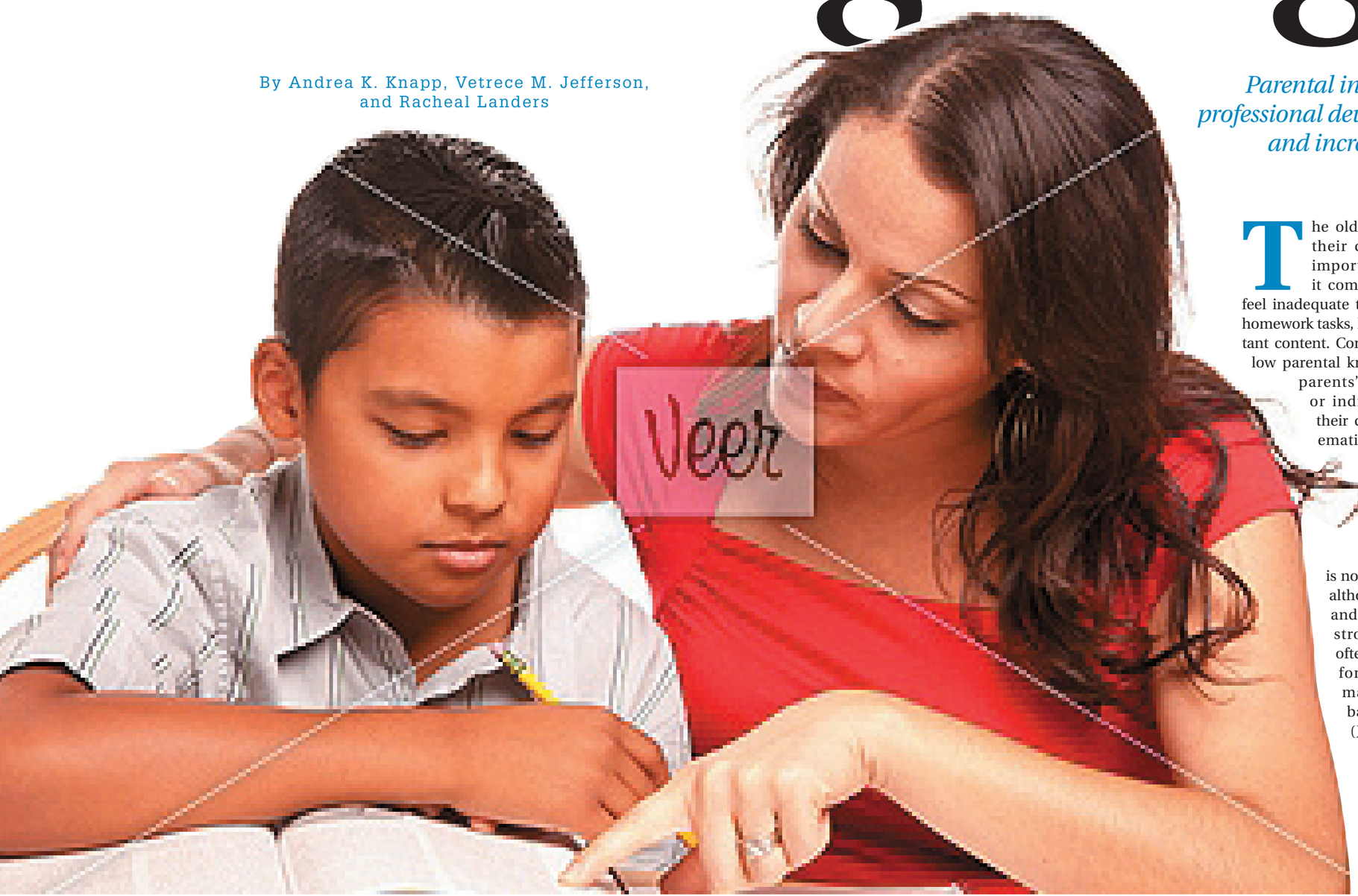
Learning Together

By Andrea K. Knapp, Vetrece M. Jefferson, and Racheal Landers



Parental involvement in a math program that includes professional development for teachers can improve relationships and increase student motivation and achievement.

The old adage goes, "Parents are their children's first and most important teachers." Yet when it comes to math, parents often feel inadequate to help their children with homework tasks, let alone teach them important content. Compounding the problem of low parental knowledge of mathematics, parents' *perceived* inadequacies or indifference toward helping their children understand mathematics can frustrate teachers. A breeding ground of misunderstanding between parents and teachers can develop when each holds expectations that the other party is not equipped to deliver. Thus, although parental involvement and student achievement are strongly linked, parents are often not tapped as resources for helping children learn mathematics in standards-based school environments (Jackson and Remillard 2005; Peressini 1998). In this article, we describe a program designed to enrich schools mathematically by involving parents.

Parental involvement and student achievement

Studies have shown that parental involvement in their children's education is strongly linked with students' academic outcomes (D'Agostino et al. 2000; Epstein 1994; Kellaghan et al. 1993).

> The evidence is consistent, positive, and convincing: Families have a major influence on their children's achievement. When schools, families, and community groups work together to support learning, children tend to do better in school, stay in school longer, and like school more. (Henderson and Mapp 2002, p. 7)

Low-income parents may be untapped resources for the mathematical achievement of their children. Henderson and her colleagues (2007) asserted that when districts are serious about closing the achievement gap, they must address the school culture gap that

TABLE 1

The local university's Office of Continuing Education hosted minicourse sessions, which convened two hours per week for eight weeks during a three-year period.

Math for Parents' Minicourse Curriculum

Eight-week minicourse title	NCTM Content Standard
Thinking about Numbers (offered two times)	Number and Operations
Thinking about Fractions, Decimals, and Percents (offered three times)	Number and Operations
Thinking in Patterns (offered once)	Algebra
Geometry for Parents (offered once)	Geometry and Measurement
Data for Parents (offered once)	Data Analysis and Probability

Note: The minicourse curriculum is available at http://mapps.math.arizona.edu/.

expects parents to remain relatively uninvolved in their children's mathematics learning.

The Math and Parent Partners (MAPPS) program (http://mapps.math.arizona.edu/) equips families to act as mathematical resources for their children and for schools. MAPPS curriculum was developed with National Science Foundation funding to engage the parents of students in K–grade 8 in exploring with peers the concepts and skills behind the mathematics that their children are learning in school. Currently, the MAPPS program serves sites in six states and the Virgin Islands. Members of one MAPPS site, located in the southeastern United States, and the focus of this article, worked toward improving the mathematical knowledge for teaching (Ball, Thames, and Phelps 2008) of parents and teachers alike in Title I schools within its district. All parents, teachers, paraprofessionals, and children from selected schools were invited to participate. The local university partnered with MAPPS and the school district to offer minicourses for parents and teachers while children participated in related mathematical activities and games. Minicourse sessions convened two hours per week for eight weeks. Spanning a three-year period, eight separate eight-week minicourses, centered on NCTM Content and Process Standards (2000), were offered (see **table 1**). The University's Office of Continuing Education hosted these minicourses, and instructors were graduate students in mathematics education who were also practicing teachers.

In all, 115 children, 59 parents, and 33 teachers, primarily from four Title I elementary schools, attended at least one minicourse on a regular basis. Nearly twice that many participants attended sporadically. Approximately 75 percent of attendees were single parents, and those who attended the minicourses did so with one to three children. Most of the parents had graduated from high school, had some technical training, and typically held low-income jobs. Approximately 40 percent of the attendees were Caucasian, 40 percent were African American, and 20 percent were Hispanic.

Activities for parents and teachers

MAPPS minicourses engage parents in doing mathematics using hands-on materials, working in small groups to solve problems, and presenting their solutions to the whole group as outlined by NCTM Process Standards (NCTM 2000). Both content knowledge and pedagogical content knowledge are intertwined with the instruction for parents (Ball, Thames, and Phelps 2008), with pedagogical considerations made relevant by minicourse instructors, depending on the grade levels of participating children. To illustrate the details of the MAPPS program, we first describe the content taught each week of an eight-week minicourse curriculum unit, Thinking about Fractions, Decimals, and Percents. Next, we discuss in depth the seventh week (a two-hour session) of this particular minicourse. We close by examining the impact of the program on parents, teachers, and children.

Instructors who taught Thinking about Fractions, Decimals, and Percents introduced fractions using tangram puzzles and the NCTM Learning Principle during the first week (Griffin 2007). The fraction concept was further developed in weeks 2–4, during which time participants learned about equivalence, common denominators, and varying fractional units. The NCTM Number and Operations, Problem Solving, and Communication Standards were addressed as well (see **table 2**). Sessions 5 and 6 shifted from fractions to decimal concepts that participants investigated through decimal strips

TABLE 2

The minicourses covered five NCTM Content and Process Standards and two Principles (NCTM 2000).

Content Taught during Mini-Course on Thinking about Fractions, Decimals, and Percents

Week 1	Introduction to fractions, decimals, and percents; NCTM Learning Principle
Week 2	Simplest form; common denominators; NCTM Problem Solving Standard
Week 3	Varying the unit; fractions as division; NCTM Number and Operations Standard
Week 4	Developing fraction concepts; reciprocals; NCTM Communication Standard
Week 5	Developing decimal concepts; NCTM Technology Principle
Week 6	Connecting fractions to decimals; NCTM Reasoning & Proof Standard
Week 7	Developing percentage concepts; NCTM Number and Operations Standard
Week 8	Connecting fractions, decimals, and percents; NCTM Connections Standard

Note: Each weekly session was two hours long.

Parents and teachers used Cuisennaire® rods to investigate fractions.

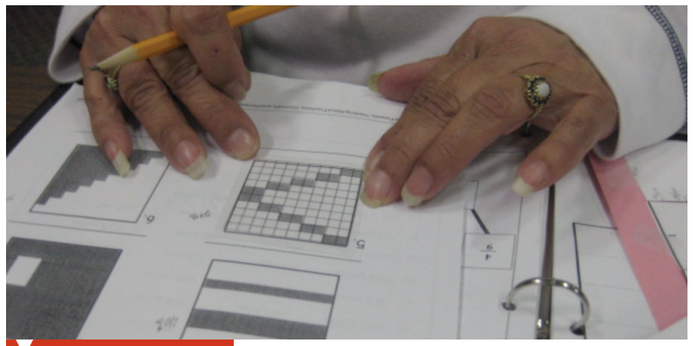
and base-ten blocks. Week 7 focused on teaching percentages with grids and colored tiles. Finally, during week 8, parents and teachers made percentage strips that they then compared to the fraction and decimal strips made during previous sessions. This comparison allowed for a contextual discussion of the Connections Standard.

A sample two-hour session: Week 7

To further exemplify the particulars of an individual session of a MAPPS minicourse, we describe the events of week 7 from the Thinking about Fractions, Decimals, and Percents minicourse. The session began at 5:30 p.m. in a large auditorium, with parents, teachers, and children grade 4 and older reviewing MAPPS homework from the week before and sharing websites they had investigated. At 6:00, the instructor began the lesson by soliciting examples of when percentages are used in real life. Parents suggested that tithes are 10 percent of one's salary and that retail stores offer percentages off the price of clothing when they have sales.

Next, participants discussed the meaning of *percent* as "for every hundred." To develop this concept, participants received several shaded squares (hundred grids without the lines) and were asked to estimate the percentage of the shaded area (see **fig. 1a**). Some drew lines to separate parts, and others made guesses. Many of the participants who drew lines came quite close to the actual percentage.

Participants then received transparent hundred grids (see **fig. 1b**) to overlay the shaded squares. While discussing their methods, they



A grandmother checked her estimate by overlaying a transparent hundred grid on the shaded grids.

worked together to find the percentages. They then presented their estimates and final solutions to the class.

The next activity offered during week 7 prompted participants to build square tile percentage models. A bucket of square tiles was distributed at each table. Participants were instructed to form a collection of tiles that was 10 percent blue, 15 percent green, 50 percent red, and 25 percent yellow. A student said that each tile is "one," meaning 1 percent. When he and his parents tried to model it, they discovered that they did not have enough tiles. So the parents suggested making each tile "two," meaning 2 percent. The student said that it would take five blue tiles and twenty-five red tiles, because he could just multiply by two. One parent wanted to know how they could figure out 15 percent. The student's response was to get seven green tiles and cut an eighth-tile in half. The instructor advised the group to use existing tiles that they had without cutting or requiring more tiles. Another group suggested letting each tile represent 5 percent. The groups eventually solved the problem, with a student presenting two blue tiles, three green tiles, ten red tiles, and five yellow tiles. Each group completed all the problems, and they were also assigned one or two problems to present to the rest of the minicourse participants. At times, some participants struggled, and this provided an opportunity for other parents, participating teachers, or students to intervene and assist.

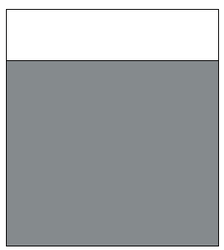
The next task of the week 7 session required participants to shade a given percentage of various grids. The first grid, a bar divided into fifths, required 60 percent to be shaded (see **fig. 2**). Participants had to determine what percentage each fifth had to represent for the entire grid to equal 100 percent. Families were to complete the grids as homework. They discussed their findings at the beginning of the next minicourse session. A father and his sixth-grade daughter found that each rectangular fifth must be 20 percent. The father held up one hand to demonstrate by using his fingers to represent the segments: "Each finger is twenty, so we shaded three of them to make sixty; see: [*pointing to his fingers*] twenty, forty, sixty."

Another family demonstrated the same problem by saying that they shaded half the figure, because they knew that *half* was 50 percent,

FIGURE 1

The activity for week 7 was to estimate and check the percentage of a shaded square.

(a) Estimate the shaded portion: 80% or .80



(b) Verify by using the transparency grid overlay.

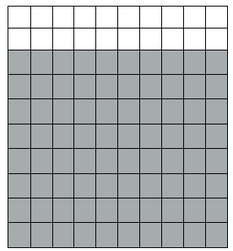


FIGURE 2

The week 7 homework task had families determine the percentage that each fifth represented for the entire grid to equal 100 percent and be ready to discuss their findings at the next session.

Shade 60% of this grid.

which equated to two-and-a-half shaded rectangles. So they decided to shade the remainder of the third rectangle to complete the representation for 60 percent. From there they saw that each rectangle must equal twenty, allowing them to verify their solution.

Children's activities

While parents and teachers learned mathematics content and pedagogy, children in preschool through grade 3 participated in age-appropriate mathematics activities and games corresponding to the content that the parents were learning. Children were separated into grade bands: pre-K, K–grade 2, and grades 2–3. Activities were aligned with the state performance standards. Some activities were derived directly from the MAPPS curriculum (Griffin 2007); others were taken from the Investigations in Number, Data, and Space curriculum (Akers et al. 1998). For example, the Fill Two game challenged children to color decimal grids, similar to the transparency grids that parents used in week 7. Students chose from a stack of decimal cards and colored their grids to match the card they had drawn from the stack. Opponents successively chose cards from the stack, and the first to fill two grids—each representing one unit—would win.

In addition to the tasks completed during the two-hour sessions, participants received take-home games, activities, and cutout manipulatives, such as base-ten blocks, pattern blocks, and tangrams, to reinforce and enact concepts learned in MAPPS. To sustain family game time and excitement about mathematics, the instructors encouraged family members to compete with one another when they used their take-home materials. Thus, MAPPS supported parents in teaching their children mathematics related to both formal, school-based tasks and to informal learning experiences as well. Pizza and soda were served to everyone midway through each two-hour session, and children aged pre-K–grade 3 played outside during a short recess time.

Impact of MAPPS minicourses

To assess the impact of the MAPPS minicourses, parents and teachers took pretests and posttests on mathematical knowledge for teaching (LMT 2006) and pretest and posttest attitude surveys (Tapia 1996). A focus group of parents, teachers, and children also participated in pretest and posttest interviews.

Increased content knowledge

Parents and teachers improved both in the areas of *common content knowledge*, which means knowing basic math, as well as in the *specialized content knowledge* of how mathematics arises in classrooms (Ball, Thames, and Phelps 2008). Pretesting and posttesting following each eight-week minicourse showed that teachers as a group started at a higher baseline knowledge level than parents, but both groups improved their knowledge. An example of improved content knowledge included a mother who learned that one-half of one-fourth is one-eighth. She related this knowledge to her experience of preparing for a recent college entrance exam where a practice question was exactly that of taking one-half of one-fourth.

A bridge to continuing education

MAPPS had a twofold benefit. First, it equipped parents with content knowledge to help their children with math; and second, it opened a bridge for participants to continue their own education. Thus, MAPPS appeared to provide a mechanism for breaking a generational cycle of math phobia and low achievement in mathematics. Teachers reported extending and reinforcing

Participants celebrated completing each eight-week minicourse with a graduation ceremony at the university.

their own mathematical knowledge, such as cultivating a conceptual understanding of fractions. Moreover, teachers consistently adapted MAPPS tasks to their own classrooms and curriculum. Finally, parents and teachers as a group significantly improved their scores on the attitude-toward-mathematics survey. Consequently, participating schools benefited from both parents and teachers with stronger knowledge.

Behavioral models

The ability to help children with mathematics homework involved more than mere content knowledge. We found that certain aspects of mathematical knowledge for teaching seemed to relate directly to parents' mathematical work with their children at home. In MAPPS classes, parents' own strategies were valued, prompting them to value their children's mathematical strategies. Likewise, parent and teacher explanations were shared with the entire group, modeling for them the importance of eliciting children's reasoning.

Increased manipulative use

Another area of development was in the use of manipulatives. Parents' and teachers' entry levels on manipulative use differed, but the MAPPS minicourses differentiated to the needs of participants by introducing and modeling appropriate tasks and sequences of instruction with manipulatives. Parents tended to learn about manipulatives for the first time, whereas teachers often knew of them but not how to use them effectively. For example, one parent learned that the pregrouped manipulative base-ten blocks better assisted her daughter with place-value concepts in multidigit addition than ungrouped pennies or drawings did (Van de Walle, Karp, and Bay-Williams 2010).

Strengthened relationships

In addition to building parent-child relationships, the learning community that MAPPS promotes strengthened parent-teacher relationships. Teachers and parents enjoyed a level playing field in which all were learning for the desired end of helping children. Parents appreciated teachers' extra efforts to help children learn, and teachers came to view parents as dedicated individuals invested in the academic success of their children. The minicourses were lighthearted in nature; families and teachers enjoyed the collaborative approach to learning.

Improved test scores

To measure impact on children, qualitative interview data was analyzed, and standardized test scores were collected from a sampling of students. Additionally, students took localized tests on content directly related to minicourse topics. Parents reported that their children's math performance in school improved. This result was substantiated by gains in the localized test scores. Moreover, standardized test scores of a sample of forty-seven MAPPS students increased significantly ($p = 0.001$) and to a greater degree than a group of forty-six comparison students two years later in 2009–2011. For a three-year comparison, a sample of thirty-nine MAPPS students improved their scores significantly from 2008–2011 ($p < 0.001$); whereas the comparison group of thirty-six students did not improve significantly. Finally, interviews following the minicourses revealed that practicing how to explain solutions in front of or to their parents boosted children's confidence and motivation to learn mathematics.

On the same team

Parents desire to assist their children with learning mathematics, and they appreciate instruction in how to do so. Teachers can become discouraged when parents do not help students with mathematics homework, or when parents "help" inappropriately for such Standards-based outcomes as Problem Solving and Reasoning. Our MAPPS program revealed that schools benefit when they pair parental involvement classes in mathematics with professional development for teachers. Such professional development should include both content and pedagogical aspects that encourage participants to collaborate in problem solving, share solutions, and explore appropriate manipulative use. In so doing, parents and teachers will join the same team to boost student achievement and understanding of mathematics.

REFERENCES

Akers, Joan, Cornelia Tierney, Claryce Evans, and Megan Murray. 1998. *Name That Portion: Fractions, Percents, and Decimals Curriculum Unit for Level 5*. Menlo Park, CA: Dale Seymour.

Ball, Deborah L., Mark H. Thames, and Geoffrey Phelps. 2008. "Content Knowledge for Teaching: What Makes It Special?" *Journal of Teacher Education* 59 (5): 389–407.

D'Agostino, Jerome V., Larry V. Hedges, Kenneth K. Wong, and Geoffrey D. Borman. 2000. "Title I Home-School Partnerships: Effects on Parenting Practices and Student Achievement." In *Title I: Compensatory Education at the Crossroads*, edited by Geoffrey D. Borman, Samuel C. Stringfield, and Robert E. Slavin, pp. 119–38. Mahwah, NJ: Lawrence Erlbaum Associates.

Epstein, Joyce L. 1994. "Theory to Practice: School and Family Partnerships Lead to School Improvement and Student Success." In *School, Family, and Community Interaction: A View from the Firing Lines,* edited by Cheryl Fagnano, and Beverly Werber, pp. 39–52. Boulder, CO: Westview Press.

Griffin, Linda, Darcy Schroeder, Mary Schumacher, and University of Arizona. 2007. *Math for Parents Minicourse: Thinking about Fractions, Decimals, and Percents.* Plymouth, MI: Hayden-McNeil.

Henderson, Anne T., and Karen L. Mapp. 2002. *A New Wave of Evidence: The Impact of School, Family, and Community Connections on Student Achievement.* Austin, TX: National Center for Family and Community Connections with Schools, Southwest Educational Development Laboratory.

Henderson, Anne T., Karen L. Mapp, Vivian R. Johnson, and Don Davies. 2007. *Beyond the Bake Sale: The Essential Guide to Family-School Partnerships.* New York: The New Press.

Jackson, Kara, and Janine Remillard. 2005. "Rethinking Parent Involvement: African American Mothers Construct Their Roles in the Mathematics Education of Their Children." *School Community Journal* 15 (1): 51–73.

Kellaghan, Thomas, Kathryn Sloane, Benjamin Alvarez, and Benjamin S. Bloom. 1993. *The Home Environment and School Learning: Promoting Parental Involvement in the Education of Children*. San Francisco, CA: Jossey-Bass.

Learning Mathematics for Teaching (LMT)/ Study of Instructional Improvement. 2006. *Instrument Dissemination Workshop Binder.* University of Michigan School of Education.

National Council of Teachers of Mathematics (NCTM). 2000. *Principles and Standards for School Mathematics*. Reston, VA: NCTM.

Peressini, Dominic D. 1998. "The Portrayal of Parents in the School Mathematics Reform Literature: Locating the Context for Parental Involvement." *Journal for Research in Mathematics Education* 29 (5): 555–82.

Tapia, Martha. 1996. *The Attitudes toward Mathematics Instrument.* Paper presented at the annual meeting of the Mid-South Educational Research Association, Tuscaloosa, AL.

Van de Walle, John A., Karen Karp, and Jennifer Bay-Williams. 2010. *Elementary and Middle School Mathematics: Teaching Developmentally*. 7th ed. Boston, MA: Allyn and Bacon.

Andrea K. Knapp, **aknapp@uwsp.edu,** currently teaches mathematics education courses at The University of Wisconsin in Stevens Point. She was codirector of the MAPPS program at the University of Georgia Griffin Campus. **Vetrece M. Jefferson**, **vetrece.jefferson@gscs.org**, teaches fifth grade at Atkinson Elementary School in Griffin, Georgia, and has been a MAPPS instructor. **Racheal Landers**, **rlanders@uga.edu**, has been the MAPPS program coordinator at the University of Georgia Griffin Campus while a graduate assistant in mathematics education. All three authors are interested in parental involvement in mathematics.