Reflections on an Extracurricular Parent-Child Mathematics Program

Elaine Simmt

"What do you want me to do?" the man asked his daughter sitting at the table beside him.

The young girl paused and then looked up to her father, "We should probably look for a pattern. That might help us with the other ones."

"Okay, I'm game. So, what do you think?"

"Maybe—I know! Let's make a chart."

"Did you do this one?" the eight year old asked her mother as she pointed to a set of dominoes arranged in a path.

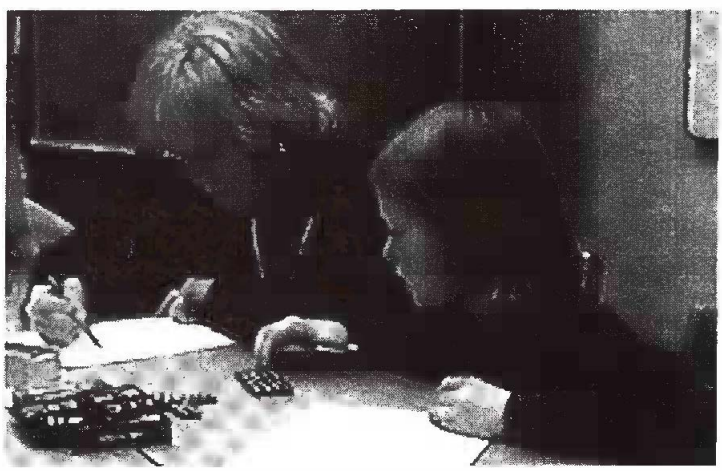
The mother looked over her records of the tiling patterns she had made. "One in the middle— No! That's good, Casey. Okay. Wait a minute— one, two, three, four, five. No, I didn't get that. Good."

The girl continued to scan her mother's records for other missed tilings.

"I think, Casey, that I might as well just go home." The mother laughed.

"I can't believe you didn't get that one, Mom!"

"Well—you know what I never thought of..."



A Mathematics Program for Parents and Children

These parents and children are participating in an extracurricular mathematics program developed in conjunction with a local school board. The program was set up in response to a need expressed by some parents to supplement their children's experiences with mathematics. The program is designed to encourage and challenge students, aged 8–14, and their parents to engage in mathematical thinking and problem solving and at the same time to educate parents to help their children with school mathematics.

The program consists of ten 1.5-hour sessions. Each session begins with a short opener, such as a number game, a game of strategy or a puzzle, that takes the first 10--15 minutes (Appendix 1). For the rest of the evening, parents and children work together in response to a variable-entry prompt (Appendix 2). This part of the session might be thought of as

problem solving, although many participants (adults and children alike) begin to think of themselves as playing with mathematics rather than solving problems. I have come to think of their activity as bringing forth a world of mathematics.

About the Participants

In general, the participants (parents and children) come to the sessions wanting to learn more about doing mathematics. Parents come because they want to be able to better help their children, and the children come so they can do better at their school mathematics. Some children explained it as follows:

- *I want to find shortcuts and hints to make it easier.*
- *I hope I can bring my grades up and my understanding of what the question is asking.*
- *Let me speed up.*
- *Let me understand so that I won't be frustrated. To get out of my special help classes.*
- *To do math with my dad.*
- *Just help me and for me to like math.*
- *I hope it can give me a better view of math and explain problems clearly.*

Not surprisingly, the motivations for the parents are somewhat different than for the children, although it is not difficult to see how they fit with the children's purposes for participating in the mathematics program:

- *I want to learn ways to make math more enjoyable and easier for my daughter to understand.*
- *Help me to help my son and others to enjoy math and see the importance of it.*
- *I want to learn about the math my daughter is learning in junior high school.*
- *Provide me with the tools to help me coach my daughter in math.*
- *Teach me patience in helping my daughter to learn and enjoy math.*
- *I want to spend quality time with my daughter and this seems like a unique opportunity to do this.*

Participation in the program is often flavored by a person's attitudes toward mathematics. More than once, an adult has hesitated to engage in an activity, suggesting that he or she is not good at mathematics or does not like doing mathematics. The parents said:

- *I do not like doing mathematics. I find it difficult. I find it vague.*
- *I like working with figures.*
- *I don't mind math. It affects everyone everyday. Simple math (+, –, ×, ÷) is enjoyable.*
- *I like doing math. Most of it makes sense. For the most part, I understand it.*
- *I like math. It is straightforward. It's logical and it's not ambiguous.*
- *I like the challenge. I like the feeling of "Oh-yea" when you think of something in a new way or gain a fresh insight.*
- *I am very poor at mathematics. It has always been a fear of mine. My mind just doesn't work that quickly—but hey, give me a computer and I'll soar.*
- *I don't particularly like mathematics. There are not enough grey areas.*

The children's comments were not much different:

- *I don't like doing mathematics. It is confusing and hard.*
- *I like it because I like working with numbers.*
- *I like figuring things out.*
- *I don't like doing mathematics. It's hard and boring.*
- *I don't like mathematics because I find it hard to understand basic things. When I move on to harder things that have basic steps in it I find it hard.*

I intended to provide the parents and children experiences with mathematics that were challenging but also fun, interesting and do-able. I hoped this would foster participants' positive attitudes toward mathematics and beliefs in themselves as quite capable of doing mathematics while enhancing their understanding of mathematics.

Facilitating the Program

For the most part, my responsibility was to bring to the group different activities. I tried to vary these activities so that the students worked in different areas of mathematics. I also tried to come up with activities that tied into their school work but that did not look like typical school mathematics. To facilitate diversity among participants (in terms of their ages, background knowledge and experiences in mathematics), I used variable-entry prompts. These prompts open a space for mathematical activity at varying levels of mathematical sophistication and occasion a variety of actions. The prompts are such that the participants do not require specific background knowledge or specific mathematical skills; however, the prompts must be intriguing and they should lead to important mathematical ideas, concepts and processes.

Obviously, my role in the math program was different from my role in my previous teaching experiences. I did almost no explaining. I provided no answers to the problems (although I did offer some of my solutions after we had exhausted participants' solutions). Mostly, I paraphrased or repeated what someone else said. I often found myself wandering around looking over shoulders and just listening.

Although participants looked to me to provide the prompts for the weekly activities, they learned to not depend on me to tell them what to do and how to do it. In most cases, both child and parent focused on doing the activity together (and sometimes apart) and, in doing so, learned new mathematics. I did have to provide more guidance to some participants than others. For some pairs, I had to come up with many small tasks within the general prompt.

I did consider it my responsibility to teach parents how they could interact with their children in the context of mathematics. For the most part this meant modeling the kinds of questions parents might ask their children when doing mathematics. I used such questions as "How did you do that?", "Why did you do that?" and "Could you explain that to me?" It took a few classes to convince most parents that they did not need to tell their children "the answer" but rather that they needed to pay attention to their children's thinking. When it came to mathematics the parents had not done or prompts they had never worked on (almost always the case), I suggested that one of the best strategies is simply for the parent to do the mathematics with the child. Finally, I tried to recommend books (Appendix 3) and activities that would be interesting to do at home.

Parents and Children Doing Mathematics Together

Young learners in classrooms often do much of their mathematical thinking independently of one another and usually have little interaction with an adult who is a fellow learner. In the parent-child program, each child learns alongside an adult learner. When observing the mathematical activity of parents and children working together, I am struck by how the mathematical understanding of both adult and child are enhanced through such interaction.

Let's go back to the two parent-child pairs introduced at the beginning of the article. This vignette is taken from a night when participants worked with the prompt in Figure 3.

Dave and Krista, the father/daughter pair in the first vignette, worked together. Krista arranged the dominoes and called out the tilings to her dad who kept records of the tilings in a table (Figure 4). Together, Dave and Krista examined the number pattern that was being generated and then determined a rule to satisfy the growth pattern they observed. They found that they could determine the number of tilings given a particular number of tiles in a set if they knew the number of tilings for the previous two sets of tiles. It is important to note here that both the parent and the child were involved in looking for a solution to this problem. The father did not know what the sequence would turn out to be in advance. And it is not clear who actually saw the recursive relationship first—Dave or Krista. What is clear is that both Dave and Krista engaged in mathematical thinking and, through their interaction with each other and by manipulating tiles and reflecting on the records they kept, both came to better understand the sequence they created through their mathematical activity.

Figure 3: Tiling Prompt

How many paths can you tile with a given number of dominoes (2×1 tiles) if the path must be two units wide?

1 tile 1 2 tiles 2 ways 3 tiles 3 ways

In contrast, Robin and Casey, the mother/daughter pair from the second vignette, were so interested in the geometry of the tilings that they did not bother to look for the relationship between the number of tiles and the number of tilings that could be generated by the set. Instead, they played with the tiles and the images of the tilings as geometrical objects. Their interaction focused on the placement of the dominoes, the symmetries they noticed and the use of mirror images to generate new tilings. Their records captured the tilings not as abstractions noted with hatch marks in a table but as full-page drawings of the domino patterns themselves (Figure 5). For Robin (the mother), the prompt for mathematical actions was shaped by her ability to draw and her interest in shape and orientation of shape in relation to space. Casey, too, was taken by the arrangements the tiles made and was quite interested in knowing if she had found *all* the possible arrangements. When Robin and Casey checked to see if they had all the tilings, it was the geometry of the patterns that provided them with a means of checking their records.

The variable-entry nature of the prompt left room for Robin and Casey to interact with each other and with mathematics in ways quite different from how Dave and Krista interacted. Although the mathematics Robin and Casey did was not the same as Dave and Krista's, in both cases the parent and child interacted in the context of mathematics and, by doing so, enhanced their personal and shared understanding of mathematics. Dave and Krista's understandings of sequences grew based on their work with number patterns. Robin and Casey's understanding of geometry grew based on their work with symmetry, flips and rotations.

Figure 4: Dave and Krista's Table

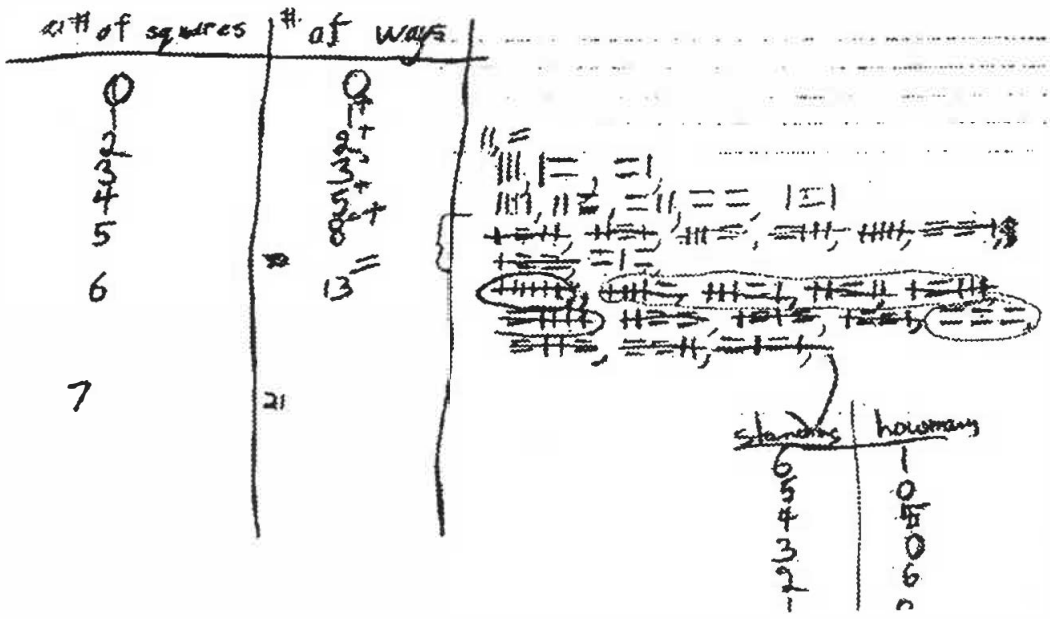
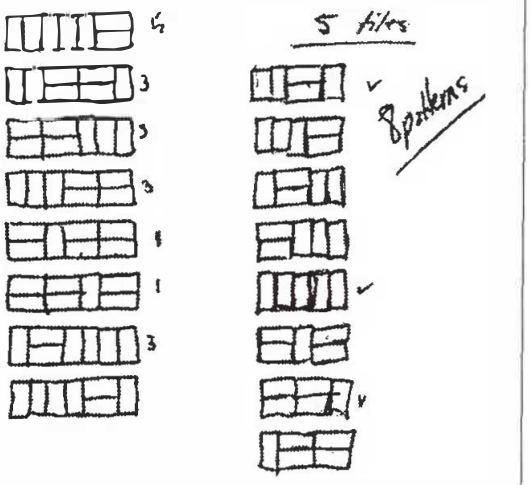


Figure 5: Casey (left) and Robin's (right) Pictures



Involving Parents

At a time when teachers and parents alike are looking for ways to enhance children's mathematical understanding, there is a need to consider alternative roles for parents to play in their children's mathematics education. Traditionally, parents have helped children with their homework. But perhaps what is needed is some work for parents and children to do together at home. Mathematics educators need to encourage parents to do mathematics with their children—to engage in purposeful, meaningful and significant mathematical activity. There is a need for programs and materials that might facilitate such activity. However, it is important that these programs and materials include the parents not as proctors or tutors but as fellow learners; that is, a person whose thinking stimulates the child's and whose thinking in turn is stimulated by the child. The extracurricular mathematics program for parents and children discussed here is one possibility for facilitating such interaction between parents and children.

Appendix 1
Warm-Up Activities

Guess My Number

The parent and child take turns trying to guess the other's secret number which is between 1 and 20 (for example).

Xs and Os

Parent and child play a game of Xs and Os on a 3 × 3 grid.

Mathematics in the Room

Have parents and children look around the room and identify mathematical "things" they can see, hear and touch.

Doubling

Ask parents and children to decide which method, A or B, they would prefer to calculate the weekly allowance: Method A: \$1/day, Method B: 1¢ on the first day and double the amount of the previous day every day thereafter.

Guess My Rule

The leader begins the session by putting on the board a set of numbers that share a common property or are generated by the same rule and then has the parents and children work on guessing the property or rule. Then the parents and children make rules for each other to guess.

Appendix 2

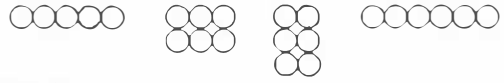
A Sample of the Variable-Entry Prompts Used in this Program

Handshake Problem

How many handshakes would there be if all of us in this room shook hands with each of the other people just once. If there were 20 of us, how many handshakes would there be?

Rectangular Numbers

Using bingo chips, find the numbers that form rectangles. For example, five chips can form only a 1×5 line, whereas six chips can be arranged in a 2×3 or 3×2 rectangle, as well as the 1×6 line. We will call those numbers of chips for which we can form a rectangle—other than the $1 \times n$ case—rectangular numbers.



Pentominoes

Using graph paper, you are to make as many shapes as you can using five squares. The squares must be touching another square on at least one edge.

This is an example.

This is not an example.

Common Letters

What do you think is the most common letter used in the English language? Using a book, newspaper or magazine, try to determine the most common letters.

Halloween Statistics

Without showing each other your candy bag, find a way to show the rest of us how much candy you collected on Halloween and the various kinds of candy you collected.

Mobius Bands

Take a strip of adding machine paper and tape the ends together. Now trace the path an ant would take walking along that tape. How many sides does the band have? Cut the band along the ant's path. How many bands do you have now? Now do the same things but put a twist in the band before you tape it together and then trace and cut the ant's path. Can you predict what will happen. What if the number of twists changes?

Square Takeaway

Cut a rectangle (not a square) from a sheet of graph paper. What is the largest square that can be cut from your rectangle? How many squares can you cut from the leftover piece of paper before you are left with a square? Try this for a number of different rectangles. What do you notice?

Diagonals

Mark off a rectangle on a piece of graph paper. Draw in one of the diagonals. How many squares does the diagonal pass through? Do this for different rectangles. What do you notice?

Appendix 3

Resources for Facilitating Parent-Child Mathematical Activity

I have found the following resources suitable for parents and children. Although not all the prompts, questions, problems and concepts are what I would consider to be variable-entry, these books are quite accessible to parents and children (especially if considered by a parent and child acting together).

- *Thinking Mathematically* by J. Mason, L. Burton and K. Stacey. London: Addison-Wesley, 1982.
- *Mathematical Investigations in Your Classrooms: A Pack for Teachers* by S. Pirie. Basingstoke, U.K.: Macmillan, 1987.
- *The Joy of Mathematics: Discovering Mathematics All Around You* (1989) and *More Joy of Mathematics: Exploring Mathematics All Around You* (1991) by T. Pappas. San Carlos, Calif.: World Wide Publishing/Tetra, 1989, 1991.
- *Math for Smarty Pants* (and other titles) by M. Burns. Boston: Little, Brown, 1982.
- *Family Math* by J. K. Stenmark, V. Thompson and R. Cossey. Berkeley, Calif.: University of California, Lawrence Hall of Science, 1986.
- *Exploratory Problems in Mathematics* by F. W. Stevenson. Reston, Va.: National Council of Teachers of Mathematics, 1991. (Look for other resources by the NCTM.)
- *Puzzles, Mazes and Numbers* by C. Snape and H. Scott. Cambridge: Cambridge University Press, 1995.