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Adults Learning Mathematics – an International Journal

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Adults Learning Mathematics – An International Journal

Guest editor
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Special Issue

Parents' involvement in mathematics education: looking for connections between family and school

In this Volume 3(2b)

Introduction to the second volume for the special issue Parents' involvement in mathematics education: looking for connections between family and school

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When working with parents, it sometimes comes to my mind the image about a father teaching mathematics to his daughter, using strategies grounded on his own memories, while the little girl solves the problem by herself in a very different way, and not paying attention to what her father is doing in front of her. We know that some parents usually help their children in doing their homework when they get home after the school time. Researchers proclaim that these children are more likely to have better school performance than those other children who do not have the opportunity to find help or support at their home environment. However, to help children with their homework in mathematics may be a hard work for some parents, for a number of factors that include parents' prior experiences with mathematics, parents' feelings about this topic, language issues, parents' self-confidence in doing mathematics, parents' identities as mathematical doers, and so forth.

Most of the times when parents are asked to help their children solving mathematics problems; they just go through their memories in order to remember how to solve any given particular exercise. Then they discover that something is different between their methods of solving problems and what their children say or what they have written in their notebooks. They even find that somehow those do not match and, even worse, those do not make any sense to them (to the parents). Researchers claim that more research is needed to connect school with home in order to look for ways to solve these conflicts.

The second volume of this special issue on parents' involvement in mathematics education addresses some of these topics through three different studies. Bartlo and Sitomer present an interesting exploratory case study where two individuals (Michelle and Jorge) were interviewed on their interactions with their children solving homework in mathematics. Their two research questions are very relevant to understanding the "big picture" underlying parents' interactions with their children when doing mathematics. They draw on parents' and adult learning literature to talk about the role of the context and the transfer knowledge problem (Evans, 2000), as well as about the resistance that some parents experience towards mathematics. They found that prior experience with school mathematics has a great impact on parents' interactions with their children, and even with mathematics itself. In addition, context as well as their experience with informal mathematics also impacts on parents' practices towards mathematics. Parents draw on their own school experience. However, Bartlo and Sitomer found that there is also the potential to draw from out-of-school practices to make sense of the type of mathematics done by the children. This leads to the transfer knowledge problem documented by Evans and Wedege (2006). Bartlo and Sitomer found that parents feel more empowered when they are able to bridge the school context with what they know from either their informal practices or their prior experiences. Consequently they conclude that parents should transform their perception on children's mathematics homework including the experiences from other (out-of-school) contexts.

Berry III addresses the role of parental involvement from a critical race point of view. His research question (How do parents of African-American middle school boys who have been successful with school mathematics conceptualize their roles in their sons' mathematical experiences?) introduces a critical point of view in the analysis of parental involvement in this second volume. Berry III draws on phenomenological and Critical Research Theory (CRT) to discuss how race could be a relevant factor in terms of parental participation. His findings include parents as guardians of opportunities, parents as standard setters, parents as resources for mathematical knowledge and parents as models for success. Berry III discusses the fact that African-American children are usually confronted with low expectations. He presents interviews with African-American parents who are really critical with this idea, and concludes with an appeal to include African-American parents' voices and African-American cultural identity in teachers' work. He states that perhaps a more critical lens from parents would be a way to overcome inequalities in teaching and learning mathematics.

The third contribution in this volume is authored by Kosheleva, Lesser, Munter and Trillo. This article is the presentation of a successful experience, Parent Power Nights, held in Texas. This experience was inspired by Family Math Nights, which involves parents as leaders in the classroom. The authors report how parents and children worked together, in small groups, and how this approach led parents (as well as teachers) to promote students' achievement in mathematics. They found that family collaborations motivated parents' further engagement and learning, which is a consistent finding with other studies (Civil & Quintos, 2007).

These three articles address some of the main features present in the current literature on parental involvement. Issues such as the impact of parents' prior experiences (and memories) in their children' homework, inequalities in learning and teaching mathematics, the influence of cultural identities (related to the idea of funds of knowledge), are very well known topics by all of us who are working with families doing mathematics. These articles represent a fresh contribution to the field and add new evidence that confirms the importance of parental involvement, in terms of children' performance in mathematics, as well as to open new questions for further research.

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Exploring parents' experiences with standards-based mathematics curricula

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Abstract

Parents may have difficulties relating to mathematics curricula that focus on conceptual rather than procedural understanding (Remillard & Jackson, 2006) because such curricula engage students in activities that are different from those that students experienced in previous generations. We report on a case study that explored how parents make sense of conceptual-based curricula by engaging two parents with tasks from their children's curriculum. Our report details both the tasks with which we engaged the parents and their ways of thinking about mathematics that emerged as they interacted with those tasks. Our findings suggest that in some cases parents' previous experiences with their school mathematics interfered with their ability to make sense of the tasks in a manner consistent with the curriculum authors' intent. However, we also found that their previous experiences with informal mathematics could be leveraged to support their endeavour to make sense of tasks from a standards-based curriculum in a manner consistent with that intended by the curriculum authors. Nevertheless, we also believe that the school-based tasks used in the study encouraged parents to interpret their children's curricular materials in terms of their own experiences with school mathematics rather than in terms of their informal knowledge. This study contributes to researchers' understanding of the complex process of sense making that is necessary for parents (and adults in general) to relate to standards-based mathematics curricula, and it raises questions about how parents might be supported in that process.

Key words: Parental involvement; informal mathematics; standards-based curricula; mathematics reform

Introduction

Recent reform documents, such as those published in the United States by the National Council of Teachers of Mathematics (National Council of Teachers of Mathematics, 1989, 2000) have called for a shift from a focus primarily on procedural knowledge of mathematics to one that includes conceptual understanding. This has prompted the development of new curricula (e.g. Lappan, Fey, Fitzgerald, Friel, & Phillips, 1996; TERC, 1998; University of Chicago School Mathematics Project, 2001). These curricula often engage students in instructional activities that are different from those their parents experienced, thereby raising questions about parents' ability to make sense of them in the manner intended.

Romberg (1996), reflecting on mathematics curricula in the United States, notes that "The acquisition of information and the ability to demonstrate proficiency at a few skills have become ends in themselves, and students spend their time absorbing what others have done" (p. 763). For instance, thirty years ago students might have been given a sheet of 50 multiplication problems to solve. Curriculum authors justified this by observing that students need to know basic facts "that is, commit them to memory to the point of instant recall" (Shoecraft & Clukey, 1981, p. ix). To the contrary, in standards-based curricula[1] "how well children come to understand mathematical ideas is far more important than how many skills they acquire" (National Council of Teachers of Mathematics, 1989, p. 16). Students are encouraged to generate their own strategies for performing arithmetic computations based on their understanding of numbers and how numbers are composed and decomposed (Mokros, 2003). This is in stark contrast to the mathematics instruction experienced by many parents, instruction based on beliefs such as "finding $7+8$ by counting on fingers or 5×6 by adding five sixes, although not horrible sins, are inadvisable" (Shoecraft & Clukey, 1981, p. ix).

Since the mathematics curricula parents experienced and those their children experience have different emphases, parents often experience difficulty making sense of their children's schoolwork and sometimes feel powerless to help their children with it (Remillard & Jackson, 2006). Since the context of school mathematics extends beyond the classroom and includes interactions with parents, guardians, and caretakers[2] at home, if standards-based curricula are to be effective, parents need to relate to and understand the intention of such curricula. This suggests that supports need to be created for and offered to parents so they can be constructively involved in their children's education. However, before helpful support for parents can be designed, the community needs to learn more about how parents presently experience standards-based curricula and what supports are most helpful to them.

In order to contribute to this understanding, we report on a study that explored ways in which parents interpret their children's school mathematics by considering two questions: (i) what experience do parents have with their children's school mathematics? and (ii) what sense do parents make of that mathematics? In particular, we will describe two different parents' experiences as they interact with their children's school curriculum.

In interpreting their children's curriculum, these parents drew both on their own school mathematics and on their informal mathematics. By *school mathematics* we mean the strategies they learned in school to solve mathematical problems, and by *informal mathematics* we mean strategies developed independent of classroom instruction. It is likely that the strategies the parents learned in school differ from those their children are learning in school. Consequently, the parents' school mathematics probably differs from that of their children. Informal mathematics includes strategies that are developed outside the context of school, as well as those that are developed in the school context but may not be considered appropriate strategies by the classroom teacher. Since a wider variety of strategies are accepted in schools today, it is possible that children's school mathematics might include strategies their parents consider to be informal.

The parents in our study initially experienced difficulty uncovering the nuances of the instructional activities largely because the intention of the tasks was different from that of the tasks with which they were familiar. Problems also arose for parents because they tended to use their knowledge of school mathematics rather than their informal knowledge of mathematics to

[1] Standards-based curricula refers to curricula created based on the NCTM (1989, 2000) standards documents. .

[2] In the remainder of this paper we will use the word *parents* to describe all of these groups. .

make sense of their children's tasks. This likely happened because the problems they were considering were from a school context, that is, the context of their children's schooling. Ultimately, however, the parents were able to use their previous experiences from outside of the mathematics classroom to help them make sense of the activities with which their children engage in school.

In this paper, we first describe the study itself, including how the interview tasks were designed to uncover the parents' ideas about the tasks in their children's mathematics curriculum and to help the parents make sense of these types of tasks. We then describe the parents' experiences interacting with their children's mathematics curriculum during the interviews. Next, we explicitly discuss how previous experience and context played a role in the parents' sense making. Finally, we elaborate some implications of this research; namely, the ways in which engaging with their children's mathematics might empower parents with respect to their children's education and enable them to be more involved with the reform process.

Background

The impetus for this study and the subsequent analysis of the data were informed by two major areas of inquiry: research on parental involvement and research on adult learning. There are various perspectives on parental involvement and what precisely is meant by this term (e.g. Lawson, 2003). Although the literature features a fair amount of discussion on the myriad of views, we will focus in particular on the research relating to parents experiences with standards-based curricula and parents as learners of mathematics. Similarly, there is a vast amount of research on adult learning, but we will focus on research related to the role of informal knowledge in learning mathematics, and issues related to context and transfer of that knowledge.

Research on parental involvement

Research has found that parents have difficulty understanding tasks from standards-based curricula (Remillard & Jackson, 2006). A similar finding is reported in Peressini (1996; 1998) who describes parents as unequal participants in the discourse on reform in mathematics education. The ways in which mathematical knowledge influences parents' participation in their children's education has been examined as well (Civil, 2001a, 2001b; Civil, Guevara, & Allexsaht-Snider, 2002; Peressini, 1998). For example, Peressini (1996) reports that, "Parents also voice apprehension regarding their inability to assist their children with these home activities" (p. 14). On the other hand, Martin (2006), who interviewed parents about their own and their children's experiences with school mathematics, uncovered that their "(re)investment in mathematics learning and (re)assuming the role as a mathematics learner can serve as the basis for meaningful parent agency and advocacy in mathematics education" (p. 202).

Civil and her colleagues have designed courses and workshops to engage parents with mathematics and have documented the impact of these courses on participants in terms of their role as parents. For example, Civil, Guevara, and Allexsaht-Snider (2002) reported that parents appeared empowered by the mathematical understanding they constructed in these workshops. Also, parents who participated in these programs came to value meaning-making and sense-making in mathematics (Civil, 2001b; Civil et al., 2002).

We attempt to add to this literature by exploring ways in which parents experience their children's curriculum, how their previous experiences with mathematics impacts this experience, and how parents can be supported in their endeavour to learn from their children's curriculum. This study aims to extend the existing research that shows parents have a difficult time making sense of their children's curricula by taking a close look at the sense that parents *do* make of their children's mathematics. This study also builds on the research that shows that mathematical knowledge affects how parents participate in their children's mathematics education by helping parents deepen their own mathematical knowledge in a way that will help them make sense of their children's mathematics. A meaningful interaction with tasks from their children's curriculum may help parents better understand the intention of the curriculum and, in turn, be better equipped to participate in their children's schooling.

Research on adult learning

Another body of research examines the role of informal knowledge in learning mathematics. Informal knowledge has several related characterizations, but in most characterizations it is described in opposition to knowledge acquired in formal or academic settings (e.g. Torff & Sternberg, 1998).

The role of context

Several researchers have examined the ways in which adults use informal mathematical knowledge in out-of-school contexts and how this knowledge transfers to a school context (e.g. Carraher & Schliemann, 2002; Schliemann & Acioly, 1989). For example, Schliemann and Acioly (1989) observed that bookies have well developed mental arithmetic skills and consistently performed computations with accuracy at work. The bookies used mental computational strategies and informal reasoning more frequently than procedures like those learned at school. Yet in the second phase of the study, the bookies were given problems that were slightly different than the problems they encounter at work. In one set of problems, the tasks were similar in structure but the numbers were not multiples of 5 and 10 (which was frequently the case in their work) and in these problems the bookies tended to use written algorithms. On the other hand, bookies were able to use informal strategies to find answers to problems that involved division, an operation for which many of the bookies had no procedural strategies. The context of the problem – either in terms of the familiarity of the numbers or in terms of the familiarity with the structure – determined whether the bookies relied on their informal knowledge or procedural knowledge of mathematics learned in school.

Transfer

In a study of apprentice ironworkers' mathematical problem solving strategies, Martin, LaCroix, and Fownes (2006) consider an alternative to the problem of the transfer of knowledge. In keeping with Benn (1997) and Evans (2000), the problem of transfer is reconceived as *translation across discourses*, where a discourse is understood as "a loose-knit collection of concepts, terms, assumptions, explanatory principles, rules of argument and background knowledge which are shared amongst the members of that discourse community" (Benn, 1997, p. 96). Adults returning to school find the discourse of school mathematics unfamiliar, and they do not see the similarities between school mathematical knowledge and their own mathematical knowledge constructed in out-of-school contexts. Evans understands knowledge as being socially constructed within communities of practice and he believes that context is important for knowledge construction. Yet he argues that transfer across contexts *is* possible and that transfer can be facilitated by analyzing both the similarities and differences across contexts.

Resistance

Another obstacle impeding the transfer of adults' informal knowledge to the context of school mathematics is resistance. Wedege and Evans (2006) observe that although adults develop mathematical competence through everyday activities, "their beliefs about mathematics are primarily related to their school experiences, and mathematics is experienced by many adults as something that others can do, but that they themselves cannot do" (p. 28). One of the resistances to learning mathematics described by Wedege and Evans is illustrated by the phrase

"Mathematics – that's what I cannot do." Wedege and Evan observe that adults often do not recognize their own knowledge as mathematical: "once people have succeeded in applying a piece of mathematics, it becomes *non-mathematics* or *common sense*...mathematics is always what they cannot do" (p. 34). Not recognizing the validity of their own informal mathematical knowledge is an issue for many adults. In the context of exploring parents' understanding of tasks from their children's mathematics curriculum, this resistance is used as an analytical lens for viewing how parents draw upon their formal and informal mathematical knowledge when working with their children on mathematical tasks.

Finally, Wedege (1999) highlights the complexity of studying adult learning within the context of mathematics education. Adults bring a variety of experiences to a mathematical task. Wedege notes that "The situation of learning mathematics depends on the experience of the individual adult with mathematics in school and everyday practice and their individual perspectives on learning. Emotional factors are just as important as cognitive ones" (p. 206). Adults who engage in mathematical tasks with their children also bring a variety of beliefs to the tasks; including their beliefs about mathematics, their beliefs about themselves as learners of mathematics, and their beliefs about their role as parents.

We draw on this body of research by considering the ways in which parents' informal knowledge contributes or hinders their learning from their children's curricula. In particular, we look at how parents draw on both their informal knowledge and their knowledge of school mathematics in their sense making. We consider the role of context, transfer, and beliefs in this process as well. In this way, we combine research on adult learning with research on parental involvement as a way to understand parents' experiences with their children's curricula and as a way to help empower parents with respect to their children's mathematics education.

The Study

In order to provide insight into the ways parents make sense of and learn from the standards-based curricula their children use, we describe a case study involving interviews with two parents. Our study was exploratory in that the goal was to understand better parents' experiences and to use this information to inform future studies. In what follows we describe the parents who participated in the study as well as the interviews themselves.

The participants

Two parents, Jorge and Michelle[3], volunteered to participate in the study. Both parents have children in a dual-language (English and Spanish), urban elementary school. Jorge has three sons in the school. At the time of the study, his sons were in first, third, and fifth grade. Michelle had a son in first grade and a three-year old daughter. Both parents were interviewed separately while they tried to make sense of tasks based on components from their children's curriculum. We developed these tasks from games, homework assignments, and parent resources included with the curriculum used at their children's school.

Although the parents interviewed have children in the same school, they are quite different in other ways. Jorge works long hours in a warehouse, often working overtime. He tries to help his children with homework whenever he can, but his schedule makes that difficult. Jorge is bilingual, but he has only studied mathematics in English. His sons occasionally bring home mathematics problems written in Spanish, and Jorge finds this an additional challenge. Michelle is a stay-at-home mother who spends a large part of her days with her children and regularly helps her son with his homework.

[3] Pseudonyms are used for the parents' names.

Both parents believe it is important for their children to be successful in mathematics, but both are insecure in their abilities to help their children. Jorge is confident in his ability to do computations but not in his ability to solve other mathematical problems; he does, however, recognize that he uses mathematics at work. He also perceives his sons' school mathematics as more advanced than what he studied in school. Michelle did not express confidence in her mathematical ability in any way.

The parents were interviewed separately so the researchers could closely monitor and probe how the parents experienced the curricular materials. The interviews were divided into two parts, each of which was related to a particular theme. The first part of the interview highlighted the use of games for learning mathematics (in particular about how numbers can be broken apart and recombined); the second part of the interview focused on the teaching and learning of multiplication. Jorge participated in the two parts of the interview on separate occasions, while Michelle participated in both parts during one longer interview. All interviews were videotaped, and all written work was collected.

The interviews

There were several goals for the interview. One goal was to see how parents responded to their children's assignments on their own with no intervention, just as they presumably would if their children brought the task home to complete. Another goal was to explore how we could support parents' sense making with respect to the mathematical materials their children use in school. These interviews were constructed around tasks from the curriculum used in their children's school, *Investigations in Number, Data and Space* (TERC, 1998). At the end of each of the two sets of interview questions described above, we gave the parents a copy of a letter that targeted one of the tasks used in that interview. Each unit of the curriculum contains a letter to be sent home to parents that elaborates the mathematics explored in that unit. These letters are from the teacher materials that accompany the curriculum.

The data that we report on in this paper are drawn from the second set of interview questions. These interview questions were based on *multiplication cluster* tasks from both the third- and fourth-grade materials. Multiplication cluster tasks suggest strategies for finding products using the distributive property of multiplication over addition. In what follows we discuss only the interview tasks that are relevant to the data we discussed in this paper.

Multiplication clusters

We began the second phase of the interview by showing each parent the problem displayed in Figure 1, which was taken directly from the books used at their children's school:

You can work on these problems in any order.
You can also use graph paper to make arrays to help you solve these problems.

4×5
4×10
5×4
4×15

Figure 1. Sample task from children's curriculum

We asked the parents if they had ever seen problems like this before. We did this to learn what initial notions parents had about problems of this type and whether it was the first time they had ever seen such a problem.

We then asked the parents the following questions: (i) what, if any, relationship they saw between the problems in the cluster, (ii) if they could think of why this type of problem was called a multiplication cluster, (iii) how their children might use graph paper to solve the problem, and (iv) how the first three products on the page could be used to find the fourth product? These questions were designed to learn what sense parents made of problems such as these, and how they would attempt this particular problem if their children came home with it.

Next, we moved on to multiplication clusters involving the product of two two-digit numbers, which is how multiplication clusters appear in the fourth grade materials. The first cluster presented to the parents involved the product of *36* and *20*, the second the product of *26* and *30*, and the third the product of *34* and *45*. We anticipated that the parents would find the last of these problems difficult since neither of the factors is a multiple of 10. So, as a follow up, we presented the following scenario to each parent:

> Suppose you look through your child's math folder and find some figures your child had drawn in class for 26×34. What are these figures illustrating? How could you use a similar figure to help your child with the product of *34* and *45*?

Figure 2 represents one of the drawings we showed them. Our aim was to explore how the parents made sense of their children's work and how they might go about applying the strategy used in their children's schoolwork to a new problem.

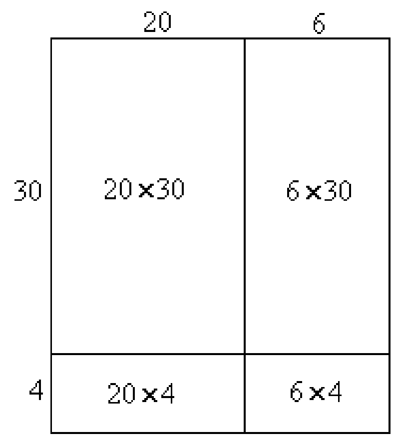

Figure 2. Model for multiplication allegedly discovered by the parent in the child's math folder.

The standard algorithm

The final task of the interviews involved the standard computational algorithm used in the United States for multiplication. We showed the parents two multiplication problems computed using this algorithm. However, each of the problems contained errors that are commonly made when the algorithm is used. These problems are shown in Figure 3 below:

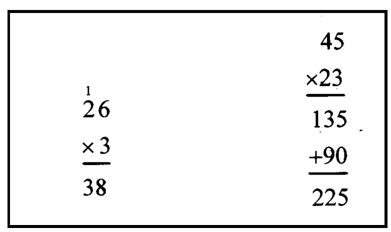

Figure 3. Typical errors

The parents were asked to find the errors in the problems and to explain to us why they thought a child might have made those errors. Our aim was to explore parents' ideas about the standard algorithm. Another purpose for this question was to see how, in light of their experiences during the interview (in particular with multiplication cluster problems), parents might help their children, and specifically, how they might do so when standard procedures are involved. Consequently, we also asked the parents what they would say or do to help their child understand each of the problems shown above. In the end, we asked them why, in general, they thought people made errors like the ones shown above. We asked this to learn about the parents' beliefs about learning mathematics, as well as to explore how those ideas might have changed over the course of the interviews. Part of our goal here was to uncover what (if anything) these parents found problematic about teaching students algorithms without understanding the mathematical concepts behind them.

Data reduction and analysis

The analysis proceeded in phases that were consistent with grounded theory (Strauss & Corbin, 1998). Once the interviews were transcribed they were viewed by each of the authors without interruption in order to capture a global view of the interviews. In this phase, each of the authors worked independently, looking for themes emerging within and between the interviews, constantly comparing the themes to the data to test them for viability, and revising them based on that comparison.

In the second phase of analysis the authors compared the themes each generated during their independent analyses, looking for commonalities between the stories that emerged for each researcher. There was significant commonality between the themes identified by each researcher. The most salient themes for each related to the parents' use of formal and informal mathematical knowledge during the interviews and the tensions between the two forms of knowledge. Both researchers were also struck by the role of the parents' beliefs relating to mathematics, including phobia and self-doubt.

In what follows we discuss these themes in more detail. Since the goal of this research was to explore how parents make sense of their children's curricula, we first focused on each parent individually and then looked for commonalities and differences between the two. Accordingly, our analysis led us to compare instances throughout the interviews where each parents' sense making could be identified, and to compare the ways in which the parents made sense of the tasks. In the next section we discuss the stories that emerged from this research as a result of this multi-staged analysis.

Findings

The main goal of the study is to explore how parents experience and make sense of their children's curricula. Our analysis of the interviews revealed that parents' previous experiences with mathematics played a large role in that process. Therefore, we begin by describing the two parents' experiences making sense of their children's mathematics in terms of their previous experiences with formal and informal mathematics. The parents drew on two sources of mathematical knowledge when they engaged with their children's mathematics: the first source is their own experiences with school mathematics (formal mathematics) and the second is an informal or everyday knowledge of mathematics that has developed within their out-of-school activities such as work, managing a household, and parenting. Additionally, we hypothesize that context influences which source of knowledge a parent draws upon in a given circumstance. Examples of each of these ideas follow.

Prior experience with school mathematics

Michelle

Michelle's previous experiences with school mathematics affected how she engaged with the tasks. These experiences included both the emotions she experienced around her own school mathematics and the solution strategies she used in her schooling. For instance, her feelings about mathematics framed how she viewed her children's mathematics education. She mentioned several times during the interview that her experience with mathematics in school was not positive, and she expressed a genuine desire to nurture a more positive experience for her son.

> M: I don't want my son to be afraid of math. You know… 'Cause I know that I was intimidated. I don't want him to be afraid of it. It needs to be something that's fun and challenging.

The first thing Michelle told us in her interview was how confusing she remembered school mathematics to be. At the beginning of the interview, she frequently began tasks by saying "I don't know," even though she often proceeded to reason successfully through the problem. She brought fear of mathematics and doubt about her mathematical ability to the interview with her.

In addition to viewing the new mathematical tasks through a perspective of insecurity and doubt rooted in her own school mathematics experiences, she brought other notions from those experiences to the interview tasks as well. Michelle also drew on mathematical strategies that she learned in school. For instance, this arose with the multiplication cluster problems. In multiplication cluster problems students are presented with four products to compute (for example, refer to Figure 1). The first three products can be used to compute the fourth because they suggest ways of breaking up the factors in the final product. To use these partial products to compute the fourth product, students implicitly rely on the distributive property of multiplication over addition. Although these problems are referred to as cluster problems in various places in the curriculum, the tasks themselves contain no reference to that language. Therefore, when multiplication cluster problems are taken home there is nothing to suggest the products are related except that they are presented together in one problem.

When we showed Michelle a multiplication cluster problem, she said she had seen problems like them before. However, since Michelle's son was in first grade at the time of the interview and multiplication cluster problems do not arise until later, it is unlikely she had actually seen multiplication clusters before. It is likely she felt she had seen similar problems before because she had seen multiplication problems and assumed this activity was no different than a worksheet of multiplication problems like those she had completed in school. Since this was her own experience with multiplication problems, there would be no reason for her to think multiplication cluster problems were any different than the problems she had seen in her own schooling. Consequently it is not surprising that Michelle interpreted the question differently than was intended by the curriculum authors.

The directions for the multiplication cluster problem mentioned using graph paper, so when Michelle explained that she had seen problems like the multiplication clusters before she added the caveat

> M: not with the graph, not associated with a graph. I don't recall that. And I don't really recall how they broke it down to show us. I think it was probably, you know, five times four would be the, you know, four groups five times, is what I am guessing.

An interesting feature about this comment is that Michelle assumed the graph paper was for making a graph[4]. Since creating graphs was likely the only activity for which Michelle had used graph paper, it makes sense that she would assume this was the intention. However, Michelle did reflect on her own school experience and described an array model of multiplication, even if it did not immediately occur to her that graph paper could be used for that purpose. Therefore, although she had ideas that were consistent with the ones her son might use, she did not realize it because she interpreted the introduction of graph paper to mean that the students should draw a graph. In these ways, her previous experiences with school mathematics both helped her address the task in the manner intended and interfered with her ability to reason through her son's school mathematics. Thus, even when she recognized that the tasks from the curriculum used in her son's school represent a different way of looking at mathematics, her natural recourse was to view the task through the lens of her own school mathematics, an instinct that both helped and hindered her sense-making process.

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[4] This problem was taken directly from the curriculum used at the school Michelle and Jorge's children attended. The directions for this problem specified *graph* paper rather than *grid* paper, which might be problematic for parents attempting to interpret the intent of the task.

Jorge

Jorge also used his experiences of school mathematics to frame his interactions with his sons' school mathematics. He described this in recounting a recent experience he had working on homework with one of his sons:

> J: But I have… I do homework with the boys when I have a chance, like last night. I was doing work with [Vincent], one of my boys, and he's doing multiplication.
> I: Cool.
> J: And… his homework comes one way, but I was showing him different ways, with flash cards, and that route, because he's good at memory, and knowing his times table is important to do his homework.

Similarly, when Jorge was presented with a problem suggesting "use graph paper to make arrays to help you solve these problems," he explained that the graph paper could be used to "make a multiplication chart."

Additionally, like Michelle, Jorge said he had seen multiplication cluster problems before. However, when we asked what relationship he saw between the problems in the cluster he explained that "they are all multiplication." This, once again, raised the question of whether Jorge had in fact seen cluster problems before, or if he assumed all activities involving multiplication were the same.

We then told Jorge that the goal of multiplication clusters was to find the last product, 4×15 in the case of our problem, and we asked if he could use other products in the cluster to find this product. The solution he described involved starting with the product 4×10, which was one of the products listed in the cluster. Next he used the standard algorithm from his schooling to find the product 4×15 and used that answer to figure out what he needed to add to 4×10 in order to find 4×15. In doing this, he had to add 20 to 40, but he did not, on his own, see the connection between the 20 he added and the 4×5 in the multiplication cluster. Below is the conversation that occurred around this task:

> J: Yeah, but it wouldn't relate to this. It's just, four times ten, if you knew what four times ten was, then add the remainder, and that's the answer.
> I: So what would the remainder be?
> J: Wait, I have to do this out first, four times ten is forty, and then there's five more, I'd have to add five to that, we'd do this first, that's sixty, so it would be twenty, if he gets this one right, it would be forty, and add twenty to that.

In sum, although Jorge could reason through this problem in the manner intended, it was not his primary method of solving the problem. Instead, he drew on his own knowledge of school mathematics in his initial approaches to problem. Later in the interview, the researcher pointed out to Jorge that he had arrived at the same result by reasoning through the problem as he had employing the algorithm from his schooling. He emphatically pointed to his work using the algorithm and said, "This is the way I know how… I keep referring to that."

In these examples, we observe that Jorge and Michelle often used their experience with school mathematics to make sense of their children's homework problems. At times the perspective of school mathematics made it difficult for them to make sense of the tasks in the intended manner, and yet at other times it helped them figure out a way to answer the questions being asked. Each parent's own experience with school mathematics played a prominent role in the sense-making processes.

Informal mathematics

Michelle

Although the parents looked at their children's school mathematics though the lens of their own school mathematics, they also looked at it from the point of view of their experiences outside of the context of school. For instance, Michelle did this when she explained why it is important to find multiple solution strategies:

> M: It gives them two different angles to look at something. And I think that's really important, because…our brains are formed a certain way, and through our experiences… I think it can be… some of us can be limited. I mean, it's just sometimes a natural thing. But I think that we've got to give them the ability to see problems from different perspectives.

In her own experience, Michelle had found value in the ability to solve problems using multiple strategies. She also stated that this is something students need to learn to do. Although this could be something that is learned in school, in Michelle's experience with school mathematics multiple strategies were not encourage or valued. Therefore, her previous experiences outside of school mathematics helped her appreciate the reason her son's curriculum included activities that support the development of multiple strategies.

Michelle also drew on her experiences with informal mathematics while exploring the multiplication cluster problems. For example, when we asked Michelle to estimate a product, she reasoned though the calculation using partial products, determining the actual product rather than an estimate. We believe this was because, as she often expressed, in her experience standard algorithms were the tools used to determine the precise answers – the type of answers required in school. In school Michelle was not given the opportunity to reason through problems, so from her perspective reasoning was not part of her school mathematics experience. Consequently, she did not feel that reasoning led to precise answers; she considered results found through reasoning to be estimates rather than precise answers.

Jorge

Jorge also drew on informal mathematical knowledge to make sense of the tasks in his children's curriculum. For example, he drew on his informal understanding of area to approach several of the interview tasks. When we presented Jorge with a diagrams of the product of *34* and *26* broken down into partial products (see Figure 2 for an example) and asked what was shown in the pictures, he immediately replied, "it might be a room, and then the dimensions, so 34 and 26 are the length and the other one [the width]." Typically, Jorge's initial responses were tentative; this was the first time he responded to one of our questions with confidence. He also elaborated on this idea:

> J: They have it broken down, it's 26 all the way across, but they have it broken down, 10, 10, and then 6, but here they have all 34, and they broke it into 10 times 34, then on this one, they broke down the 30, then the 4, it's like a closet or something, and then a 20 by 30 room, it's a big space, and then here it's 20, then they've got 6 foot of something else.

He added that 26 times 34 represented "square footage" and then used the diagram to calculate the product by finding the area of each section of the room and adding them together to find the total area. In this case, the mathematics Jorge constructed outside the context of school was immediately available to him in the context of this particular problem. Jorge's informal knowledge of floor plans became a tool he used to make sense of the alternative strategies for multiplication in his son's curriculum. Furthermore, he seemed excited about being able to use his informal mathematical knowledge to solve school mathematics problems.

In sum, as was the case with their knowledge of school mathematics, the parents' familiarity with informal mathematics served as a lens for their sense making. Although this lens was not always readily available to parents in the school context, it helped them make sense of the tasks in the intended manner. It played a large role in the sense the parents made of the tasks.

The role of context

We believe context determines which source of knowledge a parent draws upon. That is, the fact that the interview tasks were situated in the context of their children's schoolwork prompted both parents to draw on strategies from their own experiences with school mathematics. On the other hand, the parents felt more empowered to engage with problems posed in a context that drew on their everyday knowledge of mathematics (area models, money problems), but they did not always make the connections between their children's mathematical tasks and their own informal knowledge. In what follows we present evidence of this claim.

For example, using a floor-plan model empowered Jorge to engage with the multiplication cluster tasks in a way that he did not before this experience. Being presented with drawings that reminded him of floor plans gave him the context to draw on his informal knowledge. This is in contrast to tasks that reminded him more of the problems with which he was familiar from his own schooling.

Despite their sense-making experiences during the interviews, both parents immediately returned to their own school mathematics when a new problem was introduced. Near the end of the interview each parent was asked to interpret typical mistakes made by children when using a standard algorithm for multiplication (Figure 3). Although both Michelle and Jorge had made sense of alternate models for multiplication previously, they did not immediately draw on these experiences when analyzing the children's errors. It appeared that both parents' knowledge of the standard algorithms was procedural. In the course of the interview, Jorge experienced difficulty making connections between his new strategies for multiplication and the standard algorithm, but when prompted Michelle readily made such connections.

When we asked Michelle how she would help her son had he made the errors in our examples, her response was:

> M: Well, if I did it the old-fashioned way… I'd say, "You missed the two." I'd say, whatever his marking might be here, but I'd say, "Okay, so you did that first… you came up with 18, and you carried the one over to this column. I'd break it up in columns so that he would see. [Drawing a line to separate the tens and units place of the given factors in the task] And then I'd say, "You need to have your one there. You need to multiply it by that…" And I'd even probably tell him, "Mark it off with your pencil so that you know what you need to do… so you can see where you have to go. So you see you multiply by this column first and then you come up to that number in the circle and then you add that one."

However, when we asked Michelle if there was anything from our interview she could use, she excitedly pointed to the multiplication cluster problems and the accompanying drawings. Nevertheless, even when she realized that the multiplication cluster problems could help her (and in what ways they could be useful), she made it clear that that would not be her first response. However, after expressing that caveat, she did use reasoning to talk about the algorithm.

> M: Oh! I would use this [pointing to previous task papers]. Yeah… yeah…
> I: Well, how would you use that?
> M: Well…well, my automatic would be this [pointing to the pencil-and-paper strategy]. And then I'd go, "Okay. I got to go back to this thingy." So, I would break it to twenty… And I'd do it into this… [Michelle starts drawing an area model with four parts like those used for the two-digit multiplication, and explains how she would use her model to talk about the product being computed with the algorithm.]

Although Michelle was able to reason through the problems in the interview and constantly commented on how empowered she felt reasoning through mathematical tasks rather than using rote procedures, her initial reaction was to return to the algorithms and familiar strategies from her school mathematics. During the interview she frequently told us she would have immediately gone to the algorithm for most of these tasks had we not been there encouraging her to reason through them. The context of school mathematics constrained her perspective; in her experience, computing products using anything other than standard algorithms was not appropriate for school mathematics.

Jorge was able to make sense of many of the tasks in a way consistent with the curriculum authors' intention, and he was often more successful with the interview tasks when he reasoned through a solution than when he applied algorithms. Nevertheless, he continued to want to use algorithms to solve the tasks we presented him from his sons' curriculum. He explicitly stated this when he said, "this is the way I'm used to it, I keep referring to that." Even though he used other modes of solving problems, drawing on his out-of-school experiences with mathematics, he was not accustomed to reasoning in this way in the context of school mathematics; these methods seemed unfamiliar to him in this context.

For both parents, using their own informal reasoning was more effective than using standard procedures. Michelle was able to reason through multiplication problems and this reasoning helped her make sense of the procedures she previously learned in her own schooling. Jorge frequently made errors using computational procedures, but he obtained accurate results when using informal reasoning. Although informal reasoning was effective for both of the parents, the fact that the problems with which they were engaging were situated in a school context made school mathematics strategies and procedures the first recourse for each of them.

Discussion

Throughout the interviews it was clear that the tasks and activities students engage in with standards-based curricula are quite different from those with which these parents engaged in their own schooling. In this study there was evidence that the parents' first instinct was to interpret their children's mathematics curriculum in terms of their experiences with school mathematics. A parent's first attempt to answer a question often involved using a standard algorithm from his or her own schooling. Although each parent was able to solve the problems using strategies more consistent with the curriculum authors' intention, they rarely drew on such strategies initially. Since the intention and purpose of the problems in standards-based curricula are quite different from those of their more traditional predecessors, interpreting new curricula in terms of old ideas means that the tasks and activities are likely to be interpreted in ways other than those intended by the curriculum authors. However, this research also suggests that drawing on knowledge derived from their own out-of-school experiences has the potential to help parents make sense of the tasks in a way that was compatible with the curriculum authors' intention. Therefore, in order for parents to make sense of their children's school mathematics, it is helpful for them to acknowledge that their own ways of thinking are valid within the context of school mathematics. That is, for parents to make sense of their children's curriculum it is important to help the parents combine their informal knowledge with their knowledge of school mathematics and to help them realize it is appropriate to draw on both sources of knowledge in the context of school mathematics.

Several researchers who focus on adults learning mathematics (Benn, 1997; Wedege & Evans, 2006) have considered the problem of transfer of knowledge, such as transfer from the informal knowledge constructed in out-of-school contexts to the context of school mathematics. For these researchers the problem of transfer becomes one of translation across different contexts, a translation that starts with the recognition of similarities and differences between the different contexts. This lens is relevant here because in this work we are considering ways parents might translate their own informal mathematical understandings to the context of their children's standards-based school mathematics. This translation was an important component of Jorge and Michelle's sense making, but it was a non-trivial process for them.

The parents' own school mathematics often interfered with their ability to draw upon the entirety of their mathematical knowledge. Although it is not surprising that the parents drew upon their school mathematics, it is worth noting the extent to which their school mathematics hindered their ability to make sense of the tasks initially. On the other hand, when the parents were able to move beyond their school mathematics experience and draw upon their informal knowledge, they began to make sense of the tasks from their children's curriculum. If our goal is to help parents make sense of tasks from these curricula, then it is important to explore two things: first, the parents' perceptions of similarities between their own mathematical knowledge and the mathematical tasks in which their children engage in school; and second, their perceived differences that might hinder the parents' ability to make sense of their children's school mathematics. Furthermore, any course or resource designed to help parents understand the intention of the tasks from their children's school mathematics should build on parents' previous experiences as well as help parents use those experiences to relate to the tasks with which their children engage.

Finally, as Wedege (1996) observed, emotional factors to adults learning mathematics are just as important as cognitive factors. Michelle, who is competent mathematically, was strongly influenced by her own emotional experience with school mathematics. This was evident in Michelle's accounts of her own schooling, as well as the number of times she began working on a task by saying, "I don't know." Jorge brought a belief that school mathematics is predominantly about memorization and learning procedures. He made flash cards for his son and was emphatic that written procedures are "what I know." Any course or resource designed to help parents understand the intention of the tasks from their children's school mathematics should acknowledge and take into account parents' feelings and beliefs about school mathematics.

As Peressini (1996) observed, parents have historically been excluded from the discourse of mathematics education reforms. Dialoguing with parents about their experiences with mathematics both in school and in out-of-school contexts and harnessing these experiences might be one way for parents to relate to their children's school mathematics, allowing them to participate in the discourse of mathematics education reform.

Conclusion

This exploratory study was designed to consider two questions: (i) what experience do parents have of the mathematics their children engage with in school? and (ii) what sense do parents make of that mathematics? Our report focused primarily on the second question. We observed that parents tend to draw upon their own experiences with school mathematics when interpreting the mathematics with which their children engage in school, but find a meaning closer to the intent of the tasks when they draw upon their own informal knowledge constructed in out-of-school contexts.

Working with parents to help them understand tasks from a standards-based curriculum might be perceived as operating from a deficit model of parental involvement with their children's mathematics (Lawson, 2003; Peressini, 1996), but the parents in this exploratory study experienced a sense of empowerment as they constructed their own sources of mathematical knowledge and found this knowledge to be relevant within the context of their children's school mathematics. Additionally, for parents to be partners in their children's mathematics education and to participate in discussions surrounding it, it is necessary for parents to construct a new lens for viewing their children's school mathematics tasks, no longer viewing these tasks solely in terms of their own experiences with school mathematics.

In order to accomplish this, we should give parents access to the ideas that underlie reform in mathematics education and to help parents relate to the tasks their children engage with in school. This research suggests that building on parents' previous experiences with mathematics in and out of school contexts, and helping parents connect these two sources of knowledge, might be a productive place to start. Consequently, this research serves as a starting point for further research in this area. Research is needed to further develop our understanding of how parents make sense of these curricula, to gain insight into how parents connect their informal mathematics to their children's school mathematics, to explore further how context determines which source of mathematical knowledge a parent brings to her child's school mathematics, and to design and assess materials and activities that support parents in this process.

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Mathematically successful sons: the roles perceptions, and experiences of African American[1] parents

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Abstract

The stories of four mathematically successful middle schools African American boys are used to describe the roles, perceptions, and experiences of their parents. The parents of played multiple roles for their sons: (a) guardians of opportunities, (b) standard setters, (c) resources for mathematical knowledge, and (d) models of success. As guardians of opportunities, these parents were advocates, protectors, and supporters. As standards setter, parent placed high value on education and succeeding academically. As resource for mathematical knowledge, parents provided or served as a resource. As models of success, parents provided or served as roles models. Each of these roles shaped the mathematical experiences and contributed to the development of a mathematical identity that shaped the boys' understandings of and persistence with mathematics.

Key words: African American, Parents, Critical Race Theory, Culture and ethnicity

Introduction

Calvin is a sixth grade African American student in a suburban school district located in the south-eastern part of the United States. As an elementary school student, Calvin earned the highest level of achievement on standardized mathematics tests given in state for grades three, four and five. In addition, in grade four he scored in the ninety-eighth percentile on a national standardized achievement test in mathematics. On all objective measures in mathematics, Calvin performed well and in most cases he excelled. In addition, he earned good grades in mathematics by earning A's and B's consistently.

Calvin's mother acknowledges that her son is in need of a variety of stimulation in order to prevent boredom. She knows that Calvin needs to feel that his teachers are interested and cares about him in order for him to be productive in class. Calvin and his mother admitted that mathematics is his favourite subject. Both Calvin and his mother admit that he can be a handful in class. His behaviour is not always that of a model student; however, they believe his behaviour is well within acceptable classroom norms.

At the end of fifth grade, Calvin was excited about going to middle school. At that time, teachers identified students to take a mathematics placement test to gain entry into an upper-level pre-algebra mathematics course for sixth graders. Calvin was upset because he was not selected and there were students selected to take the test who he considered were not as "good at math." Calvin's mother inquired about the criteria for selection of taking the placement test and

[1] The term African American is a descriptor that includes many different segments of the American population referred to as "black" or Americans of sub-Saharan African ancestry. I am using this term to refer to those individuals of African descent who have received a significant portion of their socialization in the United States (Sellers, Smith, Shelton, Rowley, & Chavous, 1998). The term African American is culturally bound to a group of people within the context of American society.

discovered that Calvin met all criteria except one, teacher recommendation. Calvin's fifth grade teacher indicated that although Calvin scored well on assessments, his behaviour and his inability to sit still would not make him a good candidate for pre-algebra in sixth grade. In a conference with the guidance counsellor, Calvin's mother inquired about his being placed in pre-algebra. The guidance counsellor responded that she would not want to place Calvin in a class he could not pass. The counsellor assumed that Calvin would not pass the class without considering his previous performance. The principal at the middle school evaluated Calvin's situation and argued that pre-algebra is a rigorous course for sixth grade students and only disciplined students are capable of passing this course. Even though Calvin had performed well in mathematics throughout his schooling, school personnel focused their attention on behaviour rather than academics when evaluating his mathematics potential. When the sixth grade school year began, the pre-algebra class had no African American male students.

Calvin's mother felted that race was a motivating factor in Calvin not gaining access to the sixth grade pre-algebra course. Calvin's school district's mission statement focuses on excellence and fairness and enabling all students to acquire knowledge, skills and insights necessary to live productive lives in an ever-changing society. Consequently, the school district is concerned about the mathematics achievement gap. Calvin's story raises questions about whether school personnel are committed to the mission statement and beliefs that school personnel hold for African American boys.

Calvin has a mother who served as an advocate for him and worked to challenge school personnel to help Calvin gained entry into the pre-algebra course the second week of the new school year. Unfortunately, Calvin's story is not unique; African American boys are often confronted with lowered expectations even when they have shown that they are capable of achieving. School personnel are gatekeepers of power because they possess a great deal of autonomy and control over who gains access to advanced curricula, human and material resources, and quality instruction (Yosso, 2002). Access to advanced mathematics curricula in middle school impacts students opportunities to learn rigorous mathematics in high school (Lubienski, McGraw, & Strutchens, 2004). The advocacy of Calvin's mother provides insights to concerns about the number of capable African American boys who are denied access to a rigorous mathematics curriculum, pushed out of the advance mathematics pipeline, met with lowered expectations, and not provided with the support to achieve in school mathematics.

There is a dearth of research in mathematics education that considers the perspectives and experiences of African American parents. Mathematics education reform documents acknowledge that parental involvement and parental experiences have an impact on students' mathematical experiences (National Mathematics Advisory Panel, 2008; National Council Teachers of Mathematics (NCTM), 2000). These documents have identified parental involvement as an important goal for student success. However, calls for increased parental involvement have an underlying normative notion of White and middle class (Martin, 2006). Martin argues that the extant mathematics education research, with a few exceptions, has failed to present sufficient characterizations of the mathematical beliefs, experiences, and advocacy of parent of colour. This paper provides characterizations of the mathematical experiences and advocacy of African American parents in the lives of their sons who have experienced success in mathematics. Specifically, it examines the roles of the parents of eight African American boys who experienced success with middle school mathematics. For this study success is defined as middle school students enrolled in Algebra 1. Calvin's story is highlighted at the beginning because it represents the type of advocacy and obstacles these boys and their parents faced when working to gain access to rigorous mathematics.

Researchers have documented four factors in an effort to understand and explain African American parents' roles, experiences, and perspectives with regard to mathematics education. These factors are: (a) African American parents' perspective of mathematics as a tool to help children overcome structures and barriers that limit opportunities; (b) African American parents role in the mathematics reform discourse; (c) deficit assumptions educators with regards to African American students' mathematics practices and parents' roles with children with regard to mathematics literacy; and (d) African American parents' perspectives and experiences of the power and mathematics education. These factors are not beneficial exclusively to African American parents; rather these factors provide insights to perspectives rarely addressed in the literature. To situate the research reported in this work, study that focused on African American parents and mathematics education are highlighted in this review of literature. The four broad factors are discussed in the context of the studies throughout this literature review.

Martin's (2006) used ethnographic and participant observation methodologies to reveal that mathematics learning and participation can be conceptualized as racialized forms of experience. This study involved the perspectives and experiences of three groups of African American parents. The parents in Martin's (2006) situated their struggle for mathematical literacy within race-based frameworks. He found that as these parents attempted to become doers of mathematics and advocates for their children's mathematics learning, discriminatory experiences subjugated some of these parents, whereas others resisted subjugation based on a belief that mathematics knowledge can be used to change the conditions of their lives. Additionally, these parents were less concerned with whether their children were experiencing traditional or standards-based mathematics instruction and more concerned with whether they were receiving "the kind of mathematics that will help their children penetrate closed structures, improve their conditions in life, and overcome the barriers that they will likely encounter as a result of their African American status" (Martin, 2003, p. 8). Martin also found that the parents in his study made a reinvestment in mathematics by becoming doers of mathematics. That is they sought ways to deepen their mathematical understandings and skills by enrolling in courses. This reinvestment in mathematics had an impact on the ways they engaged their children mathematically because they encouraged their children's mathematical development and saw mathematics as a way for their children to participate in the larger opportunity structure.

Anderson and Gold (2006) used the lens of mathematics as situated social practice to focus on four African American children in an urban preschool classroom. They followed these children between home and school sites to shed light on their persistent underachievement in mathematics. Anderson and Gold described the ways in which numeracy practices travel with children between home and school. They found that school imperatives such as assessments and socialization curricula, obscured teachers' views of children's mathematical practices. Additionally, deficit assumptions about parental and community support for children, and limited interaction between parents and teachers, contributed to school personnel overlooking the mathematical practices children bring with them to school.

Remillard and Jackson (2006) analyzed the practices of the educators and perspectives of the low-income African American parents in their study who were trying to make sense of an elementary mathematics reform curriculum. They interviewed ten African American parents and held two focus group meetings, during which parents shared their experiences with mathematics as students themselves and as parents of children using a Standards-based curriculum. Remillard and Jackson (2006) found that even though parents saw themselves as critical to their children's mathematics learning, the implementation of the curriculum disempowered parents. Parents had little understanding of the curriculum's approaches, and thus limited parental access to the discourse of reform. Leaving parents out of the conversations about mathematics education reform and denying them access to the discourse of reform can compromise parents' confidence in playing active roles in their children's schooling (Allexsaht-Snider, 2006). Remillard and Jackson (2006) argued that if educators are to develop partnerships with parents of varied class and ethnic backgrounds in mathematics education, they cannot ignore power differentials between parents and teachers/administrators.

Peressini (1996) explored the role of parents in the reform of mathematics education at three urban high schools. He used semi-structured interviews with parents, teachers, mathematics department chairs, and principals. Peressini questioned the ways in which parents have been positioned with respect to mathematics reform. He found that parents were denied access to the discourse of the reforms and parents were powerless with respect to their children's learning of mathematics because mathematics educators and school personnel held little regard for parents' interests or concerns.

The studies in this literature review focus on the African American parents' roles, perspectives, and experiences. A common theme among these studies is the intersections between race, opportunities, and mathematics. These studies are broadly situated in that they range from parents of preschool aged children to parents of high school aged children. This study is narrow in its focus because it focuses on parents of African American middle school aged boys who have been successful with school mathematics. This narrow focus allows us to determine if the experiences of these parents are parallel to the broader group of African American parents.

Theoretical framework

An understanding about the experiences and the adaptive responses of African American parents who have sons who are successful with school mathematics can be gained through using a "critical equity lens" (Gutstein, Middleton, Fey, Matthew,et al., 2005; p. 95). A critical equity lens provides a perspective in which will allow an examination of race as a social construct and its intersections with mathematics. For this study, critical race theory (CRT) is the theoretical framework because it allows us to examine the complexities of the mathematical experiences of African American parents and their sons, and its intersection with equity and social justice.

CRT draws from a broad literature in law, sociology, and history and is being extended into education and women's studies (DeCuir & Dixson, 2004; Ladson-Billings & Tate, 1995; Solorzano & Yosso, 2001). Historically, its roots can be traced to legal studies. CRT consist of some basic insights, perspectives, and methods that seek to identify, analyze, and transform structural aspects of education that maintain subordinate and dominant racial positions within and out of the classroom (Solorzano & Yosso, 2001). There are at least five elements that form its basic model: (a) the centrality of race and racism; (b) the challenge to the dominant ideology; (c) commitment to social justice; (d) the centrality of experiential knowledge; and (e) a transdisciplinary perspective. Critical race theorists utilize methods such as storytelling, counter-storytelling, narratives, chronicles, scenarios, biographies, and parables to portray the lived experiences of people (Delgado, 1995).

As a theoretical framework, CRT was fitting for this study, because it uses mathematics as a context to provide the insights and perspectives of African American parents. This study transcends disciplinary boundaries because it moves beyond traditional mathematics education research to examine the experiences of African American parents from an anthropological and sociological viewpoint. Common to work arising from CRT, this study uses counter-storytelling.

Phenomenology is a good methodological match for this study within its theoretical framework of critical race theory because it recognizes understanding one's subjective interpretation of individuals' lived experiences. A phenomenological study describes the meaning of the lived experiences for several individuals (Creswell, 1998; Tesch, 1987). This is consistent with methodologies of critical race theory. The phenomenologist selects a phenomenon that is of interest and is stimulating in such a manner that it draws the phenomenologist into the world of those individuals who share the lived experience (Pinar, Reynolds, Slattery, & Taubman, 1995). This study draws from a larger study; consequently a common framework was used for this analysis. The larger study focused on African American middle school boys who have been successful with school mathematics and the elements of their experiences that led to their success. Phenomenology and critical race theory was fitting for these investigations. The literature overwhelmingly situates academic achievement for African American boys in terms of failure thus, success for African American boys was perceived as a phenomenon for these studies. The primary research question for this study is, "How do parents of African American middle school boys who have been successful with school mathematics conceptualize their roles in their sons' mathematical experiences?"

Participants

In a phenomenological study, the participants may be located at a single site or multiple sites. It is essential that the participants experience the phenomenon being explored and can articulate their conscious experiences (Creswell, 1998). The primary participants in this research were the parents of eight African American boys who experienced success with middle school mathematics.

Identification of the boys was done through a pre-college program's database. The pre-college program database included the approximately 1000 students in 19 public schools (12 middle schools and 7 high schools) in four school districts located in a south eastern state of the United States. The pre-college program was used as an initial starting point because its mission is to increase the number of historically under-represented students in mathematics and science by providing enrichment opportunities.

The four middle schools selected for this study are located in the same urban school district. After identifying four middle schools, one Algebra 1 class in each school with at least two African American boys enrolled was selected for the study. The initial intent of having two African American boys in the same class was to compare the experiences. However, it was found during data collection that experiences of the boys were similar. Once the boys were identified their parents were invited to participate.

The enrolment of African American boys in Algebra 1 at each of the four middle schools was five, two, four, and four. This urban school district has 46 schools (8 middle schools) with approximately 32,000 students. The racial composition of the school district is approximately 55% African American, 25% White, 14% Latino/a, 2% Asian, and remaining students are classified as other. There are approximately 51% girls and 49% boys within this school district. It is interesting to note that in a school district with a majority African American student population, the pool of African American boys enrolled in Algebra 1 was so small.

Data collection

Establishing trustworthiness

Credibility, transferability, dependability, and confirmability were the criteria used to verify trustworthiness of the data (Lincoln & Guba, 1985). Credibility was verified by providing for prolonged engagement with the participants, data triangulation, and validity check. Providing rich descriptions of the stories established transferability. Dependability was established through overlapping methods and data triangulation. An audit trail of transcripts, audio recordings, field notes, and documents established confirmability.

Approaches to data collection

Phenomenological research explores the personal construction of a person's world through in-depth, unstructured interviews (Polkinghorne, 1989; Tesch, 1987). This research reported here focuses on the parental interviews. The purposes of the parental interviews were to: understand parents' perceptions of their son's mathematical abilities; get parents' insights into their son's mathematical history; and gain insights into the ways parents advocated, encouraged, and helped their sons. I used an interview protocol; however, all of the parents provide in-depth data after all the protocol questions were answers. All sessions moved from semi-structured interviews to conversations amongst friends. Seven parents were interviewed twice and the length of the interviews ranged between one and two hours. The interviews were audio-recorded and transcribed.

In the larger study, the boys were interview three times, they completed a questionnaire, wrote a mathematical autobiography, observed in during their mathematics class, their academic records were reviewed, and their teachers were interviewed. While the data reported here focuses on parents, the data sources collected from the boys were shared with parents.

Data analysis

CRT influenced the analysis of this study by allowing me to place racialized experiences at the centre of analysis (Martin, 2006). The intersection between CRT and phenomenology provided the framework to look for the interrelationships between the parents' experiences and perceptions and issues of race. The analysis of data used a nonlinear approach, which allowed us to look for recurring themes that could be explored in greater depth. It also allowed for progression through the following processes: data management, reading and "memoing" (see Creswell, 1998; p. 143), describing, classifying and interpreting, and representing and visualizing.

Atlas TI, a qualitative computer software program, was used for data management. *Atlas TI* allowed us to create a document system to store and retrieve text, search for words or phrases, and create coding systems for text data. Because analysis occurred in conjunction with data collection, we created memos within the raw data. Memoing allowed for some initial coding and document areas where more depth was needed. The codes used during the memoing came from the review of literature. Once data collection was completed, we reread and re-coded the entire database to refine and verify the initial coding to assure consistency. After this, we sorted the database by codes then reread and re-coded the database. At this point, we looked for themes within each section (code) to see if there were dimensions that required the data to be further discriminated. Through this process, themes emerged from the data.

Researchers' identities

Asante (1980) argued that researchers should give themselves over to the act of research. That is, one has to delve deeply into oneself to reveal to the reader the motivation and the perspectives one brings to the research. The researcher should present sufficient information about himself or herself to enable the reader to assess how and to what extent the researcher's presence influences the choice and outcome of the research (Reviere, 2001). One's life experiences influence all aspects of the research process; thus, judging a researcher's work should raise questions about truthfulness, fairness, and honesty.

In order to be truthful, fair, and honest, I will reveal information about myself so that readers can assess my presence in this research. I am an African American man who taught school mathematics. For me, the roles of researcher, learner, and teacher are intertwined and complement one another. I cannot discount the fact that my race, gender, social class, and political views affected the research process. Rather than minimize this influence, I used my multiple identities as an interaction quality in the research process. In collecting the data for this study, the fact that I am an African American man was an obvious strength for me to create discourse the parents.

Findings

The presentation of the findings is based on the analysis of the data from the parents of eight boys who participated in the larger study. Bilal, Cordell, Clayton, Jabari, Darren, Phillip, Akil, and Andre are the boys discussed in the findings. Names of people and places within the stories are pseudonyms. The parents of these boys played multiple roles for their sons: (a) they were guardians of opportunities, (b) standard setters, (c) resources for mathematical knowledge, and (d) models of success. Each of these roles shaped the mathematical experiences of their sons and contributed to their son's development of a mathematical identity and shaped their son's understandings of and persistence with mathematics.

Parents as guardians of opportunities situated these parents in the roles of advocates, protectors, and supporters. As advocates, these parents advocated early on to ensure their sons' proper mathematics placement. As protectors, these parents wanted to protect their sons from low expectations. As supporters, these parents were involved in academic activities. Parents as standard setters stressed the importance of doing well in mathematics which will allow access to broader opportunities. Parents as resources for mathematical knowledge positioned the parents as primary resource for mathematics. Parents as models of success situated these parents as mathematical role models.

For these boys, their families were critical to their success. Their parents were keenly aware of the intersection between race and gender as it relate to African American males.

Parents as guardians of opportunities

Seven of the parents did not trust their sons' schools. These parents were not intimidated by educational authority figures, and were cautious about accepting opinions offered by school personnel. Because of their distrust, these parents were involved with school related activities and adopted the roles of advocates, protectors, and supporters. Advocacy works to ensure that their son's needs are met and they receive equitable treatment, and convey a message to school personnel that the student is expected to succeed. Advocacy overcomes passivity of schools that allow prejudiced behaviours to interfere with students' learning. Five of the sons were identified as gifted prior to fourth grade. The gifted designation put the sons on a track they would allow them access to a high tracked mathematics group. This placement gave parents the perceptions that their sons' would receive richer mathematics instruction in elementary school. Four of the sons' gifted placement came in spite of teachers' failure to recognize their potential. It was the advocacy from parents that garnered their sons' placement in the gifted program. Without this advocacy, these four boys would have been placed at a disadvantage and could have potentially altered their mathematical experiences.

Initially, educational gatekeepers perceived four sons', Cordell, Phillip, Clayton, and Bilal, behaviour as inappropriate for the gifted recognition. In Cordell's case, he was bored with school and he started to cause behaviour problems. Cordell's mother perceived race was a factor in school's decision not to initially test Cordell for the gifted placement. She stated, "I raised the question with the school and asked them to test him…nothing was being done, so I went up to the school and stayed on them." She felt that race was a factor in Cordell not being tested for the gifted program earlier by stating, "I do feel like if he was not Black they probably would have taken it upon themselves to make sure he was in the right class." Phillip's mother had similar perceptions and experiences and believed that race was a factor her son not initially being recognized as gifted. Phillip's second grade teacher, who was White, pre-diagnosed him with Attention Deficient Disorder, and his third grade teacher, who was African American, recognized him as being gifted. The second grade teacher focused on behaviour rather than cognitive abilities, whereas Phillip's mother believes that her son's third grad teacher understood Phillip culturally and saw Phillip's academic potential. In Clayton's case, his parents believed Clayton was overlooked because he is an African American male. Bilal's mother recounts the story providing a context as to why Bilal was not initially recognized as gifted by stating:

> He happened to have a good White friend whose mother really cared for him [Bilal] and spoke up for him a couple of times even when my husband talk to the school about him being tested for academically gifted. The response at the time was that he was not able to handle the work so she [the teacher] did not want to recommend it. It was actually his friend's mother, [the white friend's mother], who bought it up to the principal and the next thing we know he is being tested for AG. And of course, he tested well enough to be AG.

As protectors, these parents believed that schools were not immune to issues of subordination that affect African American males in the larger society. These parents were felt that schools had low expectations of African American boys, and they wanted to protect their sons from low expectations. Having a presence is critical for Bilal's parents; his mother asserted,

> We find being African American and by our son being an African American male, that we have to make sure that our presence is always at the school, with the teachers. Because if not, while he is smart, he will still be placed by the wayside

They perceived their presence, both physically and figuratively, in the school as an indicator to the teachers that they have high expectations for their sons' academic performance. Phillip's mother stated,

> I have to be at my son's school to make sure he is treated fairly. I speak to the teachers and the principals, letting them know that I am involved in his education and education is important [to me].

As supporters, these parents were involved in academic and non-academic activities. They supported their sons' schools by serving on school committees, working on fundraising events, and chaperoning events. With regards to mathematics, these parents were highly involved with a pre-college program that is a partnership between the school division and a major university. The pre-college program's mission is to increase the number of historically under-represented students in mathematics and science by providing enrichment opportunities. These parents saw participation in this program as an additional educational opportunity for their sons. They supported the program by making sure their sons attended monthly Saturday academies at the university, participate in mathematics and science competitions, and worked with teachers to ensure that the school had the necessary support materials. By supporting school activities, they further delineated their presence in the school; this presence relayed clear messages to their sons and school personnel that they valued educational experiences, both academic and non-academic.

Parents as standard setters

Parents placed the highest value on education and succeeding academically. All of the parents stressed the importance of doing well in mathematics and school. Cordell's mother stated, "…I just expect him to do well in school…if he does not do well he had better have a good excuse." With regards to mathematics performance, Clayton's mother expected Clayton to well in mathematics because he is capable. She stated, "Children tend to live up to your expectations…don't bring home C's." Jabari's mother had similar sentiments as Clayton's mother by stating,

> I know the ability is there, we just have to make sure we nurture and help bring out the better part of him in it. So, we are going to be on his case one way or the other. I'll put it this way; he is going to do well

Darren's mother declared, "I think my job is to motivate him…he has to put in the time with Algebra I to do well." Likewise, Akil's mother has strong expectations for her son by stating "I just want my son to his best [in mathematics]…his best is getting all A's." The message the parents gave their sons was that not doing well in mathematics and school was not an option. The parents constantly pushed their sons to achieve academically. They told their sons they could achieve and expected exemplary performance in school.

Parents as resources for mathematical knowledge

Seven parents served as a resource for mathematics knowledge. This does not imply that the parents understood Algebra 1; rather, these parents probed and asked questions of their sons. Five parents openly admitted that they did not understand their sons' Algebra 1work. Akil's mother stated "I make him show me how to do it so that I can understand…if I understand then I know he can do it." When the sons were in earlier grades their parent helped them with their mathematics homework. The parents quizzed their sons on mathematical concepts, asked their sons to show them how to do problems, and made their sons re-do problems/work they deemed as insufficient. Even when the parents did not understand the mathematics, they asked their sons to explain the mathematics to them.

Seven parents emphasized the importance of their sons' preschool experiences and exposure to educational materials early, as a way of ensuring that their sons receive early academic experiences. Andre's mother stated, "We played games with him when he was younger. I think this help him learn math." Similarly Clayton's father discussed that, "Clayton has been going to my tutoring program at our church since he was in pre-school…he learned a lot of math helping me tutor." These parents discussed their sons' academic readiness as a way to circumvent potential problems they perceived that Black boys encounter early in school. Parents discussed their sons' experiences with educational toys and materials, such as workbooks, flashcards, computers, educational videotapes, and other materials that supported early academic development. Phillip's mother stated, "I would just quiz him on his [additions and multiplication] tables when we were riding around town." These parents focused on helping their sons' develop addition and multiplication skills. Interestingly, the sons' perceived this as a contributing factor to their early success with school mathematics.

Parents as models of success

The sons found models of success in their parents, other family members, and people they admired. Four of the sons spoke fondly of their fathers. They saw their fathers as a model of high achieving and successful African American men. The sons spoke of their fathers as their primary role model and described how hardworking their fathers were and how they often learn from their fathers. Jabari said, "My dad knows all about math; he majored in math in college." Andre stated, "My dad is the smartest person I know, he knows everything." Bilal stated:

> I get it [mathematics] from my father. My father helps me by making me do math problems on his job or when he works, he makes me figure out how much to pay the people that is working for him by the hourly wage…I like working with my dad…he is the smartest person I know.

Not all of the sons had fathers in their lives. However, they did have other models of success. These role models served in similar capacities as the fathers described earlier. Akil described his mother by stating:

> My moms she's mainly the one who motivates me. Like sometimes I feel like I don't know it, I can't get it; she will say keep trying or whatever. I guess I get it from her because she is really a math person and she is all about school.

Discussion

African American boys are confronted with significant academic and social challenges in their quest for education. The parents in this study are keenly aware of the ways that society, including schools, devalues their sons' African American status. The popular press often reports that African American boys are overrepresented in low ability group classes, underrepresented in gifted and talented academic programs, and underrepresented in upper level mathematics classes. Consequently, parents of African American boys in this study advocated, protected, and supported their sons' from the subordination they are likely to encounter.

Martin (2006) questioned if race mattered in the mathematics learning and participation of African American parents. Martin concluded that race mattered. Likewise, in this study, race mattered to these parents. The centrality of race was a theme that was interwoven across all the roles that parents in this study played in their sons' lives and mathematical experiences. The parents in this study framed race as a being socially constructed; consequently, they recognized areas their sons received differential treatment and circumvent potential situations where their sons would be denied mathematics opportunities. These African American parents recognized the influential nature of educational gatekeepers as hindrance to their sons' academic position and exposure to high tracked mathematics. This is significant because it raises concerns about other African American boys whose academic and mathematics potential are not recognized and who may not have parents or adults to advocate, protect, and support them. It is highly plausible that their mathematically talented African American boys who are relegated to being underserved in their experiences.

Several questions arise when looking at the implications from this study. The questions are: (a) How can we raise teachers' expectations for teaching African American males? (b) How can we inform teachers about African American cultural style and learning preferences? (c) How can teachers and parents collaborate in assessing African American boys' academic potential? High expectations from teachers reduce the likelihood that African American males will experience failure with school. Knowledge about African American cultural experiences provides educators with a means for interpreting students' and parents' thoughts, feelings, and actions while raising expectations for student success (Bennett 2001). African American learning preferences are connected to African American cultural experience. Boykin (1986) identified nine interrelated dimensions of the African American cultural experience:

a. Spirituality is the conviction that non-material forces influence people's lives;
b. Harmony addresses the notion that people are interrelated with other elements;
c. Movement emphasizes the interweaving of pattern, rhythm, music, and dance;

d. Verve is a propensity for high levels of stimulation, to action that is energetic and lively;
e. Affect focuses on emotions, feelings, and nurturing;
f. Communalism is an awareness that social bonds and responsibilities transcend individual privileges;
g. Expressive individualism is the cultivation of a distinct personality and a preference for novelty, freedom, and personal distinctiveness;
h. A social time perspective is an orientation in which time is treated as passing through a social space;
i. Oral tradition is a preference for oral modes of communication in which both speaking and listening are treated as performances (Boykin and Toms 1985, p. 41).

Although African Americans share common cultural, historical, and social experiences, not all cultural characteristics uniformly apply to all African Americans. Having an understanding of research associated with the African American culture can help increase student learning when pedagogy is compatible with the cultural style of African American learners (Bennett 2001).

Shade (1997) described the African American learning preference as an aggregate of holistic, relational, and field dependent learning styles. Holistic learners seek to synthesize divergent experiences in order to obtain the essence of experiences. Relational learning preference is characterized as freedom of movement, variation, creativity, divergent thinking, inductive reasoning, and focus on people. Field dependent learners need cues from the environment, prefer external structure, are people-oriented, are intuitive thinkers, and remember material in a social context (Shade 1997).

Irvine and York (1995) suggested that the research on learning preferences and culturally diverse populations should be interpreted cautiously. Irvine and York stated,

> Although it is clear that culture, particularly ethnicity, is a powerful force that influences students' predisposition toward learning, it must be emphasized that cultural practices are learned behavior that can be unlearned and modified. Culture is neither static nor deterministic; people of color are not solely products of their culture. Consequently, culture affects individuals in different ways.

Culture and ethnicity are frameworks for the development of learning preferences; however, other factors play a significant role in cultural and learning preferences (Irvine & York, 1995).

Utilizing knowledge of the multiple roles — (a) they were guardians of opportunities, (b) standard setters, (c) resources for mathematical knowledge, and (d) models of success — parent played in this study can provide insights into perspectives that are not represented and sometimes not valued by the mainstream. These roles represent a lens that is critical of the schooling and perhaps a more critical lens from parents is necessary to address some of the inequities that exist in schools. Additionally, the roles represent empowerment. Oftentimes, the African American lens is discussed and frame within a deficit framework. These roles serve as an example of the power that African American parents have to assert themselves in an institution that, at times, devalues their perspectives. Despite being undervalued these African American parents exhibit positive agency and advocacy on their sons' behalf.

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Parent Power Nights:
A model for engaging adults/families in learning mathematics

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Abstract

Located on the U.S./México border, The University of Texas at El Paso (UTEP) offers academic programs in K-12 school teacher preparation. Many of the courses integrate parents and families into teacher preparation courses. One example of effective adult/community learning is the "Parent Power Night" (PPN) component. This model builds a learning community (Eaker, DuFour, & Burnette, 2002), engaging university faculty members with pre-service teachers and family members in effective teaching/learning activities. Pre-service teachers are concurrently enrolled in mathematics content and pedagogy courses, taught together in a "block" on the campus of a public school. PPN activities aim to engage parents and community members together with the university students in meaningful investigations of mathematical concepts. Preliminary evidence suggests that, in this predominantly Hispanic, high-poverty area, PPN activities have impacts on participating parents', children's and pre-service teachers' knowledge and attitudes towards mathematics. An unanticipated outcome has been the impact on adults with limited previous formal education; many acquired the knowledge necessary to understand rather sophisticated mathematics concepts their children were learning

in school. The paper will discuss instructional methods used and implications for effective adult/family learning of mathematics content in Hispanic communities.

Key words: adult learning, informal learning, mathematics, Parent Power Nights.

Introduction

Numerous research studies (e.g., Epstein, 2000; Marschall, 2006; Shefelbine, 2006) point to the critical importance of parental involvement in children's cognitive development and academic success. Substantial evidence indicates that consistent parental involvement in mathematics is essential for building a strong foundation for children's learning and strengthens their attitudes towards mathematics (Civil & Andrade, 2002; Kliman, 1999; Sheldon & Epstein, 2005).

Parental involvement, in this paper, will be understood to include any relatives or guardians playing a parental role for the child. Our research model builds on Epstein (2001), who describes the goals and outcomes of parental involvement as a continuum, with specific and clearly defined functions – parenting, communicating, volunteering, learning at home, community collaboration and decision making. Our experience with children, parents, extended family members and caregivers in mathematics focused Parent Power Nights (PPN) sessions allowed us to observe and measure the outcomes of parents learning mathematics informally through active participation in innovative activities together with their children.

While the impacts of parental involvement have attracted attention in recent years and several research studies examine this important dimension of student development, there are gaps in the literature that remain. This paper contributes to the growing body of knowledge about adult learning by means of a school-focused intervention – the Parent Power Night model.

Background

Review of the literature

Our theoretical approach to adult learning is grounded in socio-cultural theory that considers culture to be dynamic and related to social reality. This theoretical construct has direct implications for the innovation discussed here, with a focus on valuing the knowledge and previous life experiences of students and their families (Moll, Amanti, Neff, & Gonzalez, 2005; Velez-Ibanez & Greenberg, 2005).

Our mathematically focused Parent Power Nights were inspired by Family Math Nights and their variations, including 'Mathematics Fair' and 'Mathematics Olympics' (Reys & Wasman, 1998; Koes & Saab, 2000). The literature describes the goals of these events as providing opportunities to show the fun and non-threatening side of mathematics to parents and children. The projects engaged parents as leaders (Munter, Tinajero & del Campo, 2007) by involving parents during the planning stages. These student-centred events allow participants to have many successful and diverse types of mathematical experiences over a relatively short period of time, enabling parents to learn new concepts and strengthen previous mathematical knowledge.

An important study that discussed parent learning mathematic knowledge (De La Cruz, 2000) described a successful research initiative focused on achieving academic success among Latino and other students from diverse backgrounds. Workshops for families focused on improving mathematics knowledge and parents were encouraged to attend these workshops to help children with their homework. The mathematical activities, games and booklets used in this program were designed as a part of a reform-mathematics curriculum called Children's Math Worlds (CMW, http://www.west.asu.edu/cmw/cmwframe.html).

Chrispeels and Rivero's study (2000) described the ways in which parents learn to see their place in child's education, construct their role of how to be involved, and perceive their efficacy to help their children. Their research helps to clarify some of the factors that tend to limit the participation of Hispanic parents in U.S.A. schools. These authors propose that, if given information about how to be involved and the potential benefits, Hispanic parents will take up new practices and modify their concepts of parenting and their place in their child's education.

Another study (Peña, 2000) points out specific concerns and barriers that prevent successful parent involvement. The factors that this author uncovers include the following: a) limited systematic preparation for future teachers about family involvement and, b) tensions arising from cultural miscommunication between professionally trained educators and parents with limited formal education.

Hispanic parents' non-involvement in education may be a function of language, culture, and socioeconomic barriers, limited educational background, and the parents' own negative school experiences. Mexican American families often tend to view the academic development of a child as solely as a function of the school with which they should better not interfere. Some parents are afraid to interfere in teachers' professional duties. Other barriers to parental involvement include parents' work schedules, and limited knowledge about U.S. school policies/procedures.

The context

The University of Texas at El Paso's (UTEP) College of Education and College of Science are partners in pre-service teachers' education. Faculty from both colleges have been involved in team teaching, affirming the importance of parental involvement in establishing partnership between teachers, future teachers and university faculty. In this U.S./México border community, continuous involvement of parents and extended families in K-12 classrooms, after school activities and Parent Power Nights have been beneficial.

UTEP's Field-Based Teacher Preparation Program provides opportunities for university students and faculty members to interact directly with schools and communities. The program model is characterized by several unique features that recognize that experiential forms of education, such as internships and service-learning, offer powerful possibilities for college students to learn democratic skills. Professional development school (PDS) sites, in nearby border locations, provide unique opportunities for students to try out new practices, document outcomes, and reflect on lessons learned (Teitel, 2003). This program prioritizes the community and families as full partners in teacher preparation. Pre-service teachers combine theory with practice in their role as school interns through a variety of programs designed collaboratively, in which: a) a significant portion of pre-service teachers' course work takes place in the community and its schools, and; b) public school personnel and community members work closely with University faculty to design, implement, and evaluate pre-service teachers' efforts to serve the diverse needs of this region. A key feature of this program model is the emphasis on University faculty members' work in collaboration with K-12 school personnel to create opportunities for pre-service teachers to become meaningfully involved in effective parent-school collaboration.

Mathematics for future teachers

During their senior year, UTEP's pre-service teachers enrol in internship semesters at local elementary schools while concurrently taking courses in mathematics methods and mathematics content. One of the primary goals of the senior-level undergraduate mathematics content/methods courses is to provide capstone-type mathematics classes for future teachers, while significantly increasing their understanding of pedagogical content knowledge. The two classes are offered together (back to back) to provide intrinsic connections between abstract mathematics concepts and applied pedagogical practices. The scheduling also provides great opportunities for team-teaching of these classes.

However, several challenges faced us in teaching the mathematics content and pedagogy courses in this field-based context. As a team, we have worked collaboratively to plan appropriate instruction and field experiences for pre-service teachers with widely varying mathematical backgrounds. Many of these pre-service teachers had never experienced active engagement in mathematical learning, and thus viewed mathematics as boring and unnecessary. Furthermore, many had developed stereotypical concepts of parental roles, particularly in low-income communities. In this context, the authors decided to incorporate the Parent Power Night model, focused on mathematics in these students' senior study.

In this study we worked with the Canutillo Independent School District (CISD). Canutillo, TX is an unincorporated rural community in the far west end of El Paso County just outside El Paso city limits. Of the 90% Hispanic population in Canutillo, 75% speak Spanish in the home. One hundred percent of CISD elementary school students receive free and reduced lunch. Munter (2004) describes previous and ongoing work at Canutillo developing a culturally relevant set of school-based programs within a service-learning framework; examples described in her work include a Mayan math/culture project and Parent Power Nights with parents, children and pre-service teachers working together on mathematically and culturally rich activities.

The Parent Power Nights (PPN) intervention

Objectives

The PPN model (see Figure 1) aims to engage pre-service teacher education students and in-service teachers with parents in open communication. By engaging parents and children in these activities, pre-service teachers have unique opportunities to interact with children and parents in teams, enabling parents to learn key elementary mathematics concepts and skills necessary to assist children in their learning at home. Both pre-service teachers and parents' goal is to promote student achievement. The structure and objectives of these events is consistent with and supported by NCTM (2000), which makes clear the value and importance of engaging and involving parents in school goals.

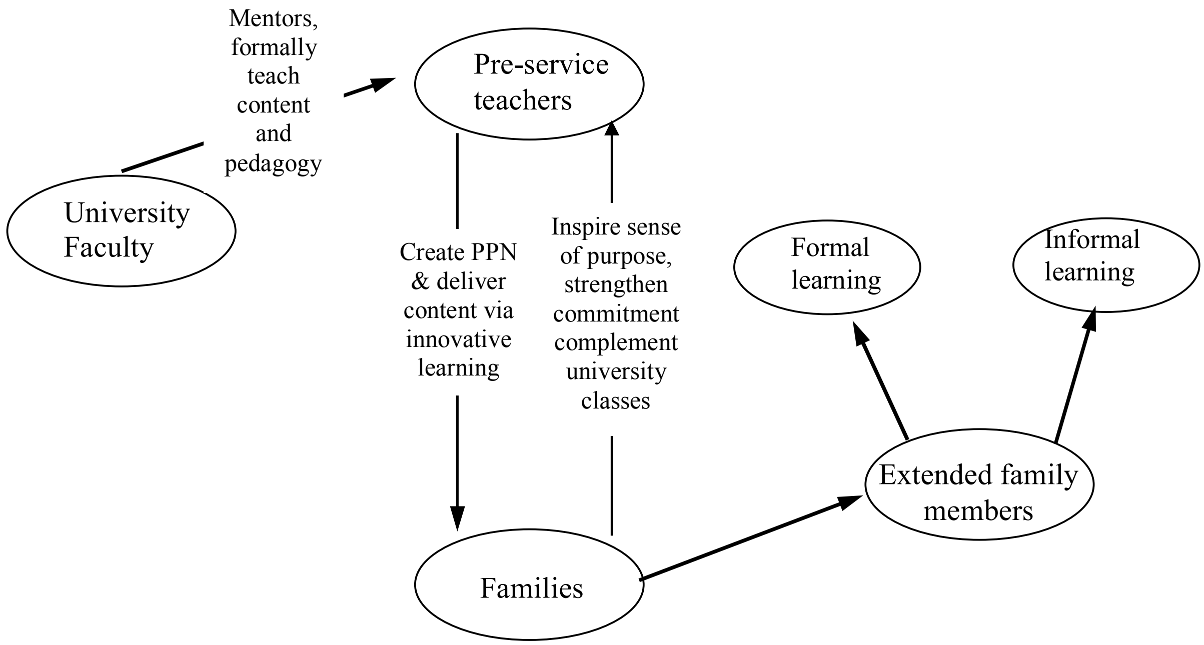

Figure 1. Diagram describing PPN model.

The preparation phase

During the preparation phase, pre-service teachers work as teams to design various hands-on, engaging elementary school mathematics projects that parents and children can complete in 20 minutes or less. The activities are developed from the mathematical content that pre-service teachers have learned in their mathematics class, the pedagogical approaches from mathematics methods class, and observations of expert teachers in the field-based internship. The field-based program allowed pre-service teachers to observe innovative mathematics teaching in action (e.g., see Aceves, 2004). Students were free to choose the mathematical topic for their activities, and they worked on preparing and practicing their projects in class with their mathematics and education professors/instructors.

Implementation

Our first PPN event was organized and implemented in Fall 2001. Since then, we have organized one or two Parent Power Nights each semester. Parents are informed about dates for upcoming PPN events through PTA meetings and flyers distributed in schools. A typical PPN event attracts between 40 and 130 adult participants. Events are conducted in selected elementary schools, with activities set up in individual classrooms and in the school cafeteria.

Snapshot of a "themed" PPN

Pi (π) day: A special vehicle for PPN

For two decades at least, math clubs and museums around the country have been celebrating March 14 as "Pi (π) Day", because the calendar date (3-14) corresponds to the beginning of this special number. While the event centres around the number pi, it is more generally a vehicle to celebrate the creativity, usefulness, and beauty of mathematics all around us in the real world, and so has served as a natural vehicle for Parent Power Nights in a local school district. We built upon the ideas of Lesser (2004), who maintains a Pi Day resource page at: www.math.utep.edu/Faculty/lesser/piday.html.

In one activity led by pre-service teachers, families compared numbers of stars they can place around the circle, and across the circle. They did this for different circles. For each circle they computed how many more stars would go around the circle versus across the circle (see Figure 2).

Figure 2. Discovering pi activity: using stars to measure around and across the circle.

In another activity they used string to measure across and around the circle; then they also used strings and beads to do similar comparisons (see Figures 3 and 4).

Figure 3. Discovering pi activity: using string to measure around and across the circle.

Figure 4. Discovering pi activity: using beads to measure around and across the circle.

In a more advanced activity (see Figure 5), pre-service teachers made cylinders from kitchen cones that had both the same height and the same base. Each cone and cylinder was decorated in the same colour to make it easier to tell which cone and cylinder went together. The children were asked whether they thought the cone or cylinder would hold more. Here is an excerpt from a pre-service teacher reflection paper:

> I wanted the children to notice that it took around three full cones to equal one cylinder. This three to one ratio was also being used in another of my group members' activities. I wanted the students to see that this relationship or ratio applied to more than just plain circles. I wanted the students to be able to see PI in more places than just circles.

Figure 5. Discovering pi activity (using cylinders and cones).

Other activities made use of innovative Tablet PC technologies. Tablet PC's are fully functional PC's running an enhanced version of Windows XP Professional. One of their most interesting features is the "digital ink" that allows a user to write on the screen using a stylus pen. The same pen is also used as a mouse. The Tablet PCs were used as ways of organizing interactive self-learning. Pre-service teachers created a PowerPoint presentation enhanced with animation features. The presentation started with a circle, followed by stars flying across. The participant would count the stars, and then he/she would be asked to estimate how many stars would fit around the circle. After that stars landed on the circle itself, with clear colour distinctions showing approximately three times more than the initial count of the stars (see Figure 6).

Figure 6. Discovering pi activity (using Tablet PCs).

The Pi Day events we have organized at various schools in El Paso County have involved a coming together not only of that school's students and teachers, but also of parents in the community. When we facilitated Canutillo Elementary School's debut Pi Day event in 2006, we involved not only UTEP pre-service teachers, Canutillo teachers, and Canutillo students, but also a fair number of adults from the community, and this particular Pi Day event attracted media coverage by the *El Paso Times*, CBS-affiliate KDBC-TV and Univision. As a vehicle for further outreach to adults, Lesser wrote a radio script for Pi Day that was broadcast multiple times for the Centennial Museum's Desert Diaries program on KTEP 88.5 FM. The script not only made natural and cultural history connections to pi but also initiated the creation of a "math category" of subsequent scripts for the radio program. Also, a pi song was published in the Winter 2007 *The Problem Solver*, a math newsletter for adult educators in Massachusetts.

A qualitative study

Methodology

The theoretical framework was purposefully non-experimental. Many researchers in education operate from a belief system which says that teaching cannot be studied by reducing it solely to objective measures (e.g., behavioural outcomes, summative evaluations or test scores). This methodological approach allowed new questions to emerge from the data, taking into account the contextual nature within which both researchers and the research phenomena exist (Lancy, 2001; Lincoln & Guba, 2000; Patton, 2002). Data for the study were collected during Parent Power Night (PPN) events, primarily through participant observation by the project research team, together with structured and semi-structured interviews of self-selected participants (i.e., participation was voluntary). Parents consistently demonstrated high levels of motivation and engaged in active learning with their children throughout the lifetime of the project. The involvement and collaboration of these adults as full partners in these learning events extended to the research components of the project as well. In several instances throughout the data collection phases, they shared their opinions and reflections on topics such as their views on the importance of working with children at home on their assignments; and teaching/learning activities besides homework that are happening at home. Researchers asked how often parents visit the school and for what purpose(s), and which barriers were preventing them from coaching their children to their fullest potential.

Data collection was ongoing throughout the lifetime of the study. The nature of the project encouraged collaborative learning at every level. Early in the study, the research team developed an open-ended research design that focused on documentation of impacts of the PPN experience, particularly in relation to learners' content knowledge acquisition. We had no preconceived notions about what kinds of effects diverse project participants might share with us. As interview followed interview, a commonality began to emerge among the various experiences. That is, although the primary goals focused on K-6 student performance objectives, it became clear that a number of unintended outcomes were surfacing. A prime example of this is encapsulated in the attitudinal changes of parents (and other adults) towards learning mathematics, demonstrated through statements such as the following: "I believe that it is critical for parents to be involved in Math learning because it [mathematics activity] shows the children that Math can be used in everyday life. The children will see what the parents do."

We worked with a two-tiered sample for the data collection processes in this project. One-on-one and small-group interviews were held with a group of 23 people consisting of university students, K-12 teachers, parents and children who were involved with Parent Power Night activities over a period of 12 months. A smaller self-selected subgroup worked with us in greater detail and with more intensity, engaging in in-depth discussion of the research project and data analysis processes. This group consisted of participants who were involved during the last year of the project and were willing to spend more time and attention on the research project as it unfolded.

Triangulation was incorporated into the design of the study to ensure credibility (see Patton 2002). This can mean using several kinds of methods or data, including using both quantitative and qualitative approaches. In this study, qualitative data were collected to explore the views and perspectives of perspectives of diverse individuals involved in Parent Power Night events in a K-16 partnership on the U.S./Mexico border. The research design of the study involved collecting qualitative data at the baseline (Year 1) and at the conclusion (Year 5) to gain a deeper understanding of barriers to parental involvement in this predominantly Hispanic community, to understand participants' experiences during the intervention (i.e., PPN events), and to explore key elements of the PPN events that had effectively brought about change over time.

Informal learning of mathematics via PPN

In this paper we will follow the definition of informal learning provided by the National Science Foundation (NSF):

> Informal learning happens throughout people's lives in a highly personalized manner based on their particular needs, interests, and past experiences. This type of multi-faceted learning is voluntary, self-directed, and often mediated within a social context (Falk, Dierking, & Foutz, 2007); it provides an experiential base and motivation for further activity and subsequent learning.
> (National Science Foundation, 2008).

We argue that Parent Power Nights provided truly informal learning environments for all the participants -- parents, their children and adult pre-service teachers. While the environment was in a school building, these events took place outside the hours of the regularly scheduled instructional day. The learning happening at these events was voluntary and self-directed. We observed high levels of engagement from all participants. The adults we worked with typically came with low-education backgrounds. Parents were encouraged to participate in mathematics explorations with their children. They were not intimidated by lack of mathematical knowledge, and they often asked questions. Sometimes we had situations when it was a child who was teaching their parents about mathematics. The mathematical activities were prepared for multi-age groups, so participants with more advanced mathematical knowledge would be provided with more advanced mathematical activities.

Typical actual comments from parents who participated in PPN in 2006 were: "I had no idea that learning could be so simple when it is explained in a different perspective" and "Learning activities presented tonight for the children and parents learning were exceptional".

UTEP pre-service teachers, however, are also members of the adult population. The age of traditional undergraduate students is considered to be 18-23 (e.g., Justice & Dornan, 2001), while the average age of UTEP undergraduates is 23.7. Literature reports that there is evidence that this group has different aptitudes, and motivations for learning compared to the traditional-age students (Kasworm, 1990) and despite family and career demands, older students achieve at levels comparable to younger students (Kasworm, 1990). Previous academic experiences and life experiences, demands of career and family affect knowledge and abilities of older students (Donaldson & Graham, 1999). Important factors are cognitive developmental changes in older students (Granott, 1998). Richardson (1994, 1995) found that older students were more likely to adopt a focus on deeper understanding while younger students were more inclined to study on the surface level and focus on test preparation approach and rote learning. Mature students reported increased use of higher-level cognitive strategies in their learning (Justice & Dornan, 2001). The relevant conclusions of this study suggest that courses with a majority of non-tradional students should be developed in such a way that students have opportunities to learn subjects with deeper understanding and not just rote learning.

These findings applied to the study of mathematics and mathematics methods by non-traditional-age students go hand-in-hand with recommendations we followed when designing our courses in mathematics methods and mathematics content. One of the primary goals of these courses was to provide capstone-type mathematics classes for future teachers, and significantly increase students' understanding of the mathematics concepts and mathematics pedagogy.

In connecting mathematics and mathematics pedagogy we had to take into account intrinsic intertwined nature of these subjects. Ball and Bass (2000) describe the work of professional mathematician as a very efficient way to "compress" information. For example, an observer collects data, and the mathematician comes up with a formula for the function that describes this data. The task of a mathematics teacher is quite different. He/she needs to proceed with "decompression", that is, not just present a formula, but use multiple representations and different contexts to explain ("expand") the formula. (Ball & Bass, 2000). As described in Ball & Bass (2000, p. 98):

> [O]ne needs to be able to deconstruct one's own mathematical knowledge into less polished and final form, where elemental components are accessible and visible. We refer to this as decompression. Paradoxically, most personal knowledge of subject matter, which is desirably and usefully compressed, can be ironically inadequate for teaching. In fact, mathematics in which compression is central…. Because teachers must be able to work with content for students in its growing, not finished, state, they must be able to do something perverse: work backward from mature and compressed understanding of the content to unpack its constituent elements.

Our pre-service teachers' grade-point average indicated that their previous mathematics classes was quite low, between 2.3 and 2.5 (for different semesters). In the beginning of semester, they typically displayed negative attitudes toward the study of mathematics, and towards using new reform approaches to teaching mathematics. Lesser (2005, p. 1) says:

> Pre-service elementary teachers often have poor attitudes and/or poor backgrounds in mathematics. For example, on item #13 from the UTEP Student Evaluation at the end of the author's recent course for pre-service elementary teachers (n = 27 students responding; 3 were absent that day), we learned that 100% of the students were taking this course to fulfil a requirement, rather than as an elective or for their own interest. We also see (on item #12) that before taking the course, students' level of interest in the subject was reported as: 0% "high", 7.4% average, 70.4% low, and 22.2% unsure.

Pre-service teachers' experiences in designing mathematical activities and conducting these activities during PPNs provided them with a great opportunity to conduct teaching mathematics not in the formal classroom setting. They were able to see the significance of focusing on the process of mathematical learning as opposed to focusing on outcomes such as test scores. Their satisfaction with the mathematics course increased. We can find in Lesser (2005) the following statistics:

> Despite the fact that students had very low interest or desire when the class began … the overall rating of the course was: 74.1% excellent, 14.8% good, 7.4% satisfactory, 3.7% poor, 0% very poor. The overall rating of the instructor: 81.5% excellent, 7.4% good, 7.4% satisfactory, 0% poor, 3.7% very poor.

A former pre-service teacher, an organizer of PPN in 2004 (and now a successful in-service teacher), reflects in writing:

> As an intern I had the opportunity to interact and discover new methods and strategies to become a better teacher. The purpose of this Parent Power Nights was to show parents the importance of learning together with their children. For me it was a great experience because just knowing that many parents eager to learn would come or parents that just wanted to have a good time would actually take the time to attend.

Results: Family collaborations motivate parents' further engagement and learning

Two samples of parent populations were selected for analysis. The group called Year 1 consisted from the parents from the first cohort and they participated in PPN in 2001. The group called Year 5 consisted from parents from the last cohort and they participated in PPN in 2005. Due to resource constraints that did not support collecting data continuously, a decision was made to collect data only for those two years in order better to see accumulated effects of impact as the program evolved. Tables below provide the information about interview responses. Semi-structured interviews were conducted at the end of Parent Power Nights.

Interview questions addressed a wide variety of issues. We will describe some of the answers that support our observation about influence of collaborative PPN learning environment and parent participation on their further engagement in learning, and specifically learning mathematics (both formally and informally).

Table 1. Age of Parents

Age	Year 1 (44)	Year 5 (31)
Under 18	2.2% (1)	3.2% (1)
19 – 24	2.2% (1)	0% (0)
25 – 29	22.7% (10)	6.5% (2)
30 – 35	34.1% (15)	29.0% (9)
36 – 40	18.2% (8)	38.7% (12)
41 – 45	15.9% (7)	16.1% (5)
46 – 50	2.3% (1)	6.5% (2)
51 and older	2.3% (1)	0% (0)

As shown in Table 1, the majority of parents from Year 1 were younger parents, 61% were people of 35 years or younger. In Group 2 (referred to in the Tables as Year 5) we had older parents, 61% of them were older than 35.

Table 2. Responses to question: "How important do you feel it is to work with your child on his/her school assignments?"

	Year 1 (46)	Year 5 (34)
Very Important	97.8% (45)	97.1% (33)
Important/somewhat important	2.2% (1)	2.9% (1)
Not Important/Not very importar	0% (0)	0% (0)
Uncertain	0% (0)	0% (0)

Table 3. Responses to question: "How often do you work with your child on his/her homework after school?"

	Year 1 (45)	Year 5 (34)
Everyday	88.9% (40)	44.1% (15)
Once or twice a week	2.2% (1)	23.5% (8)
Not very often	6.7% (3)	17.6% (6)
Never	0% (0)	2.9% (1)
Other	2.2% (1)	11.8% (4)

A significant majority of parents in both groups expressed their belief about importance of being involved in working together with children on homework assignments (97.8% in Year 1, and 97.1 % in Year 5, see Table 2). The majority of parents from Year 1 spent every day with a child working on homework assignment. Only 44% of parents from last cohort worked with a child every day (see Table 3). To understand this change we should look at the description of the barriers that parents described (see Table 4).

Table 4. Responses to question: "If you and your child do not read/study together, what are some of the barriers that prevent you from coaching your child in his/her studies?"

	Year 1 (15)	Year 5 (14)
Work schedule or studies	60.0% (9)	35.7% (5)
Language problems	6.7% (1)	42.9% (6)
Younger siblings	20.0% (3)	0,0% (0)
Other	13.3% (2)	21.4% (3)

For parents from Year 1, these were work or their own study schedule, followed by the need to spend time with younger siblings. For parents from Year 5, the most significant barrier was language problems.

Table 5. Responses to question: "Describe some of the other teaching/learning activities you engage in at home with your child."

	Year 1 (39)	Year 5 (19)
Reinforcing learning of Spanish	12.8% (5)	0% (0)
Reinforcing writing and reading	38.5% (15)	31.6% (6)
Reinforcing math	15.4% (6)	10.5% (2)
Outdoor and sports activities	12.8% (5)	15.8% (3)
Puzzles and computer games	12.8% (5)	0% (0)
Play activities	7.7% (3)	0% (0)
Help study for exams	0% (0)	10.5% (2)
Other community programs	0% (0)	31.6% (6)

**Parents responded with multiple answers*

When asked to describe type of teaching/learning activities parents practiced at home, we can see that parents considered mathematics related activities as important activities they could be engaged with children at home. Parents from Year 1 were more enthusiastic about these types of activities: 28% of home activities mentioned were related to mathematics, puzzles and computer games. However, writing and reading activities were bigger priorities for both groups of parents. One parent described mathematics related activities conducted at home as:

> For example ….Math games in the car – especially multiplication. Word games and I Spy or other car games …. I try to teach them to observe the world they live in and learn how it affects them.

Another parent described how they taught their child "practical life" experiences such as "Bank/Change" games that helped the child with their counting.

During Parent Power Night, parents were involved in advanced mathematical activities. In his comments one parent specifically stressed how important it is to continue to "challenge a child for problem solving or further investigation."

Table 6. Responses to question: "If you could change things in the school-community relationship, what would you change?" (Year 1 = 15 parents, Year 5 = 23 parents*)

	Year 1	(28)	Year 5	(34)
Language	0%	(0)	11.8%	(4)
Scheduling	7.1%	(2)	5.9%	(2)
Opportunities to learn	25.0%	(7)	23.5%	(8)
Communication	42.9%	(12)	20.6%	(7)
More parent participation	3.6%	(1)	2.9%	(1)
More activities for the students	0%	(0)	2.9%	(1)
More monitoring of students	0%	(0)	2.9%	(1)
Would not change anything	17.9%	(5)	17.6%	(6)
Other not specified	3.6%	(1)	11.8%	(4)

**Parents responded with multiple answers*

We also observe that in their responses both groups of parents (25% from Year 1 and 24% from Year 5) indicated that creating more opportunities for learning would strengthen the school-community relationship (see Table 6). We interpret this as an indication of interest to be involved in more adult learning opportunities provided by school.

One parent commented (regarding the importance of creating more opportunities to learn) that "because if parents learn they will … [understand] and value how important it is for parents to be involved."

Table 7. Responses to question: "What are some of the purposes of your visits to your child's school?" (Year 1 = 27 parents, Year 5 = 43 parents*)

	Year 1	(85)	Year 5	(52)
To progress in my own studies	28.2%	(24)	44.2%	(23)
To assist teachers	11.8%	(10)	9.6%	(5)
To resolve problems	18.8%	(16)	11.5%	(6)
To pick up a child	30.6%	(26)	26.9%	(14)
Other	10.6%	(9)	7.7%	(4)

**Parents responded with multiple answers*

When asked about reasons for visits to child's school, 28% of parents from Year 1 indicated that the purpose is to "*progress in my own studies*." Here we can observe a drastic change with Year 5 group. Forty-four percent of parents from Year 5 selected this answer. This is an indication that issues of adults learning have become more important for parents in our community (Table 7).

Conclusions

Our preliminary findings indicate that participation in Parent Power Nights empowered parents and encouraged them to be involved in their children's learning process.

Parents appeared relaxed participating in mathematical activities together with their children in front of pre-service teachers (in-service teachers were not involved in implementing PPNs). They felt empowered and dignified by the special attention provided to their families.

We did not ask parents formally to learn mathematics; their role was to help their children. In practice we saw during our observations that it often was children who were helping parents in mathematics activities and games (from anecdotal evidence collected from observation of the group of gifted and talented students). Children took pride that they could be helpful to their parents in these interesting mathematical activities. Both parents and children did not perceive these activities as formal mathematics as evidenced by their oral and written reflections; this learning was their free choice and they described it in their written reflections as very meaningful learning. The outcome of this learning was increased interest in continuing this type of learning of mathematics at home, and parents were also motivated to continue with their own study (formal or informal) of mathematics (as evidenced by their oral and written reflections, and the high percentage of parents in Table 7 who visited their child's school "*to progress in my own studies*."

Pre-service teachers, also adults, showed significant progress in learning mathematical concepts, changing their attitudes towards math, and attitudes toward innovative methods of teaching math. They also experienced a change in their stereotypes about low-income parents. Their participation in PPNs provided them with invaluable teaching and learning experiences and established good foundation for future successful communication with the teachers.

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