

Toddler Engagement in Math through Play at a Child Development Center

By Jill M. Davis

Mathematics is an important part of young children's lives. They use mathematics to solve problems, order their universe, and make sense of their world (Geist, 2009). Evidence of mathematical thinking can be observed throughout the early childhood classroom as children place one cup in front of each chair at the dramatic play center, pour sand into different sized containers at the sensory table, and sort manipulatives into their containers during clean-up time. However, children construct mathematical ideas long before entry into school. In fact, it is during the first 5 years that children begin to learn the concepts that will support the formal math learned later in life (Hansen, 2005; National Council of Teachers of Mathematics, 2000). However, there is an extremely limited amount of research on mathematical knowledge of children under the age of 5, especially toddlers (Björklund, 2008; Reikerås, Løge, & Knivsberg, 2012; Sarama & Clements, 2009). The purpose of this research was to explore how toddlers, ages 1 to 3, engage in mathematics through play at a child development center.

Literature Review

Researchers support the idea that infants begin to develop an understanding of mathematical concepts beginning at birth (Clements, 2005; Greenberg, 2012; Ozdogan, 2011; Reikerås, et al., 2012). In fact, Geist (2001) proposed that children have a *mathematical acquisition device* that allows them to attain mathematical concepts without direct teaching. He analogizes this to Chomsky's theory of an innate language acquisition device. Just as children are born ready to learn language and build literacy concepts, they are also born ready to develop mathematical understandings. This mathematical acquisition device enables young children to construct the foundation necessary for later mathematical understanding, described as *emergent mathematical understanding*. He believed that the earliest understandings occur during the first few months of life, long before children are able to verbally express their ideas. They use actions to demonstrate what they are unable to articulate through language. These actions are often expressed

through play.

Lee (2012) studied the mathematical play of young children between 13 months and three years of age. She analyzed videotapes of the children's actions and interactions and identified seven categories of mathematical play: space, number, measurement, shape, pattern, classification, and problem solving. Space included spatial understanding and explorations of space. Number included counting, cardinal knowledge, and the use of numbers as symbols. Measurement concepts included discussion of non-standard measurement, such as volume and weight. Naming, representing, and manipulating geometric shapes were included in the category of shape. Patterns included repetitions of actions and songs. Classification included sorting objects, data, and ideas. Problem solving included using strategies to solve problems both physically and cognitively. The first six categories were observed in individual episodes of play while problem solving was demonstrated in the other six categories. Lee's observations demonstrated that a variety of mathematics can be seen in a toddler classroom.

Research Methodology

The research question asked was *what kinds of math concepts do toddlers, ages one to three, engage in during play at a child development center?* This qualitative, single-case study took place in a toddler classroom at a child development center that also served as a laboratory school at a community college. It operated as a year-round, full-time childcare facility for faculty, staff, and members of the community. Purposeful sampling determined that the child-centered, play-based orientation of the classroom would make it appropriate for this study.

Participants in this study included the children and their teachers. There were 12 toddlers, 6 males and 6 females, ranging in ages from 19- to 31-months old. Ten children (83.3%) were Caucasian, one child (8.3%) was Native American, and one child (8.3%) was African American and Native American mixed. All of the children and their families spoke English as their native language. All of the parents in the class gave consent for their children to participate in the study. The two lead teachers in the classroom were both Caucasian females. Katie, age 23, worked 7:00 a.m. to 4:00 p.m. At the time of the study, she was working toward her Bachelor's degree in Early Childhood Education. As the former lead teacher in the younger toddler class, she looped up with 8 of the 12 toddlers in this study. Tonya, age 29, worked 10:00 a.m. to 6:00 p.m. She had completed a Master's degree

in Psychology. She had several years of experience working with preschoolers but this was her first experience as the lead teacher in a toddler classroom. While there were several assistant teachers and student teachers present during data collection, the focus of the study was on the toddlers' primary caregivers.

I collected data from three primary sources: observations, interviews, and field notes. At various times of the day, I observed self-guided play. Although I initially positioned myself in areas likely to have the most opportunity for mathematical play such as the block or manipulative center, when those areas were vacant, I moved to other occupied areas. The play episodes were audio-recorded and field notes were written during eight 30 minute collection periods. I transcribed the tapes and used field notes to expand the context. I conducted semi-structured interviews with the two lead teachers, focusing on the kinds of math concepts that the toddlers engaged in during play. These interviews were also audio-recorded and, later, transcribed. Member checks were done with the two lead teachers to determine accuracy. Using a starter list of codes taken from the literature, I read over the transcriptions from the interviews and observations several times. These codes corresponded to Lee's (2012) seven categories of toddler math concepts during play, including numbers, space, measurement, shape, pattern, classification, and problem solving. I triangulated the data with entries from the field notebook.

Research Findings

There were three mathematical categories there were most often seen in the data: classification, number sense, and shape.

Classification. Classification, including early skills of matching and sorting, appeared in the data most often. Beatrice (26 months) matched shapes that the teacher taped on the ground.

Beatrice notices a large, green circle that Tonya had just taped to the ground. She walks to the easel where there are many laminated shapes. She chooses a circle and lays it on the large, green circle on the floor. Beatrice repeats this several times, choosing a small circle from the easel and laying it on the circle on the floor. When there are no more circles, she uses squares and the large, purple square on the other side of the room.

Most of the toddlers only sorted by a single attribute, generally color. For example, Landon (26 months) placed each of the plastic, colored farm animals in the corresponding

bowls. When he finished, he dumped out all of the animals and sorted by color again. Although this was typical for most toddlers, Katie described how Zander (27 months) demonstrated his mathematical understanding using the same manipulatives.

He'll first group them by color and then he'll take them all out and group them by animal, not even looking at what the color is. So he might have a purple, blue, and green cow all grouped together, but they're all cows.

She compared this to some 4-year-olds who "were only able to group them one way where this child is 2 years old and he's grouping them in two different ways." Katie considered this ability to see more than one attribute in the same object to be atypical for Zander's age.

Number sense. The second most often appearing category was number sense. This included one-to-one correspondence, counting, and numerical understanding. Katie described how Beatrice demonstrated both one to one correspondence and counting while she played with construction materials and a jack in the box.

We have bristle blocks on the ground and we have this pop-up toy. She [Beatrice] had it standing up, and she lined the bristle blocks on the ground as steps going up to the pop-up toy. She had an animal and she was going one by one on the bristle block, counting them: "One, two, three, four" until she got up to the door.

Both teachers differentiated between rote counting and understanding that numbers have meaning. Tonya shared an example of a child who had an understanding of number concepts.

They just automatically say the next number without having to sit there with their fingers (counting) one, two, three. You know, without having to count to find out what happens next. That would be the one that I would say, 'Oh! He's really understanding the number concepts and numbers.' Just because they know how to count to 10 doesn't mean that they understand what they're doing... They could have memorized it because they've been counted with. You know, it's great that they can count, but does it mean that they actually understand they're counting objects? That those numbers mean something? Or is it just like singing their ABC's?

Katie supported this and stated that many of the toddlers are starting to understand that "the number represents something." According to her, the goal is for the toddlers to move beyond rote memorization.

Many of the older toddlers were observed counting. Nadine (31 months) lined up

the toy animals and counted, “One, two, three, four, five, six”. However, not all of the toddlers counted with understanding. Some of the toddlers used number words but did not necessarily use them in the correct order, especially when counting above three. McKenzie (25 months) played with a group of toy people. She counted them, pointing at some people twice and skipping others, “One, two, three, five, seven, nine!” Katie considered this and stated, “She is starting to count but doesn’t count in the correct order. So she is *starting* to understand how numbers work.”

The toddlers seemed to understand the smaller numbers when they used in a context that was meaningful. For example, Eleanor (29 months) used numbers when meaningful.

Eleanor walks carefully across the room carrying a magnetic sphere on top of a cylinder. She almost bumps into Beatrice, who is holding the same shapes. Beatrice is pretending to lick the sphere. Eleanor smiles widely and exclaims, “I have one ice cream and Beatrice has one ice cream!”

Shapes. The third most observed category was shapes. All of the documented observations involved the children naming the shapes as they noticed them during the course of their play. Joshua (25 months) played with magnetic shapes at the light table. He handed a three-sided shape to the teacher and said, “It’s a triangle, Tonya.” Eleanor had a similar experience when she picked up a piece of her shape puzzle and stated, “It’s a circle.”

Both teachers discussed shapes as a part of mathematics but had differing opinions on the importance of shapes in the toddler classroom. Tonya considered shapes to be a “big thing” and devoted a lot of time to shape-related activities. She described an activity in which the toddlers went on a shape hunt.

When we had shapes and colors (as a theme), they would go around the room and find something else that resembled the shape or color that we were looking for. They went and found rectangles, triangles, and squares around the room and we’d come back and talk about all the differences that we saw in the shapes they found.

Katie did not agree with her co-teacher’s assessment. While she went along with Tonya’s plans for doing a shape theme in the class, she confided, “A lot of parents are concerned with their children knowing their shapes. I don’t necessarily think that’s a big issue. They’re going to eventually learn them. I don’t think that’s something that should be pressed.”

Discussion

Most of the observed play and teacher discussion focused only on three of Lee's (2012) seven categories of math: classification, number sense, and shapes. A possible explanation is that teachers tend to be narrow in their understanding of appropriate early childhood math concepts. These categories are the same areas that are typically highlighted in early childhood math programs (Baratta-Lorton, 1995). Both of these teachers were familiar with preschool mathematics: one as the former lead teacher in a preschool class and one as an undergraduate in a university program that focused primarily on children ages preschool and older. An implication is that teacher must not only be *exposed to* but also *understand* a broad range of mathematical content so that all categories are encouraged during toddlers' mathematical play.

With such a limited focus on mathematics with toddlers, there is a plethora of opportunities for research. Possible areas worth further exploration include the mathematical experience of children in more traditional childcare centers; a focus on the mathematical understanding of younger toddlers, and an investigation of how toddlers explore mathematics in other environments such as with their families at home.

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