

Promoting children's achievement in mathematics using literacy strategies: A school-based intervention to increase parental involvement in children's mathematical learning

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ABSTRACT

This study provides a model of a school-based, parent intervention to support parents in building children's mathematics understanding at home. Participating parents received instruction on how to support elementary children's mathematical homework using literacy strategies. The researchers designed and implemented a five-week model with the goal to improve students' mathematics performance through support that parents provided at home. The goal of the study was to investigate the effects of a literacy-focused parent intervention on participating families' ability to support their children's school-based mathematical needs. Data collection included parent interviews, pre- and post-intervention, and audio recordings of parent-child work sessions in the home. This study contributes to the literature by providing a model for parents to utilize literacy skills to facilitate students' mathematical understanding.

Keywords: Parental involvement, mathematics education, interdisciplinary instruction

INTRODUCTION

Research has long established the relationship between parental involvement in children's school-based learning and children's success in school (Garbacz et al., 2017; Tárraga et al., 2017). Parental involvement has been shown to have especially strong effects on children of low-income families (Hill & Craft, 2003;

Marschall, 2006), children whose mothers have not completed high school (Dearing et al., 2006), and children of diverse cultural backgrounds (Jeynes, 2003). Parental involvement in education has also been an important factor in improving students' motivation, engagement with school subjects, and overall academic achievement (Clements & Sarama, 2020; Coleman & McNeese, 2009; Dumas et al., 2019). Parental involvement in children's education has benefits throughout a child's academic career. Early on, high-quality early mathematics experiences at home and in preschool have been linked to increased children's social-emotional and cognitive development (Clements & Sarama, 2020; Dumas et al., 2019), setting children on a path to success. Moreover, as children progress in school, parental involvement significantly predicts students' mathematical achievement by reducing children's mathematical anxiety for more complex mathematical topics (Cai, 2003; Vukovic et al., 2013). However, some parents may be reluctant to engage children in school-based practices in the home, even when asked, as they believe that they lack the knowledge to teach their children and want to avoid teaching their children incorrectly (Lapp et al., 2002; Rodriguez-Brown, 2010). Parental involvement often drops further as children progress in school; parents have difficulties in providing meaningful support for children's mathematical struggles due to a limited understanding of formal school curricula and effective approaches to learning mathematics (Jay et al., 2013; 2017; Patall et al., 2008). To help parents stay involved in children's education, researchers and educators have developed parental involvement programs, the most effective being those that teach parents to understand open-ended mathematics problems, allowing time for children to think, share their mathematical understanding, and reflect on reasoning processes (Jay et al., 2013).

The role of reading strategies, such as building vocabulary, in helping to develop students' mathematical understanding has also been investigated (Carter & Dean, 2006; Friedland et al., 2011; Wallace & Clark, 2005). Researchers have examined the role of language in solving word problems and whether word problem solving itself is a kind of text-oriented mathematics classroom (Draper, 2002). In response to these findings, this study initiates a collaborative effort in designing and implementing a parent program that utilizes literacy strategies (i.e., strategic reading) to support parental involvement and children's mathematical development. In this study, the researchers designed, implemented, and evaluated a five-week program to support parents in helping children with mathematics homework using literacy strategies. This program required parents to attend the program once weekly, along with their 4th-grade child.

The research questions for this study are: 1) What are the effects of a literacy-focused program on participating parents' understanding of how to support their children in school-based mathematics at home? 2) What are the effects of a literacy-focused program on participating parents' beliefs about the role of parental involvement in helping with children's mathematical homework?

This study examined the effects of a parent program designed to emphasize literacy strategies that can help promote participating parents' understanding of how to support their children with mathematics at home. This study also investigated how this program helped parents rethink their beliefs about their role in assisting with their children's mathematical homework. The following paper details the methodology used to design, implement, and evaluate the program, including an explanation of the design, setting, participants, intervention procedures, data collection methods, and data analyses. Results of the analysis are presented to address the effects of the intervention on 1) parents' knowledge of how to support children at home in mathematics, using literacy strategies, and 2) parents' beliefs about their role in supporting children's mathematics development. Finally, we present a discussion of the findings, including recommendations for future research related to parental involvement in children's learning at home when assisting their children with mathematics.

RESEARCH METHOD

The current study occurred in a mid-Atlantic public elementary school. Study participants included four parent/child dyads selected from one 4th-grade classroom (across the grade, 24 students received instruction from the same teacher). The procedures for recruiting parent participants were as follows. First, a letter was sent home with students to all parents and guardians, describing the study. Parents were asked to volunteer in data collection procedures and to attend the five-week parent program with their children. Second, the researchers solicited participants by visiting both schools before and after school hours to speak to parents on the playground. Information announcements were also distributed to parents, providing details about the program and all data collection procedures.

Participants

Within the classroom, three mothers and one father chose to participate. Of these participants, one parent, Tabitha, spoke Portuguese, and another, Valerie, spoke Russian as her first language. These parents reported that they were also fluent in English, as were their children. The other two parents spoke English as their first language; one parent, Sarah, was from the United States, and the other, Kurt, was born in and attended school in Hong Kong. (See Table 1 for a description of the parent/child dyads.)

Procedures

Based on the preliminary findings from parental pre-interviews and the mathematics curriculum (enVision Math) (Foresman & Wesley, 2011) employed in students' classrooms, the researchers designed and led five instructional sessions. At the weekly 1.5-hour meetings, the researchers introduced strategies to

support children in mathematics, utilizing literacy strategies. (See Table 2 for a list of strategies taught in the sessions.)

Table 1: Parent Participant Characteristics

Name of Parent/Child	Birthplace	English Language Proficiency	Employment Status	Help With Children’s Homework
Kurt/Kim	Hong Kong	Yes	Employed as an accountant	Daily/checks homework
Valerie/Natasha	Russia	Yes	Employed as a data analytics specialist	Child works independently
Tabitha/Marie	Portugal	Yes	Unemployed/accountant	Helps with homework 1-2 weekly
Sarah/Rachel	United States	Yes	Unemployed former early childhood specialist	Daily/checks homework

Table 2: List of Strategies Taught in Weekly Sessions

Sessions	Math strategies	Literacy strategies	Instructional focus
Session 1	Mental math to add and subtract big numbers	Connections between math and literacy in early grades	Underlying the importance of parental involvement
Session 2	Breaking apart numbers for multiplication Standard v. extended forms of multiplication/writing numbers out to show place value.	Building and using vocabulary	Linking math to daily life

Session 3	Multiplying with area model (one digit $\times$ two digit)	Determining what is important in word problems.	Using questions to promote student thinking
Session 4	Multiplying with area model (two digits $\times$ two digits)	Visualizing	Encouraging children to be teachers
Session 5	Distributive property of multiplication	Making inferences	Employing strategies interchangeably

Parents were guided in employing specific prompts with their children to facilitate their children's ability to solve mathematics problems; the problem types reflected those children completed in school and were aligned with the curriculum. Weekly sessions included the following instructional components:

1. Introducing and defining weekly strategies in math and literacy.
2. Modeling strategies and employing guided practice in which the researchers model the completion of 2-3 problems, employing a think-aloud procedure.
3. Initiating cooperative practice, asking children and parents to complete additional problems as a group, as researchers mediated their participation.
4. Providing parent/child dyads time for individual practice in break-out groups to practice using the strategies with their children, as the researchers provided help, as needed.

Across all instructional weeks, parents were taught and encouraged to use literacy strategies to help read and write word problems and share their thinking in terms of the correctness of hypothetical problems. Parents were also provided opportunities to work with children to solve the given mathematics problems. Each week, activities included writing and describing real-life word problems that could be solved with similar numbers and operations (Table 3 includes the literacy strategies and corresponding mathematic strategies).

For example, in week three, instruction targeted multiplying with the area model (1-2 digits) and utilized the literacy strategy of determining what is important in word problems. The instruction began by explaining the literacy strategy. Researchers presented the following sentence: *Sasha Smith, a 4th-grade student at Smith Elementary School, won first prize in the rotary speech contest with her essay titled "What Freedom Means to Me."* Researchers then highlighted

the most important information: *Sasha Smith won first prize in the rotary speech contest.* Students were provided three similar samples to complete with parents, while researchers mediated and provided assistance.

The next step entailed applying this strategy to a mathematical problem. Researchers provided a model using a question that entailed multiplying with an area model (1-2 digits):

Susan and her friend Jim are working on building a rectangular garden. They need to determine the total area of the garden so that they know how many plants to buy. Susan measured and found the length of the garden to be 24 feet. Jim measured the width of the garden and found it was 36 feet. What is the total area of the garden?

Researchers then selected the most important words: rectangular, total area, length, 36 feet. Then, students were provided with additional problems to complete with parents and asked to document the words selected and answer to the math problem. With this approach, researchers wanted to emphasize the approach used to effectively solve mathematical problems using the strategy of determining what is important.

Data Sources and Analysis

Data includes pre- and post-parent interviews and transcripts of parent-child work sessions. Interviews focused on parents' home practices around literacy and math, as well as their beliefs and practices surrounding their involvement and practices around children's homework. Interviews were transcribed verbatim and reviewed to identify home language and literacy use, parents' and children's educational backgrounds, as well as the beliefs, attitudes, and practices surrounding the learning of mathematics. Researchers also collected weekly transcripts of work sessions from the four parent/child dyads, which were included in an electronic file that was generated through the use of "smart pens." When children wrote information used to solve the weekly problems, the pens stored the written data in a PDF file. The smart pens also created an audio recording of parent-child talk associated with problem-solving.

Researchers transcribed all interview data and then coded it to identify themes relating to parents' ability to build on literacy strategies to solve mathematical problems. A constant comparison method was used to analyze all parent interview transcripts and electronic session artifacts to determine characteristics of identified data and enable placement in the appropriate categories (Gay & Airasian, 2003). At the outset of the analysis process, transcripts from interviews and work sessions were independently coded by another researcher; codes were compared, and agreement was calculated until an inter-rater reliability rating of .92 was reached. Codes from the interviews included how parents helped

with math homework, how parents help with literacy, parents' comfort in helping with math homework, parents' comfort in helping with literacy homework, and attitudes about parent involvement in schools. Codes from the work session data revolved around the ways of helping. For example, did parents just read the questions? Did they allow children to work and help when their child asked?

Data from the transcribed interviews were also analyzed to identify statements that best illuminated the parents' beliefs about the change in their child's understanding of math or their beliefs about their role in helping to support children's mathematical development.

RESULTS

Preliminary results indicate that parents responded differently to the program, depending on their existing experiences around mathematics. Analysis of interview and session data show that participating parents increased their understanding of how to support their children's mathematical learning at home and demonstrated some changes in beliefs about the role of parental involvement in children's mathematical development.

Effect of the program on parents' knowledge of how to support children at home in mathematics. Analysis of the interview data reveals that all participating parents, pre-interview, expressed little knowledge of how math was currently taught in school. Post-interview, all parents, even those who reported a strong initial understanding of math, reported an increase in their understanding of how math was taught. For example, one parent, Sarah, stated, "I have come to the realization that it is about breaking everything down because I was always confused by the new way of math. Now, it actually makes more sense; you can see every step of how you got to where you're going, which is not what I was taught." All parents initially reported that their goal in helping their children at home was to get the correct answer. Post-interview, all parents expressed an understanding that the "new" way of math, was just as much about the process, as the product. Another parent, Tabitha, stated, "When I learned, they didn't care *how* we got the answer, but now they seem to care just as much about how they got there, as what the answer is." Although parents expressed this knowledge, not all agreed. Two of the four parents still believed it was more important just to know the answer and one of these parents thought the new approach was "time-consuming."

All parents also acknowledged, post-intervention, the role of reading strategies in facilitating the completion of the inquiry-based and reasoning-focused approaches used in the learning of mathematics in elementary school. Kurt reported, "I recognized that I needed to stop and ask her, 'Are you sure that's the right answer?' What does that term mean? How can we visualize? [My daughter] was very quick to jump on something, and I think that's something I can work on now." Valerie reported, "Literacy skills that help—vocabulary. It really helps them

to have vocabulary to help them understand the context of story problems. Also, the vocabulary helps them understand what to do for the operation.”

The four parent-child dyads engaged in valuable practices in the work sessions, although their participation varied in the ways parents interacted around the problems with their children. We found that when all parents discussed the problems, they utilized the focal strategies during the weekly training sessions (both mathematical and literacy). Their preferred literacy strategy was using vocabulary knowledge to support, and this was followed by determining importance and visualizing. The strategy that was least utilized was making inferences (see Table 3).

Table 3: Use of Literacy Strategies Across Recorded Work Sessions

Parent/Child Dyad	Frequency of Strategy Use Across Weeks			
	Using Vocabulary (Week 2)	Determining Importance (Week 3)	Visualizing (Week 4)	Making Inferences (Week 5)
Kurt/Kim	6	2	1 (Vocabulary, 1 Determine importance)	1 (Vocabulary, 4 Determine importance, 1 Making inferences)
Valerie/Natasha	9	4	0	0
Tabitha/Marie	8	8	30	1
Sarah/Rachel	2	8	1	0

As stated above, a frequency analysis of the literacy strategies used across weeks shows the strategy of using vocabulary prevailed, both in the week it was introduced (Week 2) and in subsequent weeks. For example, session data from Week 2 shows how Kurt used vocabulary to promote his daughter’s knowledge of what is meant by “expanded form” versus “standard form”:

- Kurt:** Explain here how you pick your number using your vocabulary—why is it standard form?
- Kim:** It’s standard form, and it said five in the 10 thousand’s place (student writes).

Kurt: (Looking at writing) Can you explain that number using the expanded form? If we didn't know how to do this, how would you tell us to do that?

Kim: I would say 'five in the 10 thousands place' like standard form is the number, so I (for expanded form) I would say put a five in the 10 thousands place and put a two in the ones place.

Kurt: Good and you then have to get the rest of your digits in your standard form numbers.

Parents' beliefs about the family's role in supporting children at home in children's mathematics development, using literacy strategies. The results of this study revealed changes in parents' beliefs about the role of parents in supporting their children's mathematics homework through literacy strategies. Parents who participated in the intervention reported that they developed a stronger understanding of their children's mathematics homework, which helped facilitate the belief in their ability to support their children at home. Post-intervention, parents expressed increased comfort in using the strategies taught. For example, Tabitha cited how using visualization helped her understand the area model (Week 4). In turn, she could apply this strategy to helping her daughter at home. She reported, "[Area model] was easier to understand because I used visualization. It helps to know how to break out the ones, tens, and hundreds. You know, because I'm used to doing it a certain way." She continues, "The kids understand it because that's how they were taught—but we were taught differently. I know how to explain it now, and when I use visualization, I can explain it better [to her]."

Parents also reported a shift in their beliefs about their role in supporting children's mathematical development at home based on their increased comfort in knowing how mathematics was taught in school. One parent, Sarah, reported, "I was reticent about getting involved because I noticed that I confused her more than helped her. Now, it's fun and a new way to learn [math], and I finally understand. What I've noticed is that the more I get involved, the more stoked I can get her to do it." Valerie, who, pre-intervention, reported the goal of homework support was to find the "correct answer" reported, post-interview, a change in her approach to help. "I did [support my daughter] like an assignment. [I was able to give her] the actual mechanics and meaning behind each problem, and I felt that helps...I think she, indeed, became a little bit more motivated so, so she doesn't hate it anymore."

DISCUSSION AND CONCLUSIONS

There is consensus among researchers on the important role parents have in their children's mathematical development. Yet, researchers continue to learn how to successfully work with families to increase achievement and identify the types of home practices that lead to the greatest growth in children's overall academic achievement (Jay et al., 2013; 2017; Patall et al., 2008). We believe findings from

our research could expand our knowledge of how to work more closely and effectively with parents to help them change their beliefs about assisting their children with mathematics homework using literacy strategies.

Data analysis indicates that even though parents used literacy strategies to help children comprehend key aspects of the given word problem, they still required additional support in evaluating their children's mathematically incorrect solutions. This finding indicates that future programs may need to extend beyond five weeks, particularly to support mathematical knowledge. Moreover, data show that participating parents, those who expressed initial discomfort with math and helping their children with math homework, were more inclined to use the strategies taught in the program. In this study, parents who expressed greater knowledge of math may have less of a perceived need to use literacy strategies. This finding is important for future studies because, as we learned, the ability to do math does not necessarily equate to a knowledge of how math is taught or how to support children in developing skills, such as finding the area model using more than one approach.

There are some limitations to this program. First, there were only four parents who participated and were of a middle to upper-class population. Future research studies can improve these limitations; the researchers might conduct this parent program with a larger group of parents in a culturally and linguistically diverse population for more sustained periods of time (Tiedeman, 2006). The United States has seen an increase in the number of English Language Learners (Protacio et al., 2020). Teachers may have little experience in working with families from culturally and linguistically diverse backgrounds. Parent programs, such as the one detailed here, provide opportunities for parents to participate meaningfully in ways that impact children's educational outcomes beyond back-to-school nights and infrequent parent-teacher conferences.

IMPLICATIONS

To extend the benefit of such parental programs, teachers can also make changes in the classroom. To build on children's funds of knowledge (Moll et al., 1992), teachers might incorporate some of the methods that children are exposed to at home (e.g., the way mathematics is used in supermarkets to add up bills or to compare the price of two different items) into the curriculum implementations during instruction (Leyva et al., 2019). Classroom dialogues can engage students and encourage them to make more connections between known literacy concepts and mathematical ideas from their everyday lives (Peters et al., 2008).

Classroom talk also allows for the exploration of concepts, strategies, procedures, and facts for using the modern curriculum and relating it to literacy concepts and everyday mathematics. Teaching students the way ideas are exchanged and developed supports a social learning environment for children—

creating a community of encouragement, respect, and the exchange of funds of knowledge, a conversation that every child can relate to (Gonzalez-DeHass et al., 2005).

As we continue to learn more about the positive effects of parent involvement in children's school-based learning and the specific kinds of involvement that result in increased student achievement, it is important to investigate the effects of programs that have the potential to build home-school connections. The study aims to promote this understanding and foster achievement in two ways: (1) by teaching parents about school norms and what parents can do in the home to improve children's learning, and (2) by having children engage in practices that promote their mathematical understanding, utilizing what they know about literacy strategies.

Moreover, the current study can contribute to the body of research on parental involvement in supporting children's mathematical thinking facilitated by literacy strategies by providing information on the effects of specific strategies for parents to learn about school-based mathematical instruction.

Additionally, schools can benefit from the implementation of such programs. This model could be of interest to both math and literacy specialists in the development of and maintaining home-school partnerships. "This program model can be adopted by literacy educators in the utilization of resources to be understood and applied for families, as "Literacy leaders have a responsibility to support all literacy partners knowledge of literacy development; likewise, there is a need to respect, advocate, and learn from their partners" (International Literacy Association, 2018). Therefore, this program offers literacy leaders the opportunity to promote opportunities for families to increase their involvement in children's learning. This can be integrated through the use of target parent information sessions at the beginning of the year, continuing on a monthly basis.

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