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How Can Parents Help Their Children Learn Math?

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The Need for Early Mathematics Education in the United States

American children's mathematics performance is inadequate. In 2009, only 33% of fourth grade children nationwide were rated *proficient* and only 6% were *advanced.* A large majority of fourth grade children performed at a substandard level (National Assessment of Educational Progress, 2009). When American children's math performance is compared with that of children from other nations, the results are extremely disappointing. Children from East Asia outperform their American counterparts in mathematics achievement as early as preschool (Miller & Parades, 1996).

The situation is especially bleak for disadvantaged children, namely those from poor, and poorly educated, families, often living in unsafe neighborhoods and disproportionally composed of African Americans and Latinos. From the very beginning, the achievement gap between disadvantaged and advantaged children is wide: in the fall of their kindergarten year, 47% of low-income children are in the lowest performance group, and only 8% of low-income children perform at the top level (compared with 30% of the more affluent children) (Love & Xue, 2010). These data are worrisome because early math achievement scores at entry to school predict later performance with considerable accuracy (Dunca et al., 2007). Furthermore, the socio-economic status (SES) differences increase over time (National Assessment of Educational Progress, 2009), producing a vicious cycle: "Poor educational attainment is a major cause of poverty, and poverty is a key influence on academic failure" (Arnold & Doctoroff, 2003, p. 518). This chapter examines parents' role in early mathematics education (EME) for children from roughly 3 to 5 years of age. Helping parents to help children learn math is a complex undertaking. To succeed, we need to understand the need for EME, why parents should be involved in it, and what they can do to help.

The Educational System and Parents' Role

It is important to place low-SES students' performance in a wider perspective. Not only do they grow up in more challenging conditions than do their more affluent peers, but low-SES children also receive an inferior education. Schools serving low-SES children receive lower public funding than schools serving higher-SES children (Arnold & Doctoroff, 2003, p. 518) and provide inadequate educational opportunities (Lee & Burkham, 2002). It is especially distressing to note that "... teachers have lower expectations and more negative perceptions of low-SES students than their higher-SES peers" (Arnold & Doctoroff, 2003, p. 522) and then tend to give up on the students who need the most help. Teachers seldom teach math at the preschool and kindergarten levels, and the teaching that does take place is often low quality (Ginsburg, Lee, & Boyd, 2008).

Because disadvantaged children are at risk of both school failure and failing schools, parents need to become involved in helping their children learn math. Parents' behavior can have important consequences for math learning. For example, the extent to which parents engage in early number talk (when their children are 13 and 30 months of age) is positively related to their children's later (at 40 months) understanding of numbers (Levine, Suriyakham, Rowe, Huttenlocher, & Gunderson, 2010). Number talk need not be complex: it entails simple statements like, "Let's count the balloons. One, two, three, four, five. Five altogether."

Yet parents do not do enough. Dislike of mathematics is widespread in the American population (Burns, 1998). A diverse sample of mothers—White and Latina—reported that they more often help their preschool children learn various language and literacy skills than math skills (Cannon & Ginsburg, 2008). Mothers felt that math should be emphasized less in preschools than language, and that math is less interesting to preschoolers than language. Many explicitly stated that they did not know what mathematics their children could or should learn or how to help them learn it. Despite their uncertainty about EME, parents reported engaging in at least some math activities at home, for example, reciting number rhymes and measuring while preparing food (Benigno & Ellis, 2008).

Observational studies confirm that parents in fact do relatively little to support their children's math learning. For example, in a children's museum exhibit on number, about a third of the parents did not interact with their children at all; only a third asked children how many objects were present, and only about a quarter of the parents used the occasion to help their children learn about counting and cardinal value—the intended subject matter of the exhibition (Gelman, Massey, & McManus, 1991).

Other studies examine possible differences in low- and middle-SES parents' behavior with respect to math activities. Low SES parents generally tend to provide less support for mathematical development than do middle SES parents (Starkey et al., 1999). Disadvantaged families are more likely to focus on simpler topics such as counting and shape recognition, rather than on more complex processes such as numerical or geometric reasoning (Klein & Starkey, 1995). Also, lower income parents frequently have different expectations than do middle income parents about their role in teaching mathematics to their children. For instance, lower income parents are more likely to believe that it is the role of preschool settings to prepare children for school mathematics while middle-income families place more emphasis on the home environment (Starkey et al., 1999). In brief, parents are somewhat reluctant to engage their children in math activities and are often unsure about how to do so.

Young Children Are Ready To Learn Mathematics

Over the last 25 years or so, researchers have accumulated a wealth of evidence (Clements & Sarama, 2007b) showing that nearly from birth to age 5, young children develop mathematical ideas and skills that are surprisingly broad and complex. In this section, we address children's core mathematical abilities, their everyday mathematics, SES differences, and motivation for learning.

Core Mathematical Abilities

Even infants display core mathematical abilities. They can, for example, discriminate between two collections varying in number (Lipton & Spelke, 2003) and develop elementary systems for locating objects in space (Newcombe & Huttenlocher, 2000). Geary (1996) argues that all children, regardless of background and culture, are endowed with "biologically primary" abilities including not only number, but also basic geometry. These virtually universal abilities require only a minimum of environmental support to develop.

Everyday Mathematics

Throughout the preschool years, and often without adult assistance, young children develop a comprehensive everyday mathematics entailing a variety of topics, including space, shape and pattern, as well as number and operations. Their everyday math comprises several important features.

Spontaneous interest. Young children have a spontaneous and sometimes explicit interest in mathematical ideas. In their ordinary environments, they choose to count, even up to relatively large numbers like 100 (Irwin & Burgham, 1992), and may want to know what is the "largest number" (Gelman, 1980). Also, mathematical ideas permeate children's play: in the block area, for example, they determine which tower is higher than another, make and extend interesting patterns with blocks, explore shapes, and create symmetries (Seo & Ginsburg, 2004). Everyday mathematics is not an imposition from adults; indeed adults, including teachers, are often blissfully ignorant of it.

Competence and incompetence. Children's minds are not simple. On the one hand, from an early age, they seem to understand basic ideas of addition and subtraction (Brush, 1978) and spatial relations (Clements, 1999). On the other, children display certain kinds of mathematical incompetence as, for example, when they have difficulty understanding that the number of objects remains the same even when merely shifted around (Piaget, 1952) or when they fail to realize that an odd-looking triangle (for example, an extremely elongated, non-right-angle, "skinny" triangle) is as legitimate a triangle as one with three sides the same length (Clements, 1999).

Concrete and abstract. In many ways, young children's thinking is relatively concrete. They count the objects in two groups to get the sum. Yet in other ways, young children's thinking is very abstract. They have abstract ideas about counting objects, for example, the principle that any discrete objects can be counted (from stones to unicorns) (Gelman & Gallistel, 1986).

Language and metacognition. Learning mathematics requires learning several kinds of language. From the age of 2 or so, children learn the language and grammar of counting. They memorize the first 10 or so counting words, and then learn a set of rules to generate higher numbers (Ginsburg, 1989). For example, once they figure out that 40 comes after 30, just as 4 comes after 3, it is easy to append the numbers 1 through 9 before going on to the next logical tens number, 50.

Young children also learn other kinds of mathematical language, like the names of shapes ("square") and words for quantity ("bigger"). Indeed, some of these words (like "more") are among the first words spoken by many babies (Bloom, 1970).

Perhaps most importantly, language is required to express and justify mathematical thinking. With development, children become increasingly aware of their own thinking and begin to express it in words (Kuhn, 2000). These kinds of "metacognitive" skills develop in children as young as 4 or 5 years of age (Pappas, Ginsburg, & Jiang, 2003).

The hardest form of language for children to learn is the written symbolism of mathematics, like 5, +, − or =. For example, asked to show in writing the number of a collection of blocks, young children draw pictures of them and only much later employ symbols like 5 (Hughes, 1986).

Finally, the importance of mathematical language is underscored by the fact that the amount of teachers' math-related talk is significantly related to the growth of preschoolers' conventional mathematical knowledge over the school year (Klibanoff, Levine, Huttenlocher, Vasilyeva, & Hedges, 2006). Language is clearly deeply imbedded in mathematics learning and teaching. math is a form of literacy.

SES Differences

As we saw earlier, disadvantaged preschool and kindergarten children generally perform more poorly on simple mathematical tasks than do their more privileged peers (Denton & West, 2002). Of course, this is a statement about *groups* of children and many *individual* low-income children do very well.

A closer look at disadvantaged children's mathematical abilities reveals a complex and interesting situation. First, research shows that although disadvantaged children's *performance* on informal addition and subtraction problems usually lags behind middle-income children's, the two groups often employ similar *strategies* to solve problems (Ginsburg & Pappas, 2004). Second, although lower-income children have difficulty with *verbal* addition and subtraction problems, they perform as well as middle-income children on *non-verbal* forms of these tasks (Jordan, Huttenlocher, & Levine, 1994). Third, naturalistic observation shows that lower- and middle-income children exhibit few if any differences in the everyday mathematics they spontaneously employ in free play (Seo & Ginsburg, 2004). Low-income children traffic in pattern and shape, quantity differences, and number in the same ways and as frequently as do middle-income children. Disadvantaged children do not lack for basic competence and could do better if educators and parents could figure out how to help them.

Motivation for Learning

Young children are not only intellectually capable of learning math, but they also begin schooling with positive motivation and self-confidence. Yet they are "… likely to lose interest within the first years of school" (Arnold & Doctoroff, 2003, p. 521). Possible reasons for the decline in disadvantaged children's motivation include teachers' low expectations and inadequate teaching.

Two Goals of EME

One goal of EME is to prepare young children for later academic success in mathematics. EME may provide a kind of "cognitive multiplier" (Siegler, 2010): the more a child knows at the outset, the more he or she can form new associations and construct meaning, especially because mathematics is often structured in a hierarchical manner. Indeed, early education generally (not only in math) has been shown to provide a foundation for later academic success as measured by higher achievement test scores (Cross, Woods, & Schweingruber, 2009).

A second goal is to help children enjoy learning math for its own sake. The child should get "… out of his present experience all that there is in it for him at the time in which he has it. When preparation is made the controlling end, then the potentialities of the present are sacrificed to a suppositious future" (Dewey, 1938, p. 49). Overzealous preparation may unintentionally introduce unnecessary pressure and anxiety on the part of parent, teacher, and child alike. It may distort EME, rob children of the joys of learning, and in the end produce only a superficial success (as measured by achievement tests). Parents should not get in the position of serving as taskmasters over drill and stressful learning.

The Basics of EME

EME is not simple. It involves much more than memorizing the counting numbers or the names of shapes. Here we identify several important aspects of EME, including the nature of the mathematics content, the role of abstract thought, metacognition and mathematizing, and positive dispositions towards mathematics learning.

Broad and Deep Content

Early mathematics involves *broad* strands of "big ideas," such as number, geometry, measurement, and pattern. Each of these, in turn, entails interesting subtopics. For example, number covers such matters as the counting words ("one, two, three ..."), the ordinal positions ("first, second, third ..."), the idea of cardinal value (how many are there?), and operations on number like addition and subtraction. The topic of spatial relations includes ideas like position (in front of, behind), navigation ("three steps to the left") and mapping (for example, creating a schematic representing the location of objects in the classroom).

Early mathematics is also *deep*. Suppose that you show a child a haphazard arrangement of objects, including a red block, a small stuffed dog, and a penny. You ask the apparently simple question: "How many things are here?" To answer, the child obviously needs to know the counting words, "One, two, three ..." But that's only the beginning. To be successful at "enumeration" (determining a set's numerical value), the child needs to understand several basic mathematical ideas.

One is that any kind of elements in a set can be counted. You can count nickels and cats, big things and small things. You can even count fantastical images like red unicorns existing only in the mind.

A second idea is that each number word, "one, two, three ..." must be associated once and only once with each of the objects in the set. You point at the red block and say "one," the dog and say "two," and the penny and say "three." You can't say both "one" and "two" when referring to the red block, even though you describe it with two words, "red" and "block."

A third idea is that the final number in the sequence, "three," does not refer to the penny alone but instead to the whole group of objects. Enumeration entails a distinctive use of language. In ordinary speech, we call an object a dog or a penny because that is its name. You cannot legitimately call a penny a red block. But when we enumerate, the number name we assign to the objects does not refer to the individual object but to a very abstract property of the set as a whole. When we point to the penny and say "three," we do not mean that "three" is the name for the penny but that it is a property, the cardinal value, of *all* the things we have enumerated.

Math Is Thinking

Early mathematics does not involve simply memorizing number words; it must include *abstract thought*. Children need to learn to *reason* about number (if 2 and 3 is 5, then 3 and 2 must also be 5). Understanding shape involves more than knowing a figure's name. Children need to learn to analyze and construct shapes and to understand their defining features (Clements, 2004).

Metacognition and Mathematizing

Various *metacognitive* functions also play a key role in mathematics learning. Children need to learn to be aware of and verbalize their mathematical strategies. They need to be able to put their thinking into words so that they can communicate it to others and thus take the first steps towards joining a community that values rational discussion, argument, and proof. Learning mathematics is in part learning expressive language.

Children also need eventually to *mathematize*—to conceive of problems in explicitly mathematical terms. For example, although they can easily distinguish a square from a triangle, they need to learn explicitly that a square has four sides and a triangle three, and that the number of sides helps to determine the type of shape. Similarly, although they have sound informal ideas about addition, knowing for example that to add you can enumerate all the objects in two sets, they also need to learn that the symbol + refers to adding. Certainly, young children should not receive rote drill on memorizing symbols out of context; but they should learn to make meaningful connections between symbols and their everyday mathematics. Math teaching involves helping children to advance beyond their informal, intuitive mathematics and to acquire a meaningful understanding of the formal concepts, procedures, and symbolism of mathematics.

Positive Disposition

Learning math also involves feelings and motives. Unfortunately, many adults don't like math and work to avoid learning or teaching it. Indeed, our informal observations show that many of our students, who are prospective teachers, say that they chose to focus on early childhood *because* they would not have to teach mathematics, do not like mathematics, or feel they are not very good at it. No doubt many parents feel the same way. To counter such attitudes, teachers need to focus not only on the math, but also positive dispositions towards it. EME needs to promote motivation, interest, initiative, persistence, and focused engagement in mathematical activities.

How Parents Can Help Children Learn Math

We have seen that parents do relatively little to help their children learn math. This situation is unfortunate because exposure to math concepts in the home can have a positive impact on school readiness (LeFevre et al., 2009). For example, children's scores in standardized tests of early math are positively related to parents' mathematics attitudes, experiences and exposure to mathematics concepts at home (Blevins-Knabe et al., 2000).

How can parents help? There are at least three ways: They can provide a rich home environment to stimulate math learning. They can support the curriculum taught in school. They can engage children in specific activities—in the home or elsewhere—designed to foster math learning.

A Stimulating Environment

Homes are like schools in this respect: the richer the environment, the more opportunities there are for children to learn. At home, children can benefit from toys, blocks, books, technology, and television. But availability of a stimulating environment does not guarantee children will learn from it. Although learning much on their own, children can often benefit from parental guidance as they undertake various activities. An obvious example is book reading. Parents can stimulate children's learning not only by reading a book, but also by asking useful questions that help the child to explore relevant ideas. Furthermore, some components of an apparently stimulating environment may not be helpful. Not all television programs or books or forms of technology are of high educational quality. Indeed, some are undesirable, like drill books that promote mere memorization of meaningless symbols, violent television programs, and software that entails little more than drill exercises on steroids.

Finally, although a rich environment is not sufficient for learning, it is certainly desirable. Yet many families cannot afford them. This means that from the outset, children from poor families begin at a significant disadvantage.

Supporting School Programs

One way parents can help is by reinforcing skills and concepts children learn in school. Some early mathematics curricula attempt to involve families in young children's learning of mathematics by including explicit suggestions and/or materials for home-school connections. For example, *Big Math for Little Kids* (Ginsburg, Greenes, & Balfanz, 2003), *Building Blocks* (Clements & Sarama, 2007a), and *Number Worlds* (Griffin, 2007) all include weekly letters that inform parents of what the children have been doing in school, suggest interactions related to a classroom assignment, and offer suggestions for other home activities, including games.

Although all of these curricula recognize the value of family involvement in EME, their attempts at outreach are limited. Naturally, the programs focus mainly on promoting learning in the classroom—a huge task in itself. But other efforts provide extensive guidance for home activities not linked to curricula.

Home Activities

Parents may benefit from structured activities to help promote their young children's mathematical development. For this reason, several programs have focused specifically on building children's math-readiness skills by helping parents, especially underserved parents, provide appropriate support for their children's math learning.

Family Math/ EQUALS. The Family Math/ EQUALS program (Coates & Stenmark, 1997) provides a series of structured materials and parent workshops to promote math learning in children from pre-kindergarten to ninth grade. The program offers special games and activities for young children (pre-kindergarten to second grade). Employing hands-on materials that can often be found in the home, Family Math focuses on developing problem-solving and conceptual mathematical skills in the areas of counting, sorting, classifying, logic, arithmetic and other key mathematical skills. Further, a key aim of the program is to help families develop positive attitudes towards math. Community workshops on Family Math can be organized by groups of parents and can be offered in English or Spanish.

Helping your child learn math. This online guide for parents of children from kindergarten through fifth grade (Kanter & Darby, 1999) offers activities that help children learn and apply mathematical concepts in an enjoyable way. Activities are divided into sections: (1) Math in the Home, (2) Math in the Grocery Store, (3) Math on the Go, and (4) Math for the Fun of It. Each section contains a series of proposed activities and instructions for parents of children of different grades. Additional sections in the guide help parents explore their expectations and attitudes towards math; provide ideas to improve communication with their children's teachers; and include a list of resources to promote mathematics in the home.

Games. Mathematics plays a role in many board and card games. Of course, children play games for fun and enjoyment—not to learn math. But the unintentional learning can be deep and can prepare children for later math achievement. For example, board games with consecutively numbered, equal-size spaces often arranged in a line (straight or curved), such as *Chutes and Ladders*, provide the opportunity to learn both the order of numbers and their magnitudes and in fact produce significant improvements in low-income children's numerical knowledge (Ramani

& Siegler, 2008). Thus, parents can make a contribution to EME by playing common board games such as *Sorry* with their children.

Ramani and Siegler (2008) also showed that middle-SES children say they play board games at home more often than do lower-SES children. By contrast, lower-SES children report playing video games more often than do the middle-SES children. If board games promote math learning, then middle-SES children benefit from them more than do lower-SES children.

Books. Increasing numbers of children's books explicitly focusing on mathematical concepts can be found in stores and libraries—for example, counting books. Many other books, such as *The Three Bears*, involve implicit mathematical content. Given parent and child interest, popular books can be an important resource for home learning of math.

Further, some mathematics programs and curricula—for example, *Big Math for Little Kids* (Ginsburg et al., 2003), *Building Blocks* (Clements & Sarama, 2007c), and Storytelling Sagas (Casey, Kersh, & Young, 2004)—include story books as essential components. Home-school connections may involve parents' reading selected math-related books to their children.

Research shows that books and stories, which provide a meaningful context that may promote motivation and interest, can enhance children's mathematical learning at home (Hong, 1999) and in the classroom (Jennings, Jennings, Richey, & Dixon-Krauss, 1992).

Resources. How can parents get useful information concerning home activities, ranging from games to books? They can use the *Parent Resources* page on the website of the National Council of Teachers of Mathematics, which includes various downloadable guides for parents of children of all ages. Another resource is a website produced by the New Jersey Network Foundation's Education Department. *Bringing Home the Math* is designed to help parents support and foster their young children's understanding of key math concepts. It provides descriptions of mathematical concepts, videos to demonstrate these concepts, downloadable activities, and resources, including literature. Many other online resources are also made available to parents by various schools, educational organizations, and curriculum developers. Of course, ensuring that these online resources are available to and used by the disadvantaged families whose children are most in need remains a challenge.

Targeting Language- and Ethnic-Minority Parents

As seen above, children of language- and ethnic-minority parents are at the greatest risk for poor mathematical achievement. To reduce this risk, some researchers have focused on the role of these parents—predominantly Latino immigrants—in promoting and supporting their children's math learning in and outside of school (Civil & Bernier, 2006; Gonzalez, Andrade, Civil, & Moll, 2001; Moll, Amanti, Neff, & Gonzalez, 1992). Interviews with parents and observations made during home visits show that language- and ethnic-minority parents have "funds of knowledge" (everyday knowledge and skills permeating family life) that have the potential to support learning in the classroom but that are often neglected or discredited in traditional educational settings. Unfortunately, both parents and teachers are frequently unaware of the wealth of knowledge they can draw upon to support their children's school learning. Two projects, Project Bridge and Math and Parent Partnerships in the Southwest (MAPPS), aimed to correct this situation.

Project Bridge

The Bridge Project (Gonzalez et al., 2001) developed opportunities for learning math within the households of economically disadvantaged families and for helping parents and communities see themselves as "... mathematicians, doing mathematics in their everyday lives" (p. 119). In addition, the program helped teacher-researchers learn about the funds of knowledge in their students' households and how drawing on this resource could complement classroom instruction. To make the identified funds of knowledge meaningful to families, teachers and administrators, the project engaged them in workshops that put the knowledge in social context. These "zones of practice" were designed to bridge "academic mathematics" and home or "everyday mathematics." For example, researchers would join a mothers' group for a sewing activity. The parent leading the sewing activity would start by drawing up patterns and measurements to make a skirt. The researcher would inquire about her process and techniques for measuring and sketching, and make the link between "everyday mathematics" and "academic mathematics."

Project MAPPS

Project MAPPS (Civil & Bernier, 2006) was implemented in several schools in Arizona, New Mexico, and California. The goal was to develop leadership teams of parents, teachers, and administrators who would promote and facilitate mathematics education in their community. The program consisted of three components:

1. Leadership Development Sessions helped parents, teachers and administrators to learn how to conduct workshops for the larger parent community.
2. Mathematics Awareness Workshops on key topics in mathematics for kindergarten through 12th grade were led by parent/teacher leadership teams throughout school districts.
3. Math for Parents courses met for 8 weeks in 2-hour workshops in which parents worked on school math tasks to become comfortable with the material and learn how to use different tools and problem-solving approaches.

Programs such as MAPPS suggest that parents of minority backgrounds can bring to the educational table significant mathematical knowledge and skill to support their children's learning. Programs that build on these funds of knowledge appear to have been successful in promoting fruitful reciprocal relations between parents and teachers, and in promoting children's math learning (Civil & Bernier, 2006; Gonzalez et al., 2001).

The Family Mathematics Curriculum

The Family Mathematics Curriculum (FMC) (Starkey & Klein, 2000) is a structured program in which low-income parents and preschool children participate in mathematics classes that address a specific set of mathematics concepts and use a set of planned activities. Parents and children also have access to a take-home library of mathematics materials. The 8-class intervention is implemented on a bi-weekly basis and covers number concepts; arithmetic operations; logical reasoning; geometric and spatial concepts; and patterns. Each unit contains several activities and supporting materials.

Parent-child dyads participate in sessions that include three individual activities and one group activity per class. A three-phase process is implemented in each class: (a) demonstrating the activity, (b) monitoring parents' use of the materials/activity, and (c) providing feedback to parents when necessary. Trained teachers use role-playing techniques to demonstrate the activities, followed by practice time for parent-child dyads (using hands-on materials). At the end of each session, families are encouraged to borrow materials (up to three math kits at a time) to continue practicing at home.

The FMC was evaluated in two small studies. African American and Hispanic children who participated in the FMC with their parents had significantly higher scores in the areas of enumeration, numerical reasoning and overall math ability than did children in a control group (Starkey & Klein, 2000). The research suggests that with adequate supports and materials, parents can have a significant impact on young children's mathematical skills.

Getting Ready for School

Originally designed as an intervention for parents in developing countries with limited or no access to preschool, Getting Ready for School (GRS) (Hayes, Landers, & Dombro, 2006) aims to expand parents' knowledge about the literacy and math skills needed for success in school and to help parents to create more effective home learning environments for their preschool-aged children.

GRS can be implemented with varying frequency (weekly, biweekly, or monthly). In two-hour workshops, trained facilitators meet with groups of parents to disseminate and explore the materials. In the workshops, parents explore ways to implement math activities and adapt them to their children's interests and abilities.

GRS consists of a 9-unit curriculum of activities, available in either English or Spanish, including:

- Parent Activity Guide. This guide explains how parents can use activities with their children, and suggests ways to modify or enrich the activities depending upon children's needs.
- Children's Activity Sets. This activity has nine sets of literacy and math materials including pictures, games, and other materials.
- Facilitator's Guide. This guide provides a set of lesson plans for the Parent Facilitator in running the weekly parent sessions.
- Train-the-Trainer Guide. This guide teaches Parent Facilitators how to run effective parent meetings.

GRS follows professional guidelines for the acquisition of math concepts in the following areas: numbers and operations; geometry and spatial sense; measurement; algebra; and data analysis (Clements, Sarama, & DiBiase, 2004). Both literacy and math activities employ everyday interactions in the home and the community as the vehicles for learning. Each unit builds on the previous unit with content becoming increasingly complex. In 2010 the National Head Start Family Literacy Center identified the program as a promising new intervention, distributed the GRS materials, and provided training on its use to over 600 Head Start programs across the United States. A pilot evaluation of the program conducted in an urban Head Start program with Hispanic parent-child dyads indicated that GRS produced more overall growth in math skills than did standard Head Start (Noble et al., 2011).

A Roadmap Towards the Future

How should we move forward to promote parents' contribution to young children's math learning? In this section, we describe several issues that need to be addressed.

A Rich Environment

The roadmap towards the future should involve two features related to a rich environment. First, EME professionals can make an important contribution by developing programs and standards to help parents evaluate the quality of "educational" materials in the marketplace. Second, EME professionals should develop programs to help parents engage in cognitive parenting that can foster their children's home learning from dedicated educational materials to pots and pans.

Clearly, a home environment rich in stimulating materials is desirable for all children. But two issues arise: choice and magic. The issue of choice is not new. Parents must first identify the materials that foster learning. But how can a parent know what kinds of toys, books, games, computer software, "apps," electronic learning systems, and TV shows do in fact fit the bill? One does not need research to show that materials vary in quality. Moreover, the sheer amount of material, especially computer "apps," is increasing at a giddy pace. How then are parents supposed to know what to buy? The evaluation is especially problematic for parents who may have themselves grown up with few stimulating materials and have attended schools offering inferior math education.

Sometimes professional or private organizations provide independent evaluations, as in the case of book awards. But these evaluations are never perfect or universal. A book that is excellent for one child at a given point in development may not be useful for another child. Ultimately, parents must make difficult decisions using their best judgment. And, unfortunately, parents often lack guiding principles that might inform their judgment.

A second issue is magic. The materials themselves have no mysterious properties: they do not guarantee learning. Buying materials and making them available does not suffice. Often the parent has to supervise their use—as in the case of book reading. Again, parent judgment and skill are required. Parents need to learn sound cognitive parenting: how to observe, to question, to listen, to stimulate, to provide challenges, to engage children in dialogues, and to use language. If anything, the magic results when parents stimulate children's excitement and sense of wonder, thus engaging them in learning.

Supporting School Programs and Programs Supporting Parents

The National Research Council (Cross et al., 2009) recommends a strong parent component for EME: "Early childhood education partnerships should be formed between family and community programs so that they are equipped to work together in promoting children's mathematics" (p. 347). As we have seen, several curricula offer parent connections. Head Start has always aimed for parent participation, but parent outreach components are usually not extensive.

Clearly, one goal for the roadmap should be to expand outreach. Teachers need to play an important role in helping parents understand classroom activities and especially their own children's learning and thinking. Sharing accounts of children's learning can be very valuable for parent and teacher alike.

Further, just as parents need to learn about teachers' goals and activities, so do teachers need to learn about parents' goals (Delgado-Gaitan, 1994). As we saw, Project Bridge and Project MAPPS both help teachers understand the "funds of knowledge" available in children's homes. Another goal for the roadmap is to develop more programs of this type. "Intervention" programs run the risk of assuming that parents have no resources, intellectual or otherwise, to help their children. Struggling, low-SES parents do need help; but they too have something valuable to contribute to their children's education. Assuming that they don't is a poor strategy for eliciting their best efforts.

Home Activities and the Dispositions and Minds of Parents

It's not the parents' job to teach in the sense of following an organized math curriculum. It would be virtually impossible for almost all parents, including home-schoolers, to do a good job of it. Implementing a curriculum requires not only time, which may be in short supply for the working parent, but also considerable knowledge of EME, which unfortunately even many teachers lack. Parents should support and supplement the school's curriculum (assuming it's a good one). At the same time, parents can undertake many activities in the context of everyday life. The road map to the future should therefore involve creation of even more stimulating home activities of all types: games, learning tasks, software and the like.

But here too, as in the case of materials that comprise a rich environment, activities do not magically produce learning. The parents' role is crucial. We need to develop education programs that promote parents' ability to implement specially designed math learning activities for the home.

The first step is a positive attitude. Even if they do not understand EME in depth, and even if they do not engage in many math activities at home—after all, a high percentage of parents work and don't have the time—parents can make an important contribution by promoting a positive disposition towards math: that learning math can be interesting and need not be feared; and that children have the competence to learn math. Similarly parents need to know that learning math need not involve drudgery, like rote memorization of symbols, and that the focus should be on thinking and talking about math. If parents understand and value this approach, then they can convey it to their children—an excellent first step. Parent education programs can help parents overcome their fears of math by engaging them in the kind of enjoyable activities they can do with their children. Math is not so scary if you learn it under the right conditions.

The second step is help in implementing specific home math activities. Sometimes, this is not too difficult. A parent can learn that the goal of a geometry activity is not just to learn shape names but also to learn their essential characteristics, for example, that a triangle must have three straight sides. But sometimes, the mathematical topic and the needed pedagogy can be a bit more complex. For example, when learning ordinal relations young children have trouble understanding that an object can at the same time be smaller than another (the Mama bear is smaller than the Papa bear) and larger than another (the Mama bear is larger than the Baby bear). Thus teaching ordinal relations is not at all simple, but well designed programs can help parents learn to implement activities like these.

In brief, to help their children learn math, parents need a positive disposition towards EME, as well as knowledge of specific activities and of the difficulties children may have learning them. And, of course, parents need to learn how to help children overcome the difficulties in a productive way—not through mindless drill.

The road map to the future therefore needs to include extensive parent education about the development and math education of young children. Parents can learn about these issues in many places, from books to the Internet. But we suspect that schools should be the hub of parent education in early mathematics (and probably literacy, too). Schools should help parents understand children's math learning and how to promote it. Parents are likely to be especially motivated to learn about early math education if doing so can help their children succeed in the specific curriculum employed by their school.

Summary of the Roadmap

The roadmap should have several features. It should:

- develop standards for and evaluations of educational materials for the home.
- develop programs to help parents foster their children's everyday home learning.
- expand outreach efforts from school to home:
  - help parents understand the school math program and children's school performance.
  - help teachers understand funds of knowledge at home.
- develop new math learning activities for parents to use at home.
  - help parents develop a positive disposition towards learning math.
  - develop guidelines for implementing specific activities.

The Larger System

Parents can do much to promote their children's math learning. Indeed, public agencies should communicate the need for extensive parental involvement (analogous to a public health campaign). But parents cannot do the job alone. The system of math education in the United States is badly flawed at virtually all levels and needs to be fixed. Institutions of higher education should produce knowledgeable, competent teachers. Teachers should learn to teach math better than they do now (if they teach it at all). Preschools should employ stimulating math curricula that build on children's everyday knowledge, engage children in exciting activities, foster mathematical thinking, encourage a productive and playful disposition, teach both skills and understanding, and promote mathematical language and metacognition. Schools should support teachers and educate parents. And society at large needs to decide through the political system whether it wants to make a serious commitment to reduce poverty (so that parents can afford to engage in key aspects of math education, especially involving technology) and to invest in early education. All this, of course, is a tall order, and we are not even close to realizing it.

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