On the Meaning of Young Children's Mathematics Learning

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Abstract

Through events of kindergarten children learning mathematics, I examine how experiences can shape an idea of what mathematics is and what its purposes are. I question how mathematics is experienced by young children in schools, how those experiences may shape students' perceptions of mathematics, and how teachers can disrupt the unintentional messages that mathematics teaching can convey. I pose that mathematics instruction should foster children's understanding of how their worldviews shape their perceptions of the discipline; allowing them to experience mathematics as a resource to problem-solve and think about the realities of the world around them.

Discussion And Reflection Enhancement (DARE) Pre-Reading Questions

1. During your years in school, did you have an experience that made you fall in love with mathematics? If so, describe it.

2. What ideas about mathematics are more prevalent in recent mathematics instruction you have implemented or observed?

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> *Ogni comprensione del singolo elemento è condizionata dalla compressione del tutto. Ogni spiegazione del singolo elemento presuppone la spiegazione del tutto.*[1]
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> - *Hans-Georg Gadamer*

Beginnings

I don't remember falling in love with mathematics. I remember learning mathematics. As a child, I measured odd things like school staircases, played with Cuisenaire rods in and out of the classroom, learned about the history of fractions, made drawings, and did mathematics in the "real world". Such experiences learning mathematics ingrained in me that numbers are never a neutral representation of quantity; they are socially constructed and take their meaning from our experiences with them. My high school years centered on learning mathematics in connection to complex philosophical, historical, and aesthetic issues. I learned in deep ways that mathematics was primordially a way people had developed to see the world, with its own set of assumptions and pre-established rules. It was then that I realized that I loved mathematics because I came to understand how mathematics could help me create meaning and transform the world. It was then that I experienced mathematics as a deep expression of the ways of being of humans and the world that we live in.

This feeling of being in love with mathematics is still with me and has guided me as I continued to learn about it, transitioning from student, to teacher, to educator and researcher. In recent years, I have observed many other teachers' mathematics instruction and I taught mathematics bilingually to kindergarten students in the role of researcher and volunteer teacher. Indeed, it is through the diversity of experiences learning and teaching mathematics that I have come to be curious about the messages that children receive about mathematics in formal schooling and the impressions children may have of what doing and knowing mathematics is. I have come to wonder why it is that mathematics is so often thought of as a neutral and objective discipline, as a practice that is significant only for schooling purposes, or as an abstract skill that operates with no connection to context and of little use in understanding our social world. I have reflected on how my own experiences created such a different perspective of mathematics, helping me see it as a contextualized resource to make sense of our social world. Thus, I am curious to understand how individual experiences young children have with mathematics build on each other to create many different meanings and purposes for learning it.

Sharing Stickers Lesson

For me, questions about how young children learn about the meaning of mathematics became tangible through a conversation with a group of 22 kindergarten students that I taught two mornings a week as part of my research. The conversation came at the end of a lesson where we were collaboratively working to think of different sharing scenarios that would require subtraction to solve them. As a whole group we were discussing how many out of a group of ten stickers I should share. After I placed the sticker sheet on the whiteboard for the children to see, we discussed if I should share a few or many of the stickers that I had. Several children gave their perspectives in Spanish and English, arguing different points of view and mainly stating that I should share a few because I would want to keep most of the stickers. Some of the children stated that I should share half of them, claiming that it would be fair to share and keep the same amount. Few children argued that I should share most of them because that is what the person I would share with would want. After several children gave their perspectives, we did a quick round where most of the class suggested a specific number of stickers I should share. We finally decided to see how many I would have left if I gave 8 away. This was an opportunity for the children to practice using some of the mathematics skills and concepts they were learning. Once the children concluded that I would have two

[1] Translation from Italian: "Each understanding of a single element is conditioned by the understanding of the whole. Every explanation of the single element presupposes the explanation of the whole."

stickers left, I asked if they thought I would be happy or sad. Most of the class responded by immediately yelling that I would be sad, except for one girl who raised her hand. When I called on her, she said "Feliz porque compartiste" (happy because you shared).

After that conversation with the kindergarten students, I left school with a feeling of clarity. I started thinking more openly about the importance of the ways we present mathematics to children. I recognized the experience of the student who thought sharing would make me happy as different. It resonated as a moment of learning mathematics that afforded connections to the student's past rich experiences and to demonstrate complex thinking about the social world. I pondered if this experience simply emerged from the question I posed about feelings and questioned what contributes to young children's understanding that numbers offer a quantitative representation to think about the complexities that we face as people. As I thought of the lesson as a whole, I also reflected that I had only come to problematize and critically examine what it means to learn mathematics since my role had changed from that of a student to that of a teacher. Thus, I questioned the messages children are implicitly receiving and perceiving about mathematics learning and its purpose in our social world.

Alligator and Flies Lesson

The lesson about sharing with the kindergarten students seemed like a stark contrast from a recent lesson that I had observed that seemed so representative of many lessons I had taught myself and that I saw in classrooms I visited. During the observation, the teacher had set up her mathematics instruction in small groups of about 6 students. The group that was working with the teacher focused on word problems on a worksheet to help prepare the children for district-mandated tests. The teacher effectively coached the children to find correct results using their own mathematical strategies and developing new ones, being particularly attentive to students who had difficulties. It was an enjoyable lesson, it demonstrated many current pedagogical practices for teaching, the children were focused, and the children explicitly stated feeling successful. Still, what stood out for me was the complete lack of sense of the context proposed in the word problems that talked about an alligator eating flies. Neither the teacher nor the children seemed to spare time thinking about the alligator or the flies, their attention was on developing sophisticated representations of quantities through abstract models, numerals, and operations.

The contrast between the two lessons described helped me notice that our work as teachers of young children is often to help them identify the important information in a particular situation; for instance, the concept a lesson may address or simply the purpose of everyday classroom activities. During the small group activity the teacher helped the students identify and practice the skills they would need to be successful during the test. However, when we focus on certain pieces of information, we are also neglecting other pieces of information that may be relevant in other ways. Particularly, mathematics teaching often entails helping children learn the necessary knowledge and skills to be able to understand, represent, and solve mathematically the ideas and abstract patterns we identify in our world. During mathematics instruction, teachers may find necessary to coach children on how to distinguish the relevant or essential information to effectively follow a mathematical procedure or describe a situation mathematically. Yet, this may be sending the message to children that mathematics works mostly abstractly and independently of context.

Further Reflections

To better understand what I mean, it may be helpful to think of an example. For instance, think of a common word problem: Jane has 10 apples, she gives her friend 8 apples, how many does she have left? In this case, we may think the key information for a young child who is learning to solve this mathematically is the information that is necessary to translate the words into a number sentence that they can then solve to find the answer. In other words, we may think that the child needs to be able to separate the quantities (10 and 8) from the rest of the information and be able to identify how those quantities relate to each other through a mathematics operation (in this instance subtraction). There is probably little purpose for the child to think about Jane or the apples. Although approaches like this may support the child in being able to effectively and accurately perform a mathematics process, they may also inadvertently communicate that

mathematics implies finding the pattern, thinking abstractly, and not focusing on the context that could actually make the task relevant. This may communicate that numbers mostly work abstractly and in time this message can easily translate into understanding mathematics as an objective and neutral representation with little connection to context or the experiences children have in their social world.

In the end, the numbers and operations behind the word problem about Jane and the apples are not fundamentally different from those the children and I explored through the conversation about sharing described earlier; both instances require us to subtract 8 from 10 to find an answer. However, I pose that the experience of mathematics for the students in these two scenarios is fundamentally different and each conveys a different message to children about what mathematics is and what its purpose should be. Thus, teachers must consider how the experiences and lessons they facilitate help children understand that the mathematics skills and concepts being learned have a purpose and are useful in the situations they encounter. My experiences in multiple mathematics settings have led me to notice that even children who can carry out mathematics operations successfully and accurately often have difficulty applying their skills in authentic situations or to solve problems. For instance, a child may be able to correctly add 4 and 7, but they may not be able to correctly identify and solve that operation in a word problem or find the total number of materials they need to give to a couple of small groups when it is their turn to be the class helper. Many children are yet to learn how mathematics can be a resource when they encounter everyday dilemmas. There is a need for teachers to create genuine contexts where mathematics skills and concepts can be deployed with agency on the part of the students to make sense of complex situations, contexts where children have freedom to explore how to use different mathematical concepts and procedures with purpose.

The conversation with the kindergarten students about sharing stickers described earlier portrays an experience of mathematics that is not objective or neutral. When the students and I talked about the various ways to distribute the stickers, what was at the center of our discussion was the context surrounding the numbers and the children's past rich experiences. The children were able to experience how the numbers offered a multifaceted representation of the dilemmas that arose from sharing; a representation that allowed them to explore the complexity and implications of the situation. They were able to make connections and see how the number of stickers shared could create a feeling of happiness or sadness, and on a larger scale understand that numbers are not only abstract concepts but resources to read the world that can have important implications. Through the open conversation, the children also had the opportunity to see and experience how their worldviews shaped their perceptions of the numbers and how this may contrast with that of their peers. The lesson materialized my own experience of mathematics as a social practice, creating an opportunity for students to experience it as such.

Since I taught the lesson about sharing with the kindergarten students, I have continued to come back to it as an example that can help teachers identify different factors that facilitate a different experience of mathematics for children. For starters, it may be helpful to consider that the lesson within which the conversation about sharing emanated did not happen in isolation. Over the last few years, I have come to understand that for kindergarten children the issue of sharing is often a relevant one and one that they can easily translate into questions represented through numbers and other mathematical concepts. Hence, sharing was a scenario I presented to the kindergarten students often, creating similar lessons that provided different levels of support from me as the teacher. During the second semester of the school year, the children and I had been exploring multiple mathematics concepts in relation to the idea of sharing. During that year, the children and I thought about sharing in multiple contexts and situations to explore concepts such as addition, subtraction, and comparisons of numbers.

Throughout these lessons, the children explained and explored different perspectives on sharing, drawing on mathematics skills and concepts in their own terms and arriving at their own conclusions. The children were likely to suggest that people should share equally when talking about possible abstract scenarios. However, when it came to be their turn to share, or when we were working with real objects such as stickers or food, they were more likely to take different approaches, such as wanting to

keep the most. Children's stances also changed when they shared with someone they were friends with, being much more likely to give away something that they liked or wanted to someone that they cared for. Students were also likely to share a larger amount when both people sharing had something that the other wanted. All of these experiences gave dimensions to the numbers and mathematical concepts we were learning. Each child crafted a personal way to use mathematics skills and concepts, providing a path for them to make connections to their own lived experiences and contrast them to those of their peers.

The focus on mathematics also provided opportunities for the children to explore sharing through new concepts and ideas they were learning as part of the mathematics curriculum. For instance, the number zero proved to be an interesting way for the children to explore their own beliefs and perspectives regarding the limits of their generosity. Throughout the different lessons and conversations, the children quickly discovered that they could use the number zero to describe a situation where they wanted to keep everything that they could. This led the class to have interesting discussions about what was sharing and what was not, and when it was okay to share or not share. More often than not, when a classmate suggested sharing zero another child would explain that was not sharing. Over time the children developed an implicit rule among themselves about not using zero for sharing. There were also more complex conversations about sharing in relation to zero. For instance, when the children discovered that it was possible to give everything away and keep zero, thus challenging their perspective that zero could not be used for sharing.

Sharing proved to be a relevant concept and experience for young students to learn and think about. Yet, it was not just the focus on sharing that created a meaningful mathematics learning experience for students. It was the way sharing was approached as a concept that students were already trying to understand in different contexts, positioning it as a complex experience that was open to multiple perspectives that were appreciated as equally valid. In my work, I learned that there is a plethora of ideas and contexts that could be used to create opportunities for young students to meaningfully learn mathematics such as the conservation of resources, equality and equity, or the purpose of comparisons. Children are actively making sense and noticing the realities around them. When teachers make connections to their students' inherent curiosity, they create an opportunity to learn about the ways mathematics is a social practice itself and a resource to make sense of the world.

Accordingly, another important factor that significantly contributed to creating a different experience of mathematics for students is that the lessons around sharing were happening bilingually, drawing on both Spanish and English as resources for learning and discussing mathematics. The lessons were implemented within a Dual Language Immersion program where children received instruction in both Spanish and English, with formal instruction being predominantly in Spanish. This meant that the children in the kindergarten were bilingual in Spanish and English with varying levels of proficiency. Although mathematics instruction was intended to be in Spanish, I often encouraged the use of both Spanish and English simultaneously during my lessons. I used this as a pedagogical practice to foster children's ability to make connections across languages and to provide an authentic experience of the way languages are used to communicate and understand among bilingual speakers. In this sense, the use of both languages intended to create a comfortable learning space for children, extending and supporting the experience of mathematics as a socially relevant practice that builds and is shaped by the resources and experiences we have as individuals. The open discussions about sharing were not only intended to be an open invitation for children to engage with mathematics in their own terms, they were also spaces where the children could learn from a teacher who actively chose from her languages carefully as she thought about dilemmas.

Creating learning opportunities for children to experience mathematics meaningfully requires teachers to make intentional instructional choices. Through the discussions of earlier examples, we may note how such learning experiences involve purposefully creating a space where children can practice making choices about using mathematics concepts and skills to make sense of the world and resolve dilemmas, designing and modeling dilemmas mathematically instead of just solving them, and having open conversations about and through mathematics. For this to be possible, teachers and

educators need to create and identify meaningful contexts from which children can make sense of mathematics, arising from their noticing of children's thinking about it. Equally as important is for teachers to craft learning experiences for children to become experts; creating opportunities for repetition with concepts, skills, issues, and activities. Doing so can support a sense of mastery and comfort for children who initially were hesitant about engaging with invitations into mathematics learning. Repeated engagement can also foster multiple experiences and perspectives of the concepts and skills being learned. More importantly, creating learning experiences for children to understand mathematics as meaningful requires us as teachers to intentionally reflect on what we believe ought to be the purposes of mathematics, what we want to convey to our students through its learning, and invite young students to actively reflect on what they believe ought to be the purposes of mathematics.

I framed this writing with a quote that reminds us that each individual part constitutes the whole and that the whole is always represented in each individual part. To me, the quote evokes the idea that individual experiences we have with mathematics build on each other to teach us what mathematics *is*. The quote also helps us reflect on the idea that each individual experience of mathematics that we construct with children materializes what we have learned and think mathematics is. Thus, the quote is a reminder of the ways people are interconnected; of how single elements come into their full meaning in relation to others, as a part of a larger set or network. As I consider the experiences of mathematics that I shared in this writing, I cannot help but reflect on the importance of thinking of our students as interconnected to their communities. If we think of our students in such a way, then we are also called to think of our students as people in a process of transformative learning; as people who come with past rich experiences to our classrooms and who will have futures beyond those we can imagine as their teachers. In doing so, we can understand anew the importance of helping our students see mathematics as a resource to comprehend the complex realities that we face in our social world and start thinking more intentionally about the meanings we want to help our students find in the practice of mathematics.

Discussion And Reflection Enhancement (DARE) Post-Reading Questions

1. What ideas do you think your students have about what mathematics is?
2. What role does context currently play in your mathematics teaching?
3. What messages do you want to intentionally convey to your students about mathematics and its practice?

"DARE to Reach ALL Students!"

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