MATHEMATICAL MOTHERS: INVESTIGATING SHIFTS IN PERSPECTIVE AROUND WHAT COUNTS AS MATHEMATICS

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Bridging the gap between mathematical learning at home and school has been an issue for education research for decades (Galindo & Sheldon, 2012). Expectations for mathematics do not often align for teachers and parents (Posey-Maddox & Hayley-Lock, 2016) and a limited view of what counts as mathematics persists. What needs more attention is the meaningful mathematical learning that happens at home but is rarely seen as mathematics. Parents frequently struggle in supporting their children's mathematical learning, but that struggle becomes productive when parents are recognized as mathematically capable. This paper shows how two mothers shift their perspectives of what counts as mathematics and recognize the rich content in their current interactions with young children. Making such connections between mathematics and parent action can strengthen the relationship between at-home and school learning.

Keywords: early childhood education, informal education

Many parents and teachers struggle to connect mathematics learning for children at home and in school. In many cases, parents feel that they do not understand school mathematics and struggle to help (Jackson & Remillard, 2005), while teachers wish that parents would be more involved in their children's learning (Wilder, 2017). Parents and teachers are often talking past each other, with different goals for children in mathematical learning. Previous work has been done to help parents engage with the mathematical activity that happens at school (e.g., Blevins-Knabe, Whiteside-Mansell, & Selig, 2007; Starkey & Klein, 2000). However, attention to connecting parents to mathematics is frequently school-centric (Jackson & Remillard, 2005) and ignores the meaningful mathematical interactions that may already be happening at home. This element is often missed because parents do not often see these interactions as mathematical (Goldman, 2005), further exacerbating tensions in parents about their mathematical ability. As such, supporting at-home mathematics research would benefit from helping families recognize the mathematics that already happens in their everyday lives. I explore this issue of at-home mathematics recognition in a case study analysis of two mothers of young children by responding to the question: How do parents begin to change their perception of interactions with mathematics when made aware of the mathematics they already do? Making home connections to mathematics may not be a re-teaching of school mathematics for parents, but eye-opening to what happens already in the everyday that is mathematical and supports meaningful connections to children's mathematical learning.

Literature Perspective

In addressing the disconnect between school and family mathematics learning and considering perception changes in parents, this paper highlights literature around parental engagement, parents' current perceptions of at-home mathematics through Funds of Knowledge literature, and common activities rich with early mathematical context. Together, this literature

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perspective shows how helping parents recognize the mathematics they already do can support their intentionality and confidence in such engagement.

Many studies investigating parental engagement indicate a difference in the expectations of student learning for parents and teachers (Quaylan & White-Smith, 2018; Wilder, 2017). Some teachers want parents involved in learning by being physically present at the school, but this is not always possible (Posey-Maddox & Hayley-Lock, 2016). Beyond the disconnect of parents' and teachers' expectations of mathematics is a large body of work around at-home mathematics that shows parents are interacting with mathematics in meaningful ways but are not seeing it as mathematical (Pea & Martin, 2010; Skwarchuk et al., 2014). As Goldman (2005) recommends, "getting parents to recognize their life skills as mathematics is a first and necessary step for building more connections for students with mathematics" (p. 71). Goldman's recommendations, and the continued trends around a lack of recognition of at-home activity as mathematical, frames the intent of this study and its results, that parents of even very young children can be highly engaged with mathematics, and with attention to their interactions as mathematical, they may become more intentional in the mathematical learning for their children.

The literature on at-home mathematics that centers Funds of Knowledge (Moll, Amanti, Neff, & Gonzalez, 1992) is one area that recognizes the value of the mathematical activity that occurs in the everyday lives of families. Funds of Knowledge work has shown the significance in validating parents' mathematical skills by increasing engagement in parents, which in turn can support children's mathematical engagement (Gonzalez, Andrade, Civil, & Moll, 2001; Whyte & Karabon, 2016). The present study acts to enhance the intent of Funds of Knowledge literature on parental engagement in mathematics. The existing literature stresses the impact on children and creating stronger school and family relationships. This study highlights the specific impact on parents' mathematical identity when shifting perspectives of themselves as more mathematical thinkers.

Given this study's focus on parents with young children (i.e. pre-kindergarten age), it is important to identify what kinds of activities are likely to occur in families that are rich in mathematics. Significant literature has explored types of mathematics in authentic activity that can be done (or have been done) by parents for the sake of school readiness (e.g., Anderson & Anderson, 2018; Leyva et al., 2017) and include skills such as numeracy, shapes, spatial reasoning, and measurement. At its core, Cannon and Ginsburg (2008) argue that "mathematics education should be fun, be relevant to young children's lives, and build on their fledgling mathematical understandings" "p. 242). This means activities that parents do with their children that are connected to their interests and building on beginning math understandings are meaningful forms of mathematics education. The activities present across the literature in early childhood mathematics become touch-points for activity in the work of the participants of this study, drawing attention to similar activity that they already do, as mathematical activity.

Theoretical Perspective

Supporting parent recognition of their actions as mathematical is tied to concepts of mathematical identity. Drawing from Bishop (2012) and Martin (2000), I frame mathematics identity to mean that how a community recognizes certain actions as mathematical or not will influence an individual's perspective of their own mathematical identity. Mathematics identity is about beliefs of ability, constraints, opportunity, and positioning of self and others in what it means to do mathematics (Martin, 2000). As Bishop (2012) summarizes, "a mathematics identity is dependent on what it means [to] do mathematics in a given community, classroom, or small

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group" (p. 39). I understand this perspective to mean that how a community recognizes certain actions as mathematical or not will influence an individual's perspective of their own mathematical identity. It is centered around how people see themselves and others, particularly its limitations, as mathematical thinkers, doing work that is mathematical. Previous literature has already indicated that many parents do not see their interactions with children as mathematical (Goldman, 2005) because those actions have not been given recognition as mathematical within their community, whether that be family, schooling experience, or messages from the media. Because identities are malleable (Bishop, 2012), if people are influenced by perspectives around the self, identities can change and grow. If the actions of an individual are given credence as mathematical, then their perspective of themselves as mathematical can strengthen. Mathematical identity is a combination of positioning and action, such that affirming people's actions as mathematical can enhance their mathematical identity. As such, a parent's acceptance of their mathematical identity through recognition of their actions can support more intentional and positive interactions with their children around mathematics.

Study Details and Methods

The results reported for this paper is a case study of two participants from a larger study on the impact of past experience on current mathematical interactions for mothers. While all participants from the larger study demonstrated transitions in their understanding of what counts as mathematics, this paper focuses on the experiences of two participants, given the limited space. The two focal participants, Kelsey and Elizabeth (pseudonyms), are white middle-class mothers living in the Midwest with challenging past math experiences. These mothers are the focal points of this paper because of the interesting transition of their perspectives of what counts as mathematics over the course of the study. The results of Kelsey and Elizabeth shared here are not meant to act as a generalization of what all parents experience, as there are certainly limitations in the range of their perspectives, but the results show what may be possible in shifting parental identity and ultimately engagement with mathematics for families.

The overall study involved a series of three interviews and two observations with debriefs of mothers' past mathematical experience and their current interactions with their children in mathematical activity. All interviews and debriefs were audio recorded and transcribed. Observations were captured with written field notes. The design of the interviews as well as analysis of the data came from a narrative inquiry perspective (Clandinin & Connelly, 2000; McAdams, 1993). Analysis began with reading and rereading the words of the participants, ultimately focusing on themes of the stories told by participants (McAdams, 1993). Further analysis for capturing the participants' meanings and stories was through strategies of meaningful qualitative analysis suggested by Corbin and Strauss (2012): asking questions of the stories told, making comparisons within and across participants, and looking at the emotions expressed in their stories.

The first interview focused on past experience and drawing on memory of what mathematics was like for the participants growing up, in both in-school and out-of-school experiences. Stories shared about past experiences were attached to particular feelings, locations, and individuals. The second interview focused on current practices with mathematics, both for themselves and in interactions with their children. In order to achieve depth in responses that connect to a story-telling model, I related initial questions within Clandinin and Connelly's (2000) three-dimensional space of inquiry, where "stories have temporal dimensions and address temporal matters; they focus on the personal and the social in a balance appropriate to the inquiry; and

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they occur in specific places or sequences of places" (p. 50). Questions were directed to consider experiences in mathematics at different times within the lives of the participants, consider the personal emotions attached and the social context of the moment, as well as the location and its context to the moment. The final interview acted as a form of authenticating what participants shared across the study, with review of particular transcript excerpts and making changes to make sure the excerpts best reflected the participant.

The observations were an opportunity for participants to show activity that could be mathematical and the debriefs of the observation were a time to reflect on how it went and what mathematics was actually present. My aim was to draw attention to the positive forms of interaction that were discussed in their interviews and carried out in meaningful interactions, to show that the mathematics at home can be rich and meaningful (Pea & Martin, 2010). The debrief was also a time to expand on what is recognized as mathematical. After participants discussed what they saw as mathematical in the observation, I would point out actions that I noticed they did and how it was connected to mathematics based on early childhood mathematics literature (Anderson & Anderson, 2018). In both participants and at every observation, there was at least one moment that involved mathematics that was not initially mentioned by the participants that was mathematical. Participants were then given an opportunity to reflect on how the newly proposed mathematical connection to an activity happened in other interactions they had. The time in the debrief sessions that drew attention to, validated, and allowed for reflection of previously unrecognized mathematical action allowed the participants space to shift their perspectives of what counted as mathematics and their perceptions of themselves as mathematical.

Results

Kelsey and Elizabeth showed throughout this larger study how they were developing new understandings of the mathematics they did on a daily basis, building their confidence and their intentions to engage with their children. Kelsey was a confident and effervescent mother in her late 20s, with a 15-month-old daughter, Amelia (pseudonym). She lived with her family in a medium-sized village in the Midwest. Kelsey worked from home, teaching violin lessons, but was a speech language pathologist before Amelia was born. Kelsey consistently spoke of how hard math was for her to understand, and the extra effort she had to put in to make the good grades she wanted. Elizabeth was a deeply empathetic mother in her late thirties living in the suburbs of a city in the Midwest. She stayed at home with her two daughters, Talia who was almost two and Luna (pseudonyms) who was seven years old, both adopted as infants. Talia was part Hispanic and Elizabeth was incredibly intentional in the experiences she provided to make sure that Talia was surrounded by people, books, and toys that looked like her. Elizabeth identified a constant lack of confidence in understanding mathematics that made her more hesitant to engage in mathematics with her daughters at the start of this study.

Math Disconnection

Early experiences in mathematics for both Kelsey and Elizabeth were challenging and often confusing. Both participants identified issues with understanding mathematics and believing that math was not for them. Kelsey found math frustrating because she had to work significantly harder to understand it than any other subject. Her frustration translated into a constant desire to avoid the subject because she felt math was not for her. Elizabeth struggled with confidence in doing the work, feeling that to be considered a good math student she needed to figure it out on

her own. Elizabeth thus avoided math classes she felt she would not excel in on her own. Mathematics did not come easily and was a subject both participants avoided when possible.

Kelsey and Elizabeth did not first believe that what they did with their children was mathematical, and that mathematics was strongly associated with what happened in school. As Kelsey reflected, when she did not feel she did anything with mathematics, "well it's not a worksheet and not a test so I guess I just don't associate math with it" (Interview 2). Elizabeth made similar remarks that indicated an understanding that mathematics was something that happened at school, and for older children, when she shared "my daughter is in first grade so she started doing math already. Um, I don't remember doing math that young but maybe we did" (Interview 1). Although this study was centered on the interactions of mothers with pre-kindergarten aged children, Elizabeth's connections to mathematics frequently returned to her 7-year-old and her school work, struggling to identify what types of mathematics she might be doing with her youngest child. Kelsey and Elizabeth's statements at the start of the study reflected particular perspectives of what mathematics is (problems on worksheets or tests) and when it happens (in school and at later grades) and paralleled their own early experiences with mathematics.

In addition to their remarks about what mathematics is and where it occurs, Kelsey and Elizabeth pointed out how they did not recognize their actions as involving any kind of mathematics. Kelsey's first response to ways she interacted with her young daughter Amelia and mathematics was to laugh and say she did not think she did anything with math. As my study was focused on the interactions of mothers with their pre-kindergarten aged children, I was most interested in Elizabeth's actions with her youngest, Talia. However, Elizabeth's connections to mathematics were almost always centered around her 7-year-old and her school work, struggling to identify what types of mathematics she might be doing with her youngest child. In the debrief of the first observation, Elizabeth claimed "I think, there's a lot that happens that I don't' I don't realize is math." This claim was the first indicator from Elizabeth that her perspective of what math is and what she thought she did with math was limited. Kelsey and Elizabeth's perceptions of mathematics tied to school activities and later grades paralleled the lack of mathematical activity they saw in the interactions they had with their younger children.

Transition of Perspectives

The asking of pointed questions about mathematical activity and affirming actions seen in observation led to a shift in perspective. Following the debrief meetings that pointed out particular instances of mathematical activity that the participants already did were reflections on how they saw those interactions with new eyes, and how many other practices contained meaningful mathematics. It was the participants' reflections on recognizing current activity as mathematically rich that framed their transition of perspective about what mathematics is and their mathematical identity.

Kelsey, as a speech language pathologist, initially talked about how she did not do math but was intentional to connect to language and reading for her daughter. After the second observation, Kelsey reflected on the change in the math language she thought she used before the study:

> I feel like I've noticed a lot more since doing this [study]. Um, just different words…and initially I didn't really, when you were like 'what experiences with math do you have with Amelia?' and I'm like 'hm, nothing, she's 15 months old' [laughs] but now, having thought about it more and you asking questions I've realized how much those, how often those words

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> come up and I feel like they come up in everything. In bath time, in meal time, in playtime, in story time in…like everything. So it's the same kind of vocabulary, but in lots of activities (Debrief 2).

Her recognition of the language modeling she did as mathematical helped her to realize that math learning was possible and already occurring with her young daughter. She used language that supported size comparison, amount, compared shapes, and described quantity, in the activities she did every day. This study prompted Kelsey's attention to her actions and word choice as mathematical and already occurring in her interactions.

Elizabeth showed similar recognition of the mathematics she was already doing with her youngest daughter, when before she did not believe that mathematical learning could really happen for a toddler, starting instead in school. During the observations, Elizabeth showed engagement with her youngest in a number of activities that used mathematics: making patterns out of blocks, comparing the size of towers, fitting toy people in a train, and counting sheep in a farm book. For Elizabeth, this growth was in reflecting on ideas of what mathematics could be possible and also prompting from observations the particular interactions that were viewed as mathematical. In taking more time to think about her involvement in mathematics after the second interview, Elizabeth shared how she went to bed thinking of many more activities that they did as a family that involved mathematics but she had never thought of before. Time for reflection on what math happened brought up many other affirming actions that Elizabeth recognized in herself. Additionally, the debrief of observations for Elizabeth prompted numerous interactions that were pointed out by the researcher as mathematical. For example, in pointing out her use of patterns in a play scheme with Legos, Elizabeth explained "you said 'oh do you see patterns in other activities that you do?' and I was like 'wait patterns? This is about patterns. Oh that would be math.'" (Final Interview). Affirming a small activity involving mathematics helped her see it as a mathematical situation and prompted her to make connections to other ways she did or could in the future use mathematics with her children.

Discussion

How Kelsey and Elizabeth understood what mathematics is shaped their perspectives of themselves as doing (or specifically not doing) math. Their past experiences with mathematics shaped their perspectives of what mathematics must be and how they fit into the narrative of mathematical experience. How they framed themselves and mathematics before the study is not new for parents. Their perceptions of mathematics from their past and schooling experiences is pervasive across the United States, with mathematics viewed as doing algorithms and mental calculations (Stevens, 2013b). However, Kelsey and Elizabeth were doing mathematics with their children, in meaningful and important ways. The perspective of what counts and how Kelsey and Elizabeth saw themselves as supporting mathematical learning was already adapting with the naming and recognition of their activities as mathematics. Their initial experience reflected a continued problem in the disconnect between at-home and at-school mathematics, that the meaningful mathematics learning that was already happening in the home was not recognized as mathematics (Anderson & Minke, 2007). The transition in perspective highlights two key features for understanding parents' mathematical engagement: that what counts as mathematics is much broader than what many people would recognize and that much mathematical learning is already happening outside of school even for very young children.

Kelsey and Elizabeth's past experience in school mathematics and initial understanding of what counts as mathematics reflects a limited view of what counts as math: higher level work, tests, and worksheets. These earlier perspectives are built from what their surrounding culture has taught them that math should be, and for them that was centered on what happened in school. As Stevens (2013a) highlights, "what counts as math or science depends on how the culture represents them, and school is but one setting where math and science are represented" (p. 4). Mathematics that happens at home may not involve worksheets or algorithms but can still build important skills in mathematical thinking. What counts as mathematics includes both formal and informal activity. As Skwarchuk et al. (2014) emphasize, formal and informal mathematical learning is important for early mathematical development, and those informal activities that happen at home are part of that learning. Much of the activities that Kelsey and Elizabeth engaged in paralleled activities in existing literature about early math skills (Leyva et al., 2017).

While what counts as mathematics is much broader than what happens in a school setting, this does not mean parents need to change or incorporate specific activities to engage in real world mathematical activity. The recognition of more activity as mathematical shows how those skills are already being learned at home. There is so much mathematics that can and already is happening at home with families. For Kelsey and Elizabeth, this included describing numbers of objects and comparing them in books, talking about objects fitting into other objects during play, and describing patterns in building blocks. Each of these interactions was related to a foundational mathematical concept that before this study, neither participant would have indicated is mathematical. These sample activities of Kelsey and Elizabeth are also part of a larger list of activities parents have been shown to do with their children, engaging in informal mathematical connections (Anderson & Anderson, 2014; Leyva et al., 2017). Much of the interactions with children parents already have are mathematical, even if they do not initially recognize them as such (Goldman, 2005).

Research using a Funds of Knowledge approach (e.g., Whyte & Karabon, 2016) does center families as mathematical knowers. Similar to what occurred in this study, Funds of Knowledge research draws attention to parents' activity and mathematical skills in the context of their lives. For example, in Gonz lez and colleagues' study (2001) they found "that household knowledge is broad and diverse, and may include information about, for example, ranching, farming, and animal husbandry, which are associated with households' rural origins" (p. 117). These activities have embedded mathematics that is not often highlighted or validated as mathematical in a school setting. The body of work within Funds of Knowledge research highlights the value of parents' skills in mathematics, while the current study pushes further to consider the impact of valuing parents' skills on their changing mathematical identities.

The final link between these themes of mathematics as a broader field than what happens in school and recognition of the mathematics that parents already do with their children is shaping parents' mathematical identities. As framed earlier, mathematical identity is about what it means to do mathematics in different settings (Bishop, 2012). In the case of this study, when the participants were positioned as mathematical through the activities they engaged in with their children, it strengthened their own mathematical identities. Kelsey and Elizabeth's past experience with mathematics shaped a particular perspective of who they were in the subject: bad at mathematics. However, reflections and time in the study helped them recognize other ways to engage with mathematics and build confidence in what they did with their children in the subject. Kelsey and Elizabeth's changing perceptions of themselves and mathematics was similar to what Esmonde and colleagues (2013) found in families engaging with mathematics activities

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at home, that it is more than just "someone who was good or bad at mathematics" (p. 18). The current analysis of Kelsey and Elizabeth digs deeper into Esmonde and colleague's (2013) results by looking at the evolution of perspective for parents with a history of mathematics aversion. The difference being made for these participants shows that pointing out the mathematics that was already happening in their homes helped them recognize their actions as mathematical and feel more confident to encourage types of play that would incorporate that mathematics later.

Significance and Future Work

The experiences of parents and families interacting with mathematics can be significantly different and more diverse than what happened in the lives of Kelsey and Elizabeth. The point of this paper was not to generalize the experiences families have with mathematics and mathematical identities. Instead, it was meant to show what changes are possible in the parent perspective in mathematics and spark more research that engages exploration of parents' mathematical identities and activities with their children. Creating connections between the everyday activity of parents and that of mathematical thinking has the potential to further support children's mathematical development. As Goldman (2005) argued, "getting parents to recognize their life skills as mathematical is a first and necessary step for building more connections for students with mathematics" (p. 71). Recognition and action in mathematics has ties to Bishop's (2012) perspective of mathematical identity. Mathematics identity is built off of the actions of an individual and how those actions are accepted as mathematical by the community. In the case of this study, Kelsey and Elizabeth were already doing mathematics, but needed the recognition that their actions were mathematical. Funds of Knowledge research grounds families' experiences as legitimate mathematics, but can be pushed further to consider the change in mathematical identity of parents when their activity is validated. This change in mathematics perspective for families can build confidence and create further engagement with mathematics, ultimately supporting children's learning.

Mathematics learning is often studied as school-centric, privileging the knowledge and structure of learning that happens in school (Jackson & Remillard, 2005). However, rich and meaningful mathematical learning can and does happen outside of school (Pea & Martin, 2010). Researchers can create better connections between schools and families in mathematics by recognizing and encouraging the mathematical learning that happens from the parent perspective. Stevens (2013b) proposes this call for the research community to "build a conceptual vocabulary that does not take school mathematics as the exclusive reference frame for understanding mathematical work across society and that can follow mathematical practices in and across time and place, including school" (p. 81). This study focused specifically on parents, to recognize the authentic and contextual mathematical experiences as a bridge to children's mathematical learning. Broader vocabulary, broader understanding of experiences and what counts as mathematics has the potential to validate the mathematical activity that happens at home.

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