahwah, NJ: Lawrence Erlbaum Associates.

Ehrlich, S., Buckley, K., Midouhas, E., and Brodesky, A. (2008). *Performance patterns for students with disabilities in grade 4 mathematics education in Massachusetts* (Issues and Answers Report, REL 2008–No. 051). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Northeast and Islands. Retrieved from http://ies.ed.gov/ncee/edlabs.

Espin, C., Shin, J., and Busch, T. (2000). *Current Practice Alerts* 3(spring). Retrieved September 25, 2006, from http://www.teachingld.org/pdf/Alert3.pdf.

Everyday Learning Corporation. (2001). *Everyday Mathematics.* Chicago, IL: Everyday Learning Corporation.

Fairman, J. C. (2003). School size choices: comparing small and large school strengths. *Maine Policy Review, 12*(3), 76–86. Retrieved September 25, 2006, from http://denali.asap.um.maine.edu/mcs/?q=node/1306.

Ferrini-Mundy, J., and Johnson, L. (1996). Highlights and implications. In J. Ferrini-Mundy, and T. Shram (Eds.), *Journal for Research in Mathematics in Education. Monograph. Vol. 8. The Recognizing and Recording Reform in Mathematics Education Project: Insights, Issues, and Implications.* Reston, VA: National Council of Teachers of Mathematics.

Fisher, D., and Frey, N. (2003). *Inclusive urban schools.* Baltimore, MD: Paul H. Brookes Publishing Co.

Fleischner, J. (1993). What is special about urban special education? *Teacher Education and Special Education, 16*(1), iv–v.

Friend, M., and Cook, L. (1998). *Interactions: collaboration skills for school professionals.* White Plains, NY: Longman.

Fuchs, L. S., and Fuchs, D. (1993). Formative evaluation of academic progress: how much growth can we expect? *School Psychology Review*, *22*(1), 27.

Fuchs, L. S., and Fuchs, D. (2002a). *What is scientifically-based research on progress monitoring?* (technical report). Nashville, TN: Vanderbilt University.

Fuchs, L. S., and Fuchs, D. (2002b). Mathematical problem-solving profiles of students with mathematics disabilities with and without co-morbid reading disabilities. *Journal of Learning Disabilities, 35*(6), 564–74.

Fuchs, L. S., and Fuchs, D. (2003). Enhancing the mathematical problem-solving of students with mathematics disabilities. In H. L. Swanson, K. R. Harris, and S. Graham (Eds.), *Handbook of learning disabilities,* (pp. 306–22). New York: Guilford.

Fuchs, L. S., and Fuchs, D. (2006). Intro to RtI: what, why, and how valid is it? *Reading Research Quarterly, 41*(1), 93–9.

Fuchs, L. S., and Fuchs, D. (2007). Mathematical problem solving: Instructional intervention. In D. B. Berch and M. M. M. Mazzocco (Eds.), *Why is math so hard for some children? The nature and origins of mathematical learning difficulties and disabilities.* Baltimore, MD: Paul H. Brookes Publishing Co.

Fuchs, L. S., Fuchs, D., and Karns, K. (2001). Enhancing kindergartener's mathematical development: effects of peer-assisted learning strategies. *Elementary School Journal*, *101*(5), 495–510.

Fuchs, D., Fuchs, L., Mathes, P. H., and Simmons, D. C. (1997). Peer-assisted strategies: making classrooms more responsive to diversity. *American Educational Research Journal*, *34(1*), 174–206.

Garet, M. S., Porter, A. C., Desimone, L., Birmean, B. F., and Yoon, K. S. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal, 38*(4), 915–45.

Gaudet, R. (1998). *A study of performance on the first year of the MCAS test.* Hadley, MA: University of Massachusetts Donahue Institute. Retrieved April 2007, from http://www.edbenchmarks.org/schoolimprovement/mcas1998.htm.

Goertz, M. E., Floden, R. E., and O'Day, J. (1995). *Studies of education reform: Systemic reform. Vol. 1: Findings and Conclusions.* Rutgers, NJ: Consortium for Policy Research in Education.

Greenwood, C. R., Maheady, L., and Delquadri, J. C. (2002). Class-wide peer tutoring. In G. Stoner, M. R. Shinn, and H. Walker (Eds.), *Interventions for Achievement and Behavior Problems* (pp. 611–49). Washington, DC: National Association of School Psychologists.

Griffin, S. (2007). Early intervention for children at risk of developing mathematical learning difficulties. In D. B. Berch and M. M. Mazzocco (Eds.), *Why is math so hard for some children? The nature and origins of*

mathematical learning difficulties and disabilities (pp. 373–96). Baltimore, MD: Paul H. Brookes Publishing Co.

Gutierrez, P. S. (2002). In search of bedrock: organizing for success with diverse needs children in the classroom. *Journal of Latinos in Education, 1*(1), 49–64.

Hallinger, P., and Heck, R. H. (1996a). The principal's role in school effectiveness: an assessment of methodological progress, 1980–1995. In K. Leithwood, J. Chapman, D. Corson, P. Hallinger, and A. Hart (Eds.), *International handbook of educational leadership and administration* (pp. 723–83). The Netherlands: Kluwer Academic Publishers.

Hallinger, P., and Heck, R. H. (1996b). Reassessing the principal's role in school effectiveness: a review of empirical research, 1980–1995. *Educational Administration Quarterly, 32*(1), 5–44.

Hallinger, P., and Heck, R. H. (1998). Exploring the principal's contribution to school effectiveness: 1980–1995. *School effectiveness and school improvement, 9*(2), 157–91.

Harrison, M., and Harrison, B. (1986). Developing numeration concepts and skills. *Arithmetic Teacher, 3,(6),* 1–21.

Hasselbring, T., Goin, L., and Bradsford, J. (1987). Effective mathematics instruction: developing automaticity. *Teaching Exceptional Children, 19*(3), 30–3.

Haynes, M. C., and Jenkins, J. R. (1986). Reading instruction in special education resource rooms. *American Educational Research Journal, 23*(2), 61–190.

Hawkins, V. J. (2007). Narrowing Gaps for Special-Needs Students. *Educational Leadership, 64*(5), 61–3.

Hecht, H., Vagi, K., and Torgesen, J. (2007). Fraction skills and proportional reasoning. In D. Berch and M. Mazzocco (Eds.), *Why is Math So Hard for Some Children?* (pp. 121–32). Baltimore, MD: Paul H. Brookes Publishing Co.

Horton, S. V., Lovitt, T. C., and Bergerud, D. (1990). The effectiveness of graphic organizers for three classifications of secondary students in content area classes. *Journal of Learning Disabilities, 23*(1), 12–22, 29.

Howley, C. B., Strange, M., and Bickel, R. (2000). *Research about school size and school performance in impoverished communities.* Charleston, WV: ERIC Clearinghouse on Rural Education and Small Schools. Retrieved September 25, 2006, from http://www.ericdigests.org/2001-3/size.htm.

Hunt, P., Soto, G., Maier, J., and Doerling, K. (2003). Collaborative teaming to support students at risk and students with severe disabilities in general education classrooms. *Exceptional Children, 69*(3), 315–32.

Individuals with Disabilities Act, Pub. L. No. 108-446, 108 (2004). Retrieved from http://idea.ed.gov/.

Jitendra, A. (2002). Teaching students math problem-solving through graphic representations. *Teaching Exceptional Children, 34*(4), 34–8.

Jordan, N. C., Kaplan, D., Nabors Olah, L., and Locuniak, M. N. (2006). Number sense growth in kindergarten: a longitudinal investigation of children at risk for mathematics difficulties. *Child Development, 77,* 153–75.

Karge, B. D., McClure, M., and Patton, P. L. (1995). The success of collaboration resource programs for students with disabilities in grades 6 through 8. *Remedial and Special Education (RASE), 16*(2), 79–89.

Langer, G., Colton, A., and Goff, L. (2003). *Collaborative analysis of student work.* Alexandria, VA: Association for Supervision and Curriculum Development.

LaPointe, M. A., and Stullich, S. (2004). *Implementation and impact of the comprehensive school reform program.* U.S. Department of Education, Office of the Under Secretary, Policy and Program Studies Service. Washington, DC: Government Printing Office.

Lappan, G., Fey, J., Fitzgerald, W., Friel, S., and Phillips, D. (2006). *Connected Mathematics.* Boston, MA: Pearson Prentice Hall.

Lawton, M. (1999). Co-Teaching: are two heads better than one in an inclusion classroom? *Harvard Education Letter.* Retrieved August 21, 2007, from http://www.edletter.org/past/issues/1999-ma/coteaching.shtml.

Leithwood, K., Seashore Louis, K., Anderson, S., and Wahlstrom, K. (2004). *Executive summary: how leadership influences student learning: Learning from Leadership Project*. New York: The Wallace Foundation.

Linn, R. L., Baker, E. L., and Betebenner, D. W. (2002). Accountability systems: implications of requirements of the No Child Left Behind Act of 2001. *Educational Researcher, 31*(6), 3–16.

Little, J. (1982). Norms of collegiality and experimentation: workplace conditions of school success. *American Educational Research Journal*, *19*(3), 325–40.

Little, J., Gearhart, M., Curry, M., and Kafka, J. (2003). Looking at student work for teacher learning, teacher community, and school reform. *Phi Delta Kappan, 85*(3), 185–92.

Lott, J. (2003). The time has come for pre-K–5 mathematics specialists. *National Council of Teachers of Mathematics*. Retrieved September 25, 2006, from http://www.nctm.org/about/content.aspx?id=956.

Maccini, P., and Gagnon, J. C. (2000). Best practices for teaching mathematics to secondary students with special needs: implications from teacher perceptions and a review of the literature. *Focus on Exceptional Children*, *32*(5), 1–22.

Maccini, P., and Gagnon, J. C. (2002). Perceptions and application of NCTM standards by special and general education teachers. *Exceptional Children*, *68*(3), 325–44.

Maccini, P., and Gagnon, J. (2005). Math graphic organizers for students with disabilities. Retrieved August 22, 2007, from http://www.k8accesscenter.org/training_resources/documents/MathGraphicOrg.pdf.

Malmgren, K., McLaughlin, M., and Nolet, V. (2006). Examining school-level factors affecting performance of students with disabilities on statewide assessments. *Urban Perspectives, 1*(2*).*

Maryland State Department of Education. (2001). *Keys to math success: a report from the Maryland mathematics commission.* Baltimore, MD: Maryland State Department of Education.

Marzano, R. (2003). *What works in schools: translating research into action.* Alexandria, VA: Association for Supervision and Curriculum Development.

Marzano, R. J., Waters, T., and McNulty, B. A. (2005). *School leadership that works: from research to results.* Alexandria, VA: Association for Supervision and Curriculum Development.

Massachusetts Department of Education. Various years. *Massachusetts Comprehensive Assessment System Results.* Retrieved September 25, 2006, from http://www.doe.mass.edu/mcas/results.html.

Massachusetts Department of Education. (2005). *2004 Statewide accountability and AYP summary charts for schools and districts.* Retrieved September 12, 2005, from http://www.doe.mass.edu/sda/ayp/cycleIII/default.html.

Massachusetts Department of Education. (2006a). *State 2006 AYP report*. Retrieved February 23, 2007, from http://profiles.doe.mass.edu/ayp2006/school.aspx?orgcode=00000000.

Massachusetts Department of Education. (2006b). *Students with disabilities annual report: 2005–2006*. Retrieved February 23, 2007, from http://www.doe.mass.edu/sped/2006/annual.doc.

Massachusetts Department of Education. (2008). Profiles information. Retrieved May 28, 2008, from http://profiles.doe.mass.edu/help/?section=data.

Mathematical Sciences Education Board. (1989). *Everybody counts: a report to the nation on the future of mathematics education.* Washington, DC: National Academy Press.

Mazzocco, M. M. M. (2007). Defining and differentiating mathematical learning disabilities and difficulties. In D. Berch and M. Mazzocco (Eds.), *Why is Math So Hard for Some Children?* (pp. 29–47). Baltimore, MD: Paul H. Brookes Publishing Co.

McLaughlin, M. J., Embler, S., Hernandez, G., and Caron, E. (2005). No Child Left Behind and students with disabilities in rural and small schools. *Rural Special Education Quarterly, 24*(1), 32–9.

McLeskey, J., Tyler, N. C., and Flippin, S. S. (2004). The supply and demand of special education teachers: a review of research regarding the chronic shortage of special education teachers. *The Journal of Special Education, 38*(1), 5–21.

Mercer, C., and Mercer, A. (1998). *Teaching students with learning problems*. Englewood Cliffs, NJ: Prentice-Hall.

Meyers, J., Gelzheiser, L., Yelich, G., and Gallagher, M. (1990). Classroom, remedial, and resource teachers' views of pullout programs. *The Elementary School Journal*, *90*(5), 532–45.

Mid-continent Research for Education and Learning. (2005). *McREL insights—schools that "beat the odds."* Aurora, CO: Mid-continent Research for Education and Learning.

Miller, S., Butler, F., and Lee, K. (1998). Validated practices for teaching mathematics to students with learning disabilities: a review of the literature. *Focus on Exceptional Children, 31*(1).

Miller, S. P., and Mercer, C. D. (1993). Using data to learn about concrete-semiconcrete-abstract instruction for students with math disabilities. *Learning Disabilities Research and Practice*, *8*(2), 89–96.

Milloy, M., Winans, D., Jehlen, A., Loschert, K., and O'Neil, J. (2003, May). Cover Story: No Child Left Behind? *NEA Today* (May). Retrieved October 20, 2006, from http://www.nea.org/neatoday/0305/cover.html.

Mitchem, K., Kossar, K., and Ludlow, B. (2006). Finite resources, increasing demands: rural children left behind? Educators speak out on issues facing rural special education. *Rural Special Education Quarterly, 25*(3), 13–23.

Montague, M. (1997). Cognitive strategy instruction in mathematics for students with learning disabilities. *Journal of Learning Disabilities, 30*(2), 164–78.

Morroco, C., Aguilar, C. M., and Brigham, N. (2006) *Visionary middle schools: signature practices and the power of local invention*. New York: Teachers College Press.

Muncy, D., and McQuillan, P. (1996). *Reform and resistance in schools and classrooms: an ethnographic view of the coalition of essential schools.* New Haven, CT: Yale University Press.

Murawski, W. W., and Swanson, H. L. (2001). A meta-analysis of co-teaching research: Where are the data? *Remedial and Special Education (RASE), 22*(5), 258–67.

Nagle, K. M., Hernandez, G., Embler, S., McLaughlin, M. J., and Doh, F. (2006). Characteristics of Effective Rural Elementary Schools for Students with Disabilities. *Rural Special Education Quarterly, 25*(3), 3–12.

National Commission on Teaching and America's Future. (1996). *What matters most: teaching for America's future.* New York: National Commission on Teaching and America's Future.

National Council of Supervisors of Mathematics. (2007, September). *Improving student achievement by leading sustained professional learning for mathematics content and pedagogical knowledge development.* Retrieved November 4, 2007, from http://ncsmonline.org/NCSMPublications/position.html.

National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: The National Council of Teachers of Mathematics.

National Research Council. (1989). *Everybody counts: a report to the nation on the future of mathematics education*. Washington, DC: National Academy Press.

New York City Department of Education. (2007). *Similar school achievement comparison reports.* Department of Assessment and Accountability. Retrieved October 1, 2006, from http://schools.nyc.gov/daa/ARCHV_reports/default.asp#RR

New York State Education Department, Office of Higher Education. (2002). *NCLB NYS Field Memo #01-2002:*

Which teachers are highly qualified? Retrieved November 4, 2007, from http://www.highered.nysed.gov/nclb01-c.html.

New York State Education Department. (2005a). *New York State school report card for school year 2004–2005.* Retrieved September 25, 2006, from http://www.emsc.nysed.gov/repcrd2005/.

New York State Education Department. (2005b). *What is a similar school?* Retrieved September 25, 2006, from http://www.emsc.nysed.gov/repcrd2005/information/similar-schools/guide.shtml.

New York State Education Department. (2006). *New York, The State of Learning: Statewide Profile of the Educational System*. Retrieved February 1, 2007, from http://www.emsc.nysed.gov/irts/655report/2006/volume1.pdf.

New York State Education Department. (2007). *Annual performance report for 2005–2006.* Albany, NY: Office of Vocational and Educational Services for Individuals with Disabilities. Retrieved December 20, 2007, from http://www.vesid.nysed.gov/specialed/spp/apr2007/contents.htm.

Newmann, F. M., and Wehlage, G. G. (1995). *Successful school restructuring: a report to the public and educators by the Center on Organization and Restructuring of Schools*. Madison, WI: University of Wisconsin—Madison.

Northeast Foundation for Children. (n.d.). *Responsive classroom.* Retrieved June 10, 2007, from http://www.responsiveclassroom.org/pdf_files/rc_fact_sheet.pdf.

Office of Special Education Programs. (2005). *Twenty-fifth annual report to Congress on the implementation of IDEA*. Retrieved September 25, 2006, from http://www.ed.gov/about/reports/annual/osep/2003/execsumm.html.

Reeves, C. (2003) *Implementing the No Child Left Behind Act: implications for rural schools and districts.* Oak Brook, IL: North Central Regional Educational Laboratory. Retrieved September 25, 2007, from http://www.ncrel.org/policy/pubs/html/implicate/index.html.

Reys, B., and Fennell, F. (2003). Who should lead mathematics instruction at the elementary school level? A case for mathematics specialists. *Teaching Children Mathematics, 9*(5, January), 277–82.

Rimm-Kaufman, S. E. (2006). *Social and academic learning study on the contribution of the responsive classroom approach*. Turners Falls, MA: NE Foundation for Children.

Rosenholtz, S. J. (1989). *Teachers' workplace: the social organization of schools*. White Plains, NY: Longman, Inc.

Ross, S. Troutman, A., Horgan, D., Maxwell, S., Laitinen, R., and Lowther, D. (1997). The success of schools in implementing eight restructuring designs: a synthesis of first year evaluation outcomes. *School effectiveness and school improvement 8*(1), 95–124.

Rude, H. A., and Brewer, R. D. (2003). Assessment of professional development systems: Improving special education services. *Rural Special Education Quarterly, 22*(4), 20–8.

Rueda, R., and Garcia, E. (1997). Do portfolios make a difference? The influence of type of data on making instructional decisions. *Learning Disabilities: Research and Practice*, *12*(2), 114–22.

Salisbury, C., and McGregor, G. (2002). The administrative climate and context of inclusive elementary schools. *Exceptional Children, 68*(2), 259–74.

Schaffner, C. B., and Buswell, B. E. (1996). Ten critical elements for creating inclusive and effective school communities. In S. Stainback and W. Stainback (Eds.), *Inclusion: A Guide for Educators*, (pp. 49–66). London: Paul H. Brookes Publishing Co.

Scott Foresman. (2005) *Scott Foresman-Addison Wesley Mathematics*. Glenview, IL: Scott Foresman.

Sebring, P. B., and Bryk, A. S. (2000). School leadership and the bottom line in Chicago. *Phi Delta Kappan, 81*(6), 440–43.

Shannon, G. S., and Bylsma, P. (2007). *The nine characteristics of high-performing schools: a research-based resource for schools and districts to assist with improving student learning*). Olympia, WA: Office of Superintendent of Public Instruction.

Smith, L., Ross, S., McNelis, M., Squires, M., Wasson, R., Maxwell, S., et al. (1998). The Memphis restructuring initiative: analyses of activities and outcomes that impact implementation success. *Education and urban society, 30*(3), 296–325.

Snell, M. E., and Janney, R. (2000). *Teachers' guides to inclusive practices: collaborative teaming.* Baltimore, MD: Paul H. Brookes Publishing Co.

Stainbeck, W., and Stainbeck, S. (Eds). (1990). *Support networks for inclusive schooling: Interdependent integrated education*. Baltimore, MD: Paul H. Brookes Publishing Co.

Strangman, N., Hitchcock, C., Hall, T., Meo, G., and Coyne, P. (2006). *Response-to-instruction and universal design for learning: how might they intersect in the general education classroom?* Retrieved August 22, 2007, from http://www.ldonline.org/article/13002.

Stringfield, S., and Datnow, A. (Eds.). (1998). *Education and urban society, 30*(3).

Stringfield, S., Milsap, M. A., Yoder, N., Brigham, N., Nesselrodt, P., Schaffer, E., et al. (1997). *Urban and suburban/rural special strategies for educating disadvantaged children* (Final report). Washington, DC: U.S. Department of Education, Planning and Evaluation Service.

Suarez, T. M., Torlone, D. J., McGrath, S. T., and Clark, D. L. (1991, September). Enhancing effective instructional time: a review of research. *Policy Brief (1)*2, Chapel Hill, NC: North Carolina Educational Policy Research Center. (ERIC ED 373 409)

Suydam, M. N., and Higgins, J. L. (1977). *Activity-based learning in elementary school mathematics: recommendations from research*. Columbus, OH: ERIC Center for Science, Mathematics, and Environmental Education.

Swanson, H. L. (1999). Instructional components that predict treatment outcomes for students with learning disabilities: support for a combined strategy and direct instruction model. *Learning Disabilities and Research*, *14*, 129–40.

TERC. (1998). *Investigations in Number, Data, and Space.* Menlo Park, CA: Dale Seymour Publications.

Thurlow, M., Moen, R., and Wiley, H. (2005). *Performance reports: 2002-2003; State assessment data.* National Center on Educational Outcomes. Retrieved September 12, 2005, from http://education.umn.edu/NCEO/OnlinePubs/.

Tushnet, N., Flaherty, J., and Smith, A. (2004). *Longitudinal assessment of comprehensive school reform program implementation and outcomes—first-year report.* U.S. Department of Education, Office of the Under Secretary, Policy and Program Studies Service. Washington, DC: Government Printing Office.

Tyler, N. C., Cantou-Clarke, C. D., Easterling, J., and Klepper, T. (2003). Recruitment and retention and special education teacher preparation in rural areas: diversity, federal funding, and technical assistance considerations. *Rural Special Education Quarterly, 22*(3), 3–12.

University of Massachusetts Donahue Institute Research and Evaluation Group. (2004). *A study of MCAS achievement and promising practices in urban special education.* Retrieved December 15, 2006, from http://www.donahue.umassp.edu/docs/?item_id=12699.

University of Massachusetts, Donahue Institute, Research and Evaluation Group. (2007). *Gaining traction: urban educators' perspectives on the critical factors influencing student achievement in high and low performing urban public schools.* Retrieved August 22, 2007, from http://www.donahue.umassp.edu/docs/gain-trac-report.

U.S. Department of Education. (2001). *23rd annual report to Congress on the implementation of IDEA.* Washington, DC: U.S. Department of Education.

U.S. Department of Education. (2004a). *Implementation and Early Outcomes of the Comprehensive School Reform Demonstration (CSRD) Program*. Washington, DC: Office of the Under Secretary.

U.S. Department of Education. (2004b). *Implementation and Early Outcomes of the Comprehensive School Reform Demonstration (CSRD) Program. Doc # 2004-15.* Retrieved January 22, 2007, from http://eric.ed.gov/ERICWebPortal/contentdelivery/servlet/ERICServlet?accno=ED483148.

U.S. Department of Education, National Center for Education Statistics. (1999). *Teacher quality: a report on the preparation and qualifications of public school teachers.* Washington, DC: U.S. Department of Education.

U.S. Department of Education, National Center for Education Statistics. (2006). *NAEP Questions.* Retrieved April 12, 2007, from http://nces.ed.gov/nationsreportcard/itmrls/.

U.S. Department of Education, National Center for Education Statistics. (2007). *The condition of education 2007* (NCES 2007-064). Washington, DC: Government Printing Office.

U.S. Department of Education, Policy and Program Studies Service. (1997). *Special strategies study: final report.* Washington, DC: U.S. Department of Education.

Voltz, D. L. (2000). Challenges and choices in urban teaching: the perspectives of general and special educators. *Multiple Voices for Ethnically Diverse Exceptional Learners, 4*(1), 41–53.

Voltz, D. L., and Fore, C. (2006). Urban special education in the context of standards-based reform. *Remedial and Special Education, 27*(6), 329–36.

Waters, J. T., and Marzano, R. J. (2006). School district leadership that works: the effect of superintendent leadership on student achievement (a working paper). Denver, CO: Mid-continent Research for Education and Learning.

West Regional Equity Network. (2007). Glossary of terms. Retrieved February 1, 2007, from http://www.ed.arizona.edu/wren/glossary.html

Williams, D. T. (2003). *Closing the achievement gap: rural schools.* CSR Connection. Retrieved from http://www.goodschools.gwu.edu/pubs/annual/csrconsp03.pdf.

Williams, J. M., Martin, S. M., and Hess, R. K. (2002). Personnel preparation and service delivery issues in rural areas: the state of the art. *Rural Special Education Quarterly, 24*(1), 32–9.

Woodward, J., and Baxter, J. (1997). The effects of an innovative approach to mathematics on academically low achieving students in inclusive settings. *Exceptional Children*, *63*(3), 373–88.

Woodward, J., Baxter J., and Robinson R. (1999). Rules and reasons: decimal instructions for academically low achieving students. *Learning Disabilities Research and Practice*, *14*(1), 15–24.

Woodward, J., Monroe, K., and Baxter, J. (2001). Enhancing student achievement on performance assessments in mathematics. *Learning Disability Quarterly*, *24*(1), 33–46.

Woodward, J., and Montague, M. (2002). Meeting the challenge of mathematics reform for students with LD. *The Journal of Special Education, 36*, 89–101.

Working Forum on Inclusive Schools. (1994). *Creating schools for all our students: what 12 schools have to say.* Reston, VA: Council for Exceptional Children.

Xin, Y. P., and Jitendra, A. K. (1999). The effects of instruction in solving mathematical word problems for students with learning problems: a meta-analysis. *Journal of Special Education, 32*(4), 207.

Yin, R., and Kim, D. (2003). *Findings from the field-focused study of the CSRD program: final report.* U.S. Department of Education, Office of the Under Secretary, Policy and Program Studies Service. Washington, DC: Government Printing Office.

Yoon, K. S., Duncan, T. S., Lee, S. W.-Y., Scarloss, B., and Shapley, K. (2007). *Reviewing the evidence on how teacher professional development affects student achievement* (Issues and Answers Report, REL 2007-No. 033). Washington, DC: U.S. Department of Education, Institute of Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Southwest. Retrieved from http://ies.ed.gov/ncee/edlabs/projects/project.asp?id=70.

Zentall, S. (2007). Mathematics Performance of Students with ADHD: cognitive and behavioral contributors and interventions. In D. Berch and M. Mazzocco (Eds.), *Why is Math So Hard for Some Children?* (pp. 29–47). Baltimore, MD: Paul H. Brookes Publishing Co.