COMMUNITY MATHEMATICS PROJECT: TUTORING LOW-INCOME PARENTS TO MAKE SENSE OF MATHEMATICS

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Abstract: This research report explores the ways in which the Community Mathematics Project (CMP) supports underserved populations to learn mathematics in a large urban area. This project seeks for parents to have tools to teach their children mathematics at home. As part of a longitudinal study, in this report we explore the experiences of a student-parent when learning and re-learning mathematics with the supports of a researcher and a teacher-parent. Findings suggest that sense-making strategies supported the student-parent to make connections with prior knowledge to figure out new mathematical concepts. Further, the student-parent leveraged from this mathematical knowledge to use it in her daily life and to support her son learn mathematics at home.

Keywords: equity and diversity, social justice, culturally relevant pedagogy.

Objectives of the Study

Family and parent engagement in mathematics is a crucial practice that facilitates and enhances deep mathematical learning (Turner et al., 2012), yet many parents feel disconnected from schools and from their child's education in mathematics (Civil & Berneir, 2006; Mistretta, 2013). Thus, it is essential that teachers learn to leverage children's funds of knowledge (Moll et al., 1992) in mathematics instruction (Turner et al., 2016) to engage families and communities, but it is also imperative that parents feel connected to their child's learning. Indeed, parent participation in the early years of math education of children can increase academic development and math achievement (Cho, 2017).

When parents and families become a part of the goal-setting and deep learning, children benefit. This research report will describe preliminary findings from the *Community Mathematics Project* (CMP)[1], a collaborative endeavor that aims to address mathematics opportunity and achievement gaps that exist, especially as they relate to Hispanic and low-income students in the urban center of San Antonio, Texas. The project supports prospective elementary school teachers to attend to both in school (pedagogy that is centered on the use of student funds of knowledge) and out of school (to connect parents and communities to school/mathematics) opportunities through partnerships between a community college, a four-year institution of higher education, and community centers based in low-income neighborhoods, with a goal of sustainability through the identification of parent experts. This study focuses on a one-on-one tutoring program between a parent educator and a parent tutee.

The CMP is multi-faceted and includes various mechanisms for facilitating partnership between these entities. The community college and four-year institution work to align curricula to improve prospective teacher pedagogical content knowledge and theoretical foundations. Moreover, prospective teachers are provided with bridging opportunities as they matriculate to the four-year institution's teacher preparation program. In this program, students who have been identified work with faculty in a community center to provide mathematics tutoring to parents in low-income communities. This allows the prospective teacher to gain knowledge about community members and parents while engaging them in culturally relevant mathematics activities. Further, parents are

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empowered to connect everyday practices to the school mathematics that they will be learning, and can engage more readily with their student who is learning similar concepts. After one semester of this program in a community center, we envision identifying a "parent scholar" who can assist in sustaining the program once our prospective teachers move on. In subsequent semesters, then, we will work with additional community centers. This one-on-one tutoring aspect of the project will be the focus of this presentation, which will present data related to the following guiding question: What are the experiences of a parent tutee who participated in the CMP tutoring center?

Theoretical Framework

To answer the aforementioned research questions of CMP, there are two main theoretical frameworks that undergird our work. The first framework draws from the immense research that foregrounds the mathematical knowledge and expertise of parents and families. The research in the literature review is situated in frameworks that resist the deficit notion that parents, families, and young children do not engage in practices that connect to mathematical ideas and skills. Rooted within seminal work of Moll et al. (1992) and the research of Funds of Knowledge perspective, when mathematics teachers value the experiences and practices of parents and families, they can make more connections to authentic ways that children use mathematics at home and in their communities.

The second framework continues to dispel the myth that young children only learn mathematics in traditional classroom or pre-school settings—parents and families can play a role in how and in what contexts young children develop their mathematical knowledge and experiences (Berkowitz et al., 2015; Cho, 2017). That is, through collaborations with researchers and mathematics teachers, parents and families can have more opportunities to learn mathematics, which may be shared with their children at home. The work of Marta Civil (Civil, 2007; Civil, Bratton, & Quintos, 2005) and colleagues (Rodriguez, 2013; Téllez, Moschkovich, & Civil, 2011; Willey, 2008) offer examples of how parents and families can engage in learning new mathematics based on their existing experiences. When parents and families have more opportunities to strengthen their own mathematical knowledge by making more connections to new ideas and skills, they can also have more opportunities to engage in similar discussions with their young children; thereby further pushing back on the notion of learning only occurring in the classroom. As a result, a broader outcome of this project is to support more families, parents, and young children to build upon their existing knowledge while seeking new connections to more knowledge. The following sections will briefly discuss the existing literature and seminal scholars who have explored the notion of families of young children in the field of mathematics education. Given these frameworks, it is important to continue to study the integral role that parents and families play on how young children learn mathematics (Berkowitz et al., 2015; Civil, Díez-Palomar, Menéndez, & Acosta-Iriqui, 2008; Jackson & Remillard, 2005; Sheldon & Epstein, 2008) and their background knowledge that can be used as foundation for learning more mathematics.

Methods

Context. In an eight-week course, the researchers and a parent-tutor used aligned curricula to provide mathematics tutoring to parents and care givers seeking for them to have the tools to teach mathematics to their children at home. On this phase of this longitudinal study, the researchers worked with a Latino community in which parents spoke Spanish as first language (L1), they had limited knowledge of English, and in most cases parents held a high school diploma or less. The researchers provided supports in the form of co-teaching and content knowledge to a mother-tutor—Isabel [all names are pseudonyms]—who taught mathematics to parents in her community. Isabel's role was to promote sustainability of the program. From the twenty parents who started the program, we chose one of them—Ofelia—as a case study. We sought to understand teaching moves that could

support Ofelia make sense of mathematics, and understand additional supports that Ofelia can benefit from to learn and to teach mathematics to her child.

Participants. Ofelia participated in an eight-week course in which the parent worked in a triad with the researcher and the parent expert Isabel. One of the researchers observed Ofelia at the community center as she received tutoring classes from Isabel. We sought to observe a parent whose educational background and characteristics represents the average parent of the Latino community.

At the time of the study, Ofelia was 44 years-old. She arrived to the USA 12 years ago by crossing the border. Ofelia has been married for 20 years and has 2 children—the oldest was 19 (attended a local community college), and the youngest was 10 (5^{th} grade). Ofelia went to school in Mexico and studied until 9^{th} grade. Ofelia's main job was cleaning house, however, at the time of the study, she was unemployed. Ofelia shared that she enrolled in the "*Latino Math*" program to support her youngest child to learn mathematics at home. Ofelia expressed that her youngest struggled with mathematics, and prior participating in the program, Ofelia did not have the mathematical knowledge to support him increase his mathematical achievement (Cho, 2015). Ofelia expressed that the differences between the way she learned mathematics in Mexico, and the way mathematics is taught in the USA presented challenges to support her child at home.

Data collection. Data collection took place throughout eight weeks, which was the duration of the course. For one hour each week, one of the researchers went to the community center and supported Ofelia in developing understanding of mathematical concepts along with the parent-instructor—Isabel. In class, the researcher used sense-making moves to support Ofelia relearn mathematical concepts, and also understand and figure out new ones.

Data sources include: 420 minutes of transcripts from classroom observations, 99 minutes of transcript from two interviews to Ofelia and Isabel, detailed field notes from 7 classroom observations, and artifacts such as pictures from Ofelia's work in her mathematics book.

Analysis. Data collection and analysis were iterative processes (Yin, 2014). Coding took place in four cycles. Before coding we adopted an interpretivist approach (Miles & Huberman, 1994) to capture the essence of the participant's sense-making process. Specifically, we coded the different ways in which the participant made sense of mathematics. We also coded on how the participant figured out content by building on prior knowledge. Because we acknowledged the participant's educational background, we coded for her studying strategies to support her in developing new ones.

Initial coding started by re-reading the data, but this time we looked for provisional themes and highlighted relevant quotes. Next, we used a descriptive coding process (Saldaña, 2013) which enabled us to analyze participant's sense-making and figuring out over time. A provisional list of codes emerged and we organized these codes into a "meta-matrix" (Miles & Huberman, 1994, p. 178). In other words, we assembled the descriptive data on a spreadsheet in chronological order. We used short phrases to find basic topics across the different data sources, and labeled each data source with codes. For instance, we focused on how different sense-making moves systematically supported Ofelia to learn the mathematics content and to figure out content without receiving explanations but from building on prior knowledge. Examples of these codes are: patterns, association, logical reasoning, look backwards, negotiate, think out loud, talk at every stage of problem solving, think of alternative ways to perform a task, and so on. To organize and refine the codes and themes we used "code mapping" (Saldaña, 2013, p. 194). In other words, we went through three iterations of analysis to reorganize the full set of codes into a list of 17 categories, to later condense those into 3 central themes: sense-making, figuring out, and studying strategies. These themes are unpacked in the following section.

Results

Working with Ofelia one-on-one for eight weeks enabled us to explore in-depth the supports that she needed to make sense of mathematics. Analysis of the data suggests that sense-making moves supported Ofelia in developing understanding of mathematical concepts to systematically figure out new ones. At the same time, learning about mathematics provided Ofelia with tools to support her 10-year-old son learn math at home, and to be confident to use math in her daily life.

Sense-making and figuring out. One of the challenges to support the development of *sense-making* was to bridge the disconnect between the way Ofelia was taught in Mexico and the way that mathematics is taught in the USA— "apprenticeship of observation" (Lortie, 1975, p. 61). In multiple opportunities Ofelia expressed the need to memorize mathematical procedures and time tables, and to be given answers away as opposed to making sense and finding answers for the mathematical problems. During our first sessions, Ofelia explicitly asked to be explained procedures and to be a passive listener. Ofelia would often give up when working on tasks and asked to be given answers. To move away from top-down learning, the researchers relied on sense-making moves such as building on prior knowledge and using logical reasoning. For example, Ofelia was working on factorization and the number she had was 75. Ofelia's first attempt was to factorize by 2, "¿Se le hace? 75 entre… Y es 5, entre 2 (giggle), 35. [Is this? 75 divided by… And it is 5, divided by, 35.]" In the previous lesson, I explained that numbers that end in 5 or 0 are multiple of 5. The researcher encouraged Ofelia to make connections with the prior lesson and to reflect on how to solve the problem. Ofelia revisited the previous lesson and reflected, "Ay, a ver (erase). ¿Entonces voy a dividir entre qué? Entre 5, a ver (thinking out loud and working). 5x5=25. ¿Entonces divide entre 5? Y luego me da 15. Y 3x5, pienso. [Oh, let's see. Then, I divide it between what? Between 5, let's see. 5x5=25. Then, divide it by 5? And I get 15. And 3x5, I think.]" As part of teaching Ofelia studying strategies, the researcher encouraged her to check her answers. She shared, "A ver, entonces pongo 5x3=15. A ver. Es 75. Let's see, then I write 5x3=15. Let's see. It is 75.]" In this example, we share one way in which we supported sense making by building on prior knowledge and reasoning, and avoided giving answers away and memorization.

Another sense-making move used was thinking out-loud. Thinking out-loud supported Ofelia to self-correct, negotiate, reflect, build from prior knowledge, and to think of multiple ways to perform a task. For instance, Ofelia worked on another factorization problem,

> Ofelia: 7x5=35 estoy repitiendo las tablas (giggle). 7x5=35; 7x6=42. Ah entonces es 42. Entonces me dijo según yo, aquí pongo el 42, lo resto. Serían 2 y aquí sería cero. Entonces bajo el 7, verdad? O ya voy mal? Ahora, 7x3=21; 7x4=28; sería 3. 7x3=21. Hago una restita, y luego son 6 y aquí son cero. Y el último lo bajo. ¡Yo ya no sabía que hacer con este híjole! (giggle). Okay, serían hay ya yai. 7x9=63. 9x7=63. ¿Será? Ya ya recordé (giggle).
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> [*7x5=35 I am repeating timetables. 7x5=35; 7x6=42. Then, it is 42. Then according to me, here I write the 42, I subtract it. It would be 2 and here it would be zero. Then, I bring down the 7, right? Or am I wrong? Now, 7x3=21; 7x4=28; it is 3. 7x3=21. I subtract, and then here is 6 and here 0. And the last one I bring down. I didn't know what to do! Okay, it will be… hay ya yai.7x9=63. 9x7=63. Would that be? I I remembered*.]

In this example, Ofelia said timetables out loud as she looked to the answers. Then, she walked us through the procedure and because she was talking, she self-corrected, and she revisited previous exercises to solve this problem.

Changes in terms of sense-making were more evident by the fourth learning session. By then, Ofelia asked *not* to be told the answers to the problems and she started looking for alternative ways to solve them—*figure out*.

Mathematics in Ofelia's daily life. The learning sessions supported Ofelia not only to make sense of mathematics and to figure out. The learning sessions also supported Ofelia in developing confidence about using math in her daily life, and bonding with her son more as they studied mathematics together. By the end of the program, Ofelia shared how she started using mathematics outside the learning sessions,

Another important aspect of learning mathematics was that Ofelia could develop a better relationship with her son. Ofelia expressed, that learning mathematics allowed her to teach her son content related to his grade level and spend more time together,

Discussion and Conclusions

Secondly because Ofelia comes with an immense amount of mathematical experiences that she can draw from (as is what we posit is true for all parents, families, and young children who do mathematics) we bore witness to Ofelia actively leveraging her existing knowledge with her new knowledge and sense-making practices to advocate for herself during a purchase at a garage sale. Ofelia shows how when parents and families engage in mathematical sense-making while accessing connections to new mathematical knowledge, they also identify moments in which they can access and use this knowledge and practices in their daily lives. Moreover, Ofelia inspires us to help more parents and families to seek a wide number of opportunities for them to use their mathematical knowledge and sense-making practices to enact a sense of agency for fairness for themselves, their families, and communities (McGee & Spencer, 2015). The practice of engaging in sense-making while advocating for fairness and social justice is a line of research that can help the field to know more about the role of parents and families in the broader field of mathematics education (e.g., Mistretta, 2013; Rodriguez, 2013).

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