Math before kindergarten

“What would the world be like if we mathed with our kids in the same way we read with our kids?” (http://www.numbersarefun.biz)

In a fall 2014 study, Penn State researchers answer the question, “Who Is At Risk for Persistent Mathematics Difficulties (PMD) in the United States?” As part of their findings, they identify lower socio-economic status as a primary factor for children who have ongoing struggles with math. (Schwartz 2015) Unfortunately, early childhood educators play only a small role in a family's economic status, but according to the research, preschool educators can take specific steps to help children have success in math. The researchers found that “Before entering school, children may not have much informal exposure to mathematics. Conversations and activities that include talking about mathematics may help reduce children’s later struggles when they are being taught more formally in the elementary- and middle-school grades.” (Morgan et al. 2014) Early childhood researchers like Douglas Clements go a step further to say that intentional math interactions and exercises during the preschool years have direct impact on later learning across domains and are crucial to a child’s future academic success. “While the emphasis on reading proficiency is critical, research shows that the development of mathematics skills early on may be an even greater predictor of later school success. Early knowledge of math not only predicts later success in math, but also predicts later reading achievement even better than early reading skills.” (Clements 2013)

The challenge is that many early child care professionals lack the confidence and understanding of core math concepts to nurture the budding mathematicians in their programs. (Ryan, Whitebook, and Cassidy 2014) Early childhood professionals need to change the direction of attitudes about math before kindergarten so that children receive the message that ALL children can learn math, and all staff gain confidence that ALL adults can facilitate math, given appropriate training and support. It’s no longer “some people are born good at math and some people are not.”

Math skills and understanding

The Erikson Early Math Collaborative lists the following as foundational math concepts:

- **Counting**: not just saying the number, but seeing that there is a connection between a number and an item
- **Data analysis**: basic quantitative information (like how many) and organization of information so comparisons and realizations can be made
- **Measurement**
- **Number operations**: join sets together and separate a collection into parts, recognize how quantities can change
- **Number sense**: connect counting to quantities, understand ideas of more or less and estimates
- **Patterns**
- **Sets**: group, categorize, understand size (small, medium, large)
- **Shapes**
- **Spatial relations**: express directions from different locations and understand relative positions
Understanding in each of these areas happens on a “trajectory.” For example, as a child matures and enhances her understanding of addition, she demonstrates different evidence. Early on, she is able to replicate the number of blocks that she observed being hidden under a fabric. Later, she can act out and “count all” using manipulatives to answer the question “If you have three blocks and add four more, how many will you have?” She might begin to add using her fingers to figure out the written problem 3 + 2. Even though children LOVE large numbers, the research finds that during the early years, DEEP learning on small numbers (up to 10 or 20) produce the most benefit in overall mathematical competencies. (Sarama and Clements 2004)

Math talk

Susan Levine, early childhood researcher, explains that because of the wide variations in the amount and quality of “math talk” in families and classrooms, some children have a much greater opportunity to think about math during preschool years than others do. (Ryan, Whitebook, and Cassidy 2014) All children need adults and older children to talk with them around math concepts. In fact, girls especially need practitioners to scaffold and extend their learning during spatial thinking tasks like block building because there are already gender differences in spatial problem solving as early as three years of age and spatial skills are predictive of later math success. (Ryan, Whitebook, and Cassidy 2014) Adults can talk about patterns the children create or that occur in nature and architecture, or consider taking a “shape walk” to look for a specific geometric shape along with exercise and fresh air.

What the research says about appropriate strategies

Daphna Bassok, assistant professor of education at the University of Virginia, says, “As a field, there’s been a big mind-shift. The question now is not whether to teach it, but how to teach it.” (Carr 2014) Math experiences and interactions need to be intentional. In a recent study, 60% of three-year-olds had no mathematical experience of any kind across 180 observations of everyday preschool activities. (Clements 2013) Math learning can occur during informal play but it generally needs to be facilitated and won’t happen naturally among peers without initial coaching and modeling by adults. Many practitioners have a daily, large-group calendar time and consider that a significant math experience. Experts prefer that math experiences and math tools be in every activity area in a preschool classroom. Adults should look for and prepare to introduce math questions in every play experience. This is not forcing kindergarten and first-grade content into preschool minds but rather challenging these young thinkers through purposeful math experiences developed from their own play.
Staff can also encourage children to think out loud about their problem-solving: Why do you think that? How did you decide that? “Go slowly and try again” is a very effective encouragement for a child who attempts a math task and comes up with an incorrect response.

Caregivers can stretch children’s experiences by challenging them. For example, the adult might observe a child playing with tangrams and ask, “How many different kinds of shapes can you make with these two triangles?” Or she might show them a photo of a building and ask, “Can you build this structure out of blocks?” or “Can you make a copy of your tower on the computer using computer shapes?”

“Good early childhood mathematics is broader and deeper than mere practice in counting and adding. It includes debating which child is bigger and drawing maps to the ‘treasure’ buried outside. Quality mathematics instruction includes providing loads of unit blocks, along with loads of time to use them; asking children to get just enough pencils for everyone in the group; and challenging children to estimate and check how many steps are required to walk to the playground.” (Clements 2001)

Block play

When they play with blocks, children use many math ideas at once. They fine-tune their spatial reasoning as they work to keep block towers from tumbling. They reinforce geometric understanding as they sort out all the rectangles or create a square from two triangle pieces. Unit blocks, by design, give these young architects concrete experience with multiples and fractions. Todd Erickson of Stanford University’s Bing Nursery School describes how children are even doing basic algebra as they build. “Essentially they are solving for X. They’ve got one piece on one side and one piece on the other and a distance to fill. So what is that amount going to be?” That’s algebraic thinking! (Westervelt 2015)
Role play centers

Preschoolers easily use early math when they role play in areas like a manufacturing plant, a restaurant, a kitchen, a grocery store. Early childhood professionals can be sure to provide tablets where children can write orders, counters that can be used as money, and measuring tools. An intentional teacher can suggest that a child present two orders: two of one item and four of another, and ask how many coins total the child would pay if all items cost one coin. When a child combines the two items and the four items and counts the items together, this is a very important, foundational math procedure. Finding opportunities for children to combine groups and count totals or to separate groups into collections of related items are valuable experiences that strengthen a child’s math competencies. (Sarama and Clements 2004)

Appropriate materials for independent access by preschoolers

- blocks (unit blocks, counting cubes, parquetry and pattern blocks)
- number line
- playing cards, basic board games
- geo-boards
- nature collections to measure, sort, and analyze
- table or wall-sized grids that children can use to create bar graphs
- paper and markers for taking orders, drawing maps and shapes, recording data
- play dough and sculpting clay
- rulers, measuring cups, timers, pan balance

References


“Numbers Are Fun!” http://www.numbersarefun.biz/


