TEACHING PRESCHOOLERS ABOUT MEASURING LENGTH

By Sallee Beneke

When we measure length we apply a predetermined unit to an object so that we can to see how long, or wide, or tall it is (e.g., inches, meters). For example, we might use a ruler to measure the length of a table. Three- and four-year-old children typically know how to compare the length of things by looking at them side-by-side. However, they typically do not understand how to measure them using a unit. Their competencies grow over time as teachers model measuring using a third object or unit for comparing the lengths of two or more things (e.g., a block, a ruler, a thumb). Their understanding of the how and why of measurement also grows as teachers use measurement language to mathematize naturally occurring, everyday experiences (e.g., "Wow! That playdough snake must be 8 inches long! It's longer than my fingers!" "I wonder if this new book will be too tall for our bookshelf. Let's measure it!"). Providing standard measuring tools (i.e., ruler, tape measure) in the classroom environment helps familiarize children with them and encourages children to engage in measurement play. While many teachers begin exposing children to units of measurement using nonstandard units (e.g., a hand, a block, a floor tile), research shows that frequent switching back and forth between several different nonstandard units of measurement may be confusing to young children until they develop a basic understanding of measurement. Therefore, it is preferable to begin with a standard unit, such as a ruler (Clements & Sarama, 2014).

Preschoolers' Competencies at Measuring Length

Length is an aspect of measurement that is appealing to preoperational learners. They rely on their visual perception and are often interested in determining which of two objects is longer, shorter, or wider than the other. They can sequence objects by length when they align the edges of the objects. For example, objects can be aligned to measure height by standing them side-by side on a table or the floor, or, in the case of width, by pushing both objects up against a wall. However, children are not truly able to conceptualize and measure length accurately until they reach the stage of concrete operations at around age

8. "Measurement is a difficult *skill*, but also involves many *concepts*" (Clements & Sarama, 2014, p. 187). Preoperational learners have not mastered the developmental concepts of conservation and transivity described by Piaget.

When a child can conserve, she understands that "properties and amounts stay the same even when physical appearances are changed" (Trawick-Smith, 2014). Imagine two sticks that are equal in length and positioned with their ends lined up evenly. Children who cannot conserve believe that one stick is longer than the other if it is moved forward. Children who can conserve understand that the length of the sticks remains equal, even when the sticks are placed in different positions.

Measurement also involves transitive inferences. A child must understand transivity before she can use a third object such as a ruler or a piece of string to measure two objects. This means that a child understands that if A = B (the measure) and B = C, then A and C are equivalent (National Research Council, 2009). In the classroom "A" might be a toy railroad track the child wishes to measure. "B" might be a piece of yarn the child has used to measure the railroad track, "A." The child can then use the same piece of yarn to see if a second piece of railroad track, "C," is the same length as railroad tie

"A." The piece of yarn in this example is a nonstandard unit of measure. While children enjoy measuring with nonstandard units of measure, they are more successful measuring with standard tools for measurement (e.g., rulers, Unifix® cubes) than they are with nonstandard units (National Research Council, 2009).

Accurate measurement also involves unitizing. This means that the child perceives the finite length of the object to be measured and can visualize measuring it using a repeated unit of measurement such as a ruler or Unifix® cube—they can mentally picture the object to be measured as divided into units of equal length. Children are typically not able to unitize before age 8. Developing the ability to measure units without leaving gaps between the units or overlapping them is an important task for young children who are beginning to learning to measure units.

While mastering the concepts of conservation, transivity, and unitizing make measurement easier, young children are able to begin to learn the idea of measurement (Sarama & Clements, 2014), as seen through the examples provided in Table 1.

Strategies for Helping Preschoolers Learn About Measuring Length

Engaging young children in the following five mathematical processes helps them develop and communicate their thinking about all areas of mathematics, including measurement (National Council of Teachers of Mathematics, 2000). These mathematical processes are: (a) representing, (b) problem solving, (c) reasoning and proof, (d) connecting, and (e) communicating. Educators can teach children to use these five processes to mathematize or relate measurement concepts to their everyday world. Tables 2 and 3 provide examples of language and materials that teachers can employ to help preschoolers use these processes.

Representing. Children may represent their understanding of measuring length in a variety of ways. For example, drawing pictures of objects that are the same or different lengths. As children develop a basic understanding of math concepts, encourage children to select nonstandard objects and use them to measure (e.g., unit blocks, LEGOS®, hands). As they become more competent at measuring length, children can be encouraged to make their own rulers.

Problem solving. "Problem solving and reasoning are the heart of mathematics" (NAEYC, 2010). Young children learn by engaging with and solving meaningful problems in their everyday environments. A major way young children begin to learn to measure length is by comparing. Teachers can encourage children to learn to measure by challenging them to solve problems of comparison (e.g., "Is one longer, shorter, or are they the same?"). Teachers can challenge children to compare length by lining up the ends of 2 objects. Or children can be challenged to measure objects in the environment using a standard unit of measurement, such as ruler, beginning with zero. Inviting children to measure and

Table 1. Steps/Ages in Learning to Think About Linear Measurement*

Steps/Ages	Skill	Related Competencies
STEP 1: Beginning Two & Three Year Olds	1.1 Thinking visually/holistically	Informally recognizes length as an extention of 1-D space. Compare 2 objects directly, noting equality or inequality.
STEP 2: Four Year Olds	2.1 Thinking about parts	Compares the length of two objects by representing them with a third object. Initially measures by laying units end to end.
	2.2 Relating parts and wholes	Seriates up to six objects by length (e.g., connecting cube towers).

Adapted from National Research Council (2009)

Engaging young children in five important mathematical processes helps them develop and communicate their thinking about all areas of mathematics, including geometry

then re-measure to see if their measurement is accurate. This process can help them identify strategies that assist them in measuring more accurately.

Reasoning and proof. Teachers can challenge preschool children's reasoning by conversing with them about their efforts to measure the length of objects and by asking them to explain the decisions they make as they work with units of measurement (e.g., "How do you know where to put the ruler?" "Why do you start with the end of the ruler lined up with the car you are measuring?"). Asking children to explain their rules for measuring accurately also can be help them begin to solidify their thinking about measuring length.

Connecting. At the preschool level teachers can help children see the relationship of learning to measure and their everyday world. They also can take advantage of naturally occurring opportunities to explore the usefulness of being able to measure length. For example, when the teacher needs to make a new card for the job chart she might say, "Hey, let's measure one of the other cards, so we can make the new one the same length." Teachers can help focus children's attention on the relationship of number to length. For example, while measuring the length of the new card for the job chart, the teacher might count out loud, emphasizing that the card is eight inches long.

Communicating. Encouraging children to communicate their thinking by verbalizing, drawing, writing, gesturing, and using concrete objects or symbols can help them share their ideas about measuring length with other children and adults. As children learn vocabulary related to measuring length they are better able to communicate about it (e.g., "shorter," "longer," "same," "taller"). Teachers can encourage children to demonstrate and explain how they measure (e.g., marking the place of the end of the ruler with a finger and then starting from exactly that point when measuring the next unit) to assess their knowledge, and push them further in their thinking. Table 2. Examples of teacher language that supports children's measurement of length

Strategies for Supporting Dual Language Learners

Although we do not expect young children to use formal measurement tools accurately, teachers can support children in beginning to use tools. Some young DLLs learn to think about length using a system of measurement that differs from that used in the U.S. (i.e., the metric system). If that is the case, then they will use different names for the units, and the units themselves will differ. Teachers can find out about the system used to measure length in the home by developing collaborative relationships with family members and informally interviewing them about the system of linear measurement they use at home. When the linear measurement system is different, teachers can discuss ways to support the young DLL in learning the U.S. system. Teaching young DLLs a new system involves helping them learn new vocabulary for the units of measurement (i.e., inch, foot, yard).

When the home system for measuring length is the same as the US system, teachers can use several strategies to help young DLLs learn to bridge home language and English names for the units (e.g., inch, foot, yard). For example, a teacher can use the measurement terms used at home and English terms together in a meaningful context to describe length (e.g., "How many inches long is the table? Cuántas pulgadas de largo is the table?"). Similarly, teachers can develop visually attractive charts that show examples of differences in length. Labeling these charts in English and a child's home language can help teachers, peers, and family members describe the differences in length using both languages. Similarly, storybooks that involve measuring length and that are presented in both English and the young DLL's home language can be used to bridge his or her understanding in both languages (e.g., Tamano Real/Actual Size by Steve Jensen). Finally, gesturing is a very effective way to support the young DLL's understanding of length. For example, a teacher can spread his arms wide apart or close together to emphasize length (e.g., "Which one is longer? Cuál es más largo?").

Table 2. Examples of teacher language that supports children's measurement of length

Representing
How would that look if it were _____ (longer, shorter, wider, narrower)?
What could we use to measure the length of this?
Let's take turns measuring!
Where should we place the ruler if we want to measure this?
Now that you've measured the two objects, how can you record your findings? Can you draw them? How can you show which one is longer?
Problem-Solving
Hmmm... how can we line these up so we can tell which one is _____ (longer, shorter, wider, narrower)?
What should we use to measure this? Why?
How many _____ (feet, inches, blocks, hands) long do you think this sandbox is?
I wonder how we could find out how wide this table is?
I don't have a ruler. What else could we use to measure it?
Reasoning & Proof
How do you know where to put the ruler to begin measuring?
How do you know where to put the ruler next?
How did you figure out how long this is?
Why do you think this is X inches long?
Connecting
Why does that carpenter need a ruler?
Do you ever see anyone at your house measure to see how long something is? Why did they need to measure it?
Let's use string to measure this book, and then we can see how many things in our room are the same length!
See how the number 6 on the ruler lines up with the edge of the book? What do you think that means?
Communicating
How did you go about measuring that?
Am I measuring length or width when I measure from side to side? What makes you think so?
Can you show your friend how to use the ruler?
Why did you call this one too _____ (narrow, wide, long, short)?
Would you call this a kite or a rhombus? How can you tell?

**Mathematical processes described by the National Research Council (2009).*

Table 3. Examples of useful materials for teaching and learning about linear measurement in preschool

Blocks
Unit blocks
LEGOs®
Dr. Drew blocks
Table Toys
Measuring Motors™
Inchworm blocks
Unifix cubes
Wooden cubes
Ruler
Yardstick
Measuring tape
Books
Actual Size by Steve Jenkins
Length by Henry Pluckrose
Size by Henry Pluckrose
Hand Measuring: Measure Lengths by Jordan Shae
Measuring Penny by Loreen Leedy
How Long is Long?: Comparing Animals (Measuring and Comparing) by Vic Parker

Instructions for Doing the Microteach

1. This microteach is to take place with a group of at least 3 children, ideally of diverse abilities.

2. Assess the children in advance to determine what step they are on, on the pathway for mastery of length (see Table 1).

3. Select one mathematical process you will emphasize in your lesson (i.e., communicating, connecting, reasoning and proof, problem-solving, or representing).

4. Use the *Lesson Plan Template* to plan a lesson on length that will support the learning of the children you will be teaching. Consider how you will individualize for the children in your small group.

5. Videotape yourself implementing the lesson with the children.

6. Follow the *Procedure for Microteach* handout.

References

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