What can early childhood teachers plan to do and say to enhance children's understanding of age-appropriate math concepts? Educators can apply these practical ideas during everyday learning experiences.

One, Two, Buckle My Shoe: Using Math-Mediated Language in Preschool

Loretta C. Rudd, Macy Satterwhite, and Matthew C. Lambert

In typical early childhood programs, several groups of young children and adults are often engaged in daily learning experiences such as these.

A group of four children is constructing a dinosaur habitat with unit blocks while a teacher sits nearby. Three children are pouring brightly colored sand into and out of different containers in a sand table. Two preschoolers are rolling and cutting modeling clay on trays. At a small table, an adult prepares snack. Four children are cutting paper and gluing their pieces into collages on recycled boxes they had painted. Three others are playing with dolls in the pretend play area.

An observer might notice that most of the talking was among children, although now and then the adults asked a question or made a comment about what the children were doing. While the children were actively engaged in learning opportunities prepared for them by devoted early educators, there seemed to be a missing element—intentional teacher conversations that enable children to think more deeply about the meaning of their learning experiences. This article focuses on ways teachers can increase the use of math-mediated language to enhance learning in early childhood classrooms.

What Is Math-Mediated Language?

Mathematical Mediated Language (MML) is a teaching technique designed to enhance children's learning. Teachers who use MML engage in informal, intentional dialogues with children about mathematics concepts that apply to the activity in which they are engaged.

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In other words, teachers recognize opportunities to use language related to mathematical concepts during children's play. For example, a teacher might point out the shapes of unit blocks as a child stacks them or discuss the length and thickness of clay a child is rolling. Skilled teachers recognize the importance of language as a tool for teaching mathematics (Whiten & Whiten, 2003). They shape and guide conversations using language to help children further their development of mathematical concepts.

In addition to recognizing the importance of language as a tool for teaching mathematics, teachers can plan experiences that connect new mathematical terms or phrases to ideas children already know (Rubenstein & Thompson, 2002). When teachers focus on the language of math and present mathematical concepts in fun, engaging ways, children are motivated to learn concepts beyond what has been traditionally expected of their age (Kamii & Anderson, 2003).

A joint position statement from the National Council of Teachers of Mathematics (NCTM) and the National Association for the Education of Young Children (NAEYC) points out that “high-quality, challenging, and accessible mathematics education...is a vital foundation for future mathematics learning” (NCTM & NAEYC, 2002, p. 1). The position statement recommendations, summarized in Table 1, are intended to improve classroom practice in order to meet state and program standards, as well as to inform policy makers. This article offers specific examples of using informal, math-mediated language in preschool classrooms.

### Table 1. Recommendations to improve mathematics education

<table>
<thead>
<tr>
<th>In high-quality mathematics education for 3- to 6-year-old children, teachers and other key professionals should</th>
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<tbody>
<tr>
<td>1. Enhance children's natural interest in mathematics and their disposition to use it to make sense of their physical and social worlds</td>
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<tr>
<td>2. Build on children's experience and knowledge, including their family, linguistic, cultural, and community backgrounds; their individual approaches to learning; and their informal knowledge</td>
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<tr>
<td>3. Base mathematics curriculum and teaching practices on knowledge of young children's cognitive, linguistic, physical, and social-emotional development</td>
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<td>4. Use curriculum and teaching practices that strengthen children's problem-solving and reasoning processes as well as representing, communicating, and connecting mathematical ideas</td>
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<td>5. Ensure that the curriculum is coherent and compatible with known relationships and sequences of important mathematical ideas</td>
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<td>6. Provide for children's deep and sustained interaction with key mathematical ideas</td>
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<td>7. Integrate mathematics with other activities and other activities with mathematics</td>
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<tr>
<td>8. Provide ample time, materials, and teacher support for children to engage in play, a context in which they explore and manipulate mathematical ideas with keen interest</td>
</tr>
<tr>
<td>9. Actively introduce mathematical concepts, methods, and language through a range of appropriate experiences and teaching strategies</td>
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In high-quality mathematics education for 3- to 6-year-old children, teachers and other key professionals should introduce more complex counting strategies.

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### Ways to Implement Math-Mediated Language

The math concepts focused on here are based on those described in Young (2005, p. 385). In other words, teachers recognize opportunities to use language related to mathematical concepts during children's play. For example, a teacher might point out the shapes of unit blocks as a child stacks them or discuss the length and thickness of clay a child is rolling.
Children and Mathematics (Copley, 2000). They are presented in an order that generally indicates increasingly difficult levels of thinking. Therefore, the categories at the end of the list require more complex thinking than those at the beginning. While Copley identified these categories before NCTM and NAECY published their joint position statement, the categories are a useful tool for implementing many of the recommendations made in the joint statement.

Examples of how teachers can include these concepts in everyday talk with children are found both in the discussion here and in Table 2. Mastery of each of these skills is important for children to continue to succeed in school and in life.
Number

Early childhood teachers frequently hear children using numbers. Children typically begin by counting out how many fingers represent their ages. Soon, they can count how many beads they placed on strings or how many children are sitting at their table. Young children learn to count objects in order (1, 2, 3, 4, 5), and to match one number with one item only once (one-to-one correspondence). Counting first to 10, and then to 20, is a major accomplishment for young children.

As children become skilled with simple counting, teachers are urged to introduce more complex counting strategies. For example, instead of counting objects by one, teachers can model how to count by twos or threes. If children are playing with large cardboard blocks, a teacher might hand one of them two blocks at a time, saying, “2, 4, 6” and so on.

These early “skip counting” experiences enable children to more easily understand multiplication activities in later grades. Children can also begin to see that groups of two or three objects can be counted to make sets and then that the sets can be added to find “how many in all.”

Spatial Relations

Another frequently used math category in early childhood settings is spatial relations. Early childhood teachers frequently ask children to put toys on the shelves, crayons in their boxes, and trays under their science experiments. Other prepositions include over, between, beside, around, and similar higher-level verbal descriptions of spatial relations.

Well-informed teachers of young children plan to use these higher-level forms of language to identify spatial relations when children play with blocks, in the dramatic play area, on the playground, and anywhere else that
Plan to use higher-level language to identify spatial relations when children play with blocks, in the dramatic play area, on the playground, and anywhere else that children are learning. This way, children naturally become aware of spatial relations and build their vocabularies.

Measurement

Young children are naturally inquisitive about relative sizes. They often notice, “My tower is taller than yours.” They are proud that “I’m older than you are!” “My truck goes faster than your train.” Children’s desire to measure and compare is facilitated when early childhood teachers plan to include objects of varying sizes, lengths, weights, and speeds in the learning environment and then provide the language associated with measurement.

A teacher might sit with a group of children rolling clay into different lengths. First, invite children to comment on the lengths and masses (shorter, heavier) of their clay forms. “Which roll do you think is the longest, Raoul? Which ball is the lightest?”

Carry the experience a step further by using measurement tools. Improvised tools such as pieces of yarn and even fingers can be used to compare lengths. “Chianna’s roll is as long as three markers.” Introduce standardized tools (in both metric and U.S. measures) such as rulers and scales. Measure, record, and compare the findings.

To extend the learning even further, a teacher might join the children in creating rolls and then forming the
rolls into balls. Ask children questions about the mass of clay as it changes shape, such as “Which shape do you think has more clay—the long, skinny roll you made first or the small ball when you smushed it together?” Thinking about these changes helps children to begin to understand higher-level developmental tasks such as the conservation of mass and weight (Piaget, 1977).

Geometry

Although most young children are interested in measurement, their natural propensity for identifying shapes seems to be even greater! Even 2-year-olds start to recognize shapes and can begin to sort by these attributes. Therefore, good-quality early learning environments have plenty of geometrical objects—both flat (2-dimensional shapes) and solid (3-dimensional forms)—in a variety of aesthetically pleasing textures such as wood, fabric, rubber, and paper, as well as plastic.

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Simply naming shapes—starting with squares, triangles, and circles—is just the beginning of young children’s geometry explorations. Provide young children opportunities to explore more complex ideas about geometric shapes, such as their properties of corners, sides, size, and how two or more shapes are similar or different. When teachers plan opportunities for young children to handle and discuss these properties, children develop skills that form the basis for understanding even more complex mathematical concepts.

Children who are cutting paper might be joined by a teacher who plans to comment on the shapes they
make. If children are already familiar with squares and rectangles, for example, a teacher might comment on or show the children what happens when a square is cut in half diagonally (two triangles) or if it is cut horizontally or vertically the result is two rectangles.

Another creative way to explore geometric shapes is during snack and lunch times. Children can use plastic knives to cut cheese, fruit, and whole wheat bread into geometric shapes. As children make their shapes, discuss each shape's corners, sides, curves, and other attributes. Again, by planning to infuse math-mediated language into children's natural explorations, teachers meet several of the NCTM and NAEYC recommendations.

**Operations**

Understanding basic mathematical operations seems to come naturally to most children. They soon grasp the idea that more objects can be added to a group of items (or some taken away from it) to create an even bigger (or smaller) group. When they use concrete objects, such as toy animals, little vehicles, or raisins, young children soon are able to add and subtract—to express the sum or difference by using a mathematical operation.

Teachers can make the most of naturally occurring opportunities to infuse the language of mathematical operations into children's everyday play. For example, if children are making paper bag puppets, ask them how many pieces of yarn each of them needs. If KellyAnne asks for five, count out two or three. Then ask, “How many more do I need to give you five in all?” This kind of exchange can be adapted to almost every activity in the classroom many times a day.

**Seriation**

Placing things in sequence—ordering objects by size or events by time—is a complex task for young children. Those who have opportunities to do so will enhance their mathematical development in significant ways.

Young children seem to enjoy comparing objects on the basis of size. Children in one group of 4-year-olds placed their shoes in order by length. They even stacked the shoes that were the same size so there would be no confusion about which ones where bigger than the previous ones. In a multi-age prekindergarten/kindergarten class, small groups of children ordered colored paper squares from lightest to darkest. Their teacher recorded their thinking as they negotiated the placement of the pieces. JeVaughn said “Yellow is like sunshine. It’s bright and you can color on yellow paper. It’s lighter than purple. You can’t draw on purple paper very well.”

When children are engaged in ordering, teachers provide the math-mediated language appropriate to the activity. For instance, when children are ordering shoes by size, a teacher might ask “What if I move this shoe over here? Would your shoes still be in order from shortest to longest?” Or a teacher could say, “You are laying your shoes out in a row. I wonder how you decided which shoes would go where?” Questions like these enable children to verbalize their thinking processes.

Ordinal numbers (first, second, third) are typically used to describe classroom events. “Jaycee and Orel asked to be first to experiment with weights on the new balance scale. The second children to have a turn are Bryanna and Joseph.” With such personal connections, children soon grasp how seriation affects their everyday lives.

**Patterns**

Children experience a wide variety of patterns in their daily lives, including:

- daily schedules (wake up, get dressed, eat breakfast, brush teeth, pick up school bag…)
- auditory patterns (songs, poetry, and stories with repetitive phrases: “Run, run, run as fast as you can; you can’t catch me, I’m the gingerbread man!”)
- visual patterns in clothing and nature (zebra stripes)

Young children also benefit from opportunities to create, repeat, and extend patterns in a variety of modalities. Teachers can plan activities and the environment to meet these goals. Use examples of patterns, and even demonstrate the patterning process. “Let’s make a pattern with the dishes in the pretend play area. What shall we start with? What comes next?… Let’s review your pattern: Plate, cup, spoon, plate, cup, spoon.”

Children who are cutting paper might create visual patterns by using different colored strips to make paper chains. They might paint stripes on a paper-maché tiger. Children can repeat or make auditory patterns by clapping, singing, or drumming a sound pattern. Children might sit at a table by alternating boy, boy, girl, boy, boy, girl.
Children who can recognize patterns are better able to make generalizations about number combinations, counting, and problem solving (McClain & Cobb, 1999), all skills they will use in algebra and other more advanced learning experiences.

**Display and Analyze Data**

Graphical displays are both fun and informative for young children. Graphical displays are characterized by:
- sorting objects,
- counting objects, and
- comparing groups

using simple visual representations such as bar graphs (Rudd, Lambert, Satterwhite, & Zaier, 2008). Graphs visually represent data, so they are yet another concrete method to compare things such as frequencies or numbers. Graphs in early childhood classrooms can be both interactive and engaging.

For example, children might first search for and collect multiple pictures of vehicles (school bus, car, truck, bicycle) that they expect to see on a walk in the neighborhood. Place the pictures in a bag. On the walk, children call out or point to the vehicles they see. As the children name the vehicles, one of them puts a picture of that vehicle into another bag. When the group returns, children count how many of each vehicle that they saw. Then the children place their pictures in parallel rows to construct a bar graph. This graph compares the number of each vehicle the children saw during the walk. “We saw 21 cars. How many bicycles did we see? Why do you think there were so many more cars?”

* * *

Young children are capable of understanding far more complex mathematical concepts than adults believe them to be (Ginsberg, Inoue, & Seo, 1999). Early childhood teachers can dramatically increase the use of math-mediated language by seeking professional development (such as reading this article) and coaching on these strategies (Rudd, Lambert, Satterwhite, & Smith, 2009). Teachers who explicitly plan for opportunities to infuse math-mediated language into children’s everyday play activities will give them the opportunity to flourish in mathematics!

**References**


Put These Ideas Into Practice!

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What is math-mediated language?

What to say to highlight math ideas

These math concepts, listed by increasing levels of complexity, meet most state and program standards.

<table>
<thead>
<tr>
<th>Math Concepts</th>
<th>Examples of “Teacher Talk” (Math-Mediated Language)</th>
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</table>
| Number              | Model counting: “1, 2, 3, …”   
|                     | Skip count “2, 4, 6, …”   
|                     | Ask “How many…”   |
| Spatial Relations    | Locate objects with spatial words such as in, on, under, behind.                   |
| Measurement         | Compare size, length, weight, and other measures. “Which is longer? Your red paper strip or the blue one?” |
| Geometry            | Name and describe 2-D and 3-D shapes. “This puzzle shape has three corners and three sides. It is a triangle.” “Another word for ball is sphere.” |
| Operations          | Solve problems. Ask “How many are left?” or “How many all together?”           |
| Seriation           | Count using ordinal numbers (1st, 2nd, 3rd). Order events by time. “First, we put on our coats. Then we walk out the door. What happens next?” Sort objects by size or weight. “Which seed is the smallest? Which seed is biggest?” |
| Patterns            | Identify patterns in nature. “The swirls go round and round on the shell.” 
|                     | Create patterns. “Let’s clap, loud, soft, soft, loud. We made a sound pattern!” |
| Display and Analyze Data | Make and record children’s choices. Sort, count, and then graph children’s findings. “Three children have pet fish. Six of you have dogs. Four have cats. Let’s show that information on a bar graph.” |

For more information