

TEACHING PRESCHOOLERS ABOUT CARDINAL NUMBERS

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Numbers are an abstract concept. We use numbers to describe the quantity in a set (e.g., 3 cookies, 5 chairs, 1 dog). Children come to preschool with some potentially limited understanding of the relationship between numbers and things that can be done with them (i.e., number sense). Their competencies grow as teachers and family members model how to count to determine quantity. This includes describing the process of counting sets of objects, providing guidance in using cardinal number to solve problems and feedback on children's efforts to use cardinal numbers. A range of opportunities to develop cardinal number can be provided through consideration of the materials available in the environment, adult-child and child-child interactions, routines, as well as planned activities. The frequency of opportunities a child has to develop number competencies is also a factor. When young children become competent at using cardinal numbers, they can automatically use the skill in everyday situations. Therefore, it is important for teachers to provide children with an abundance of opportunities to practice using cardinal numbers in a variety of situations and with a range of materials.

Preschoolers' Cardinal Number Competencies

Before they can become skilled counters, children master several foundational concepts and skills called the number core (National Research Council, 2009). These foundational concepts and skills are cardinality, the number word list, 1-to-1 correspondences, and written number symbols.

Cardinality is the knowledge of how many things are in a set and the number name for that quantity. Children who have mastered this competency understand that the last number counted is the number of objects in the set. For example, they can accurately count 10 objects, and when asked how many are in the set, they answer "ten." Preschoolers typically recognize the number of objects in a set of three or fewer instantly. This ability is called *perceptual subitizing*. As they become more familiar with sets of numbers they begin to see the quantity in larger sets by quickly recognizing the smaller sets that make up the quantity (e.g., the set of eight on a die is made up of two groups of four). This is called *conceptual subitizing* (Clements, 1999). For example, children can see a group of dots on the side of a die and they "just know" how many dots are present without counting them.

Children's developing competence in understanding and using cardinality is interrelated with 1-to-1 correspondence and the number word list. For example, when a child can move her finger down a row of objects and touch each object in the row just once before moving her finger to the next object, she can then begin to attach a number name to each object. As children learn to recite the number word list, she will be better able to count with accuracy. Development in one core skill or concept is likely to positively influence development in another area. Experts in the field of early mathematics have described developmental pathways or trajectories for each of the core areas (National Research Council, 2009; Clements & Sarama, 2014). This developmental view of cardinality is summarized in Table 1.

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

Steps/Ages	Skill	Related Competencies
Step 1: Beginning Two & Three Year Olds	1.1 Subitizing	Uses perceptual subitizing to give the number for 1, 2, or 3 things.
Step 2: Later Two & Three Year Olds	2.1 Subitizing	Continues to generalize perceptual subitizing to new configurations and extends to some instances of conceptual subitizing for 4 and 5. Can give number for 1 to 5 things
STEP 3: Four Year Olds	3.1 Using 5-groups	Extends conceptual subitizing to groups of 5 plus 1, 2, 3, 4, 5 to see 6 though 10 (e.g., 6 is 5 + 1, 7 is 5 + 2).
	3.2 Using fingers	Uses 5 fingers on one hand plus additional fingers on the other hand as a kinesthetic and visual aid for conceptual subitizing.

*Adapted from National Research Council (2009)

Strategies for Helping Preschoolers Learn About Cardinality

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

Representing. Children may represent their understanding of number in a variety of ways. For example, children might count out five crackers for each of their friends or count the characters as they arrive in the book, *The Doorbell Rang*. Teachers can encourage children to represent their understanding of the quantity in a set by drawing it, or by representing it with other objects. For example, if a child says that there are five people in his family, the teacher can ask the child to represent

them with counters (e.g., “Can you show me with buttons?”), or children can draw each member of a set. For example, if a child says that he played with three friends on the playground, the teacher can ask him to draw the group of friends. Preschoolers also love to use fingers to represent sets of people or objects. When asked how many people are in her family, a child may hold up four fingers, wiggling each finger as she describes the family member (e.g., “mommy, daddy, my brother, and me”).

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. Young children love conducting surveys to find answers to questions that they pose. For example, one four-year-old labeled one column of a T-chart with a drawing of a sun and the other column with a picture of the sun with an X drawn over it. He went from child to child asking, “Do you like the sun?” He made a tally mark in the column that matched each child’s preferences. After he had gathered

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data from several children the boy counted the tally marks in each of the two columns and wrote the number that represented the quantity at the bottom of each column. Group games that involve counting challenge children to apply their counting skills. For example, a bowling game with plastic pins challenges children to count the number of pins that are knocked down and the number that remain standing (Charlesworth, 2012). Board games that make use of dice and game pieces that move along a path are enjoyable to young children and challenge them to figure out how many spaces they can move their game pieces along the path.

Reasoning and proof. Teachers can challenge a preschooler's reasoning by conversing with him about his work with quantities and asking him to explain how he came to a certain conclusion about the quantity represented by a set (e.g., "How do you know there are six children at the round table?"). The child will typically recount, demonstrating how he reached his conclusion using rational counting skills. Children also can learn to demonstrate the accuracy of their conclusions by representing the objects in the set with fingers or counters. For example, if a child says he has four pieces of candy (3 candy canes and 1 Tootsie Roll), the child can count out three red counters for the candy canes and one black counter for the Tootsie Roll. The child can then count the total number of counters (both red and black).

Connecting. Teachers can help preschoolers see the connection between rational counting and their everyday world as they naturally occur (e.g., "Look, there are horses by the fence! How many do you think are there?"). Routine activities, such as snack time provide many opportunities for children to see the value in figuring out the answer to the question, "how many?" For example, children can count the number of children in attendance and then use that quantity to figure out how many snacks, cups, napkins, etc. to set out.

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 quantity with other children and adults. As children learn to count larger sets, adults can challenge them to apply this ability in everyday contexts and to explain how they determined the quantity. Adults can help children learn mathematical terms related to cardinal number, such as "quantity," and "set" by modeling them in conversations (e.g., "Can you please put six muffins on the plate").

Strategies for Supporting Dual Language Learners

Several strategies can be used to help Dual Language Learners (DLLs) learn about cardinal numbers. The teacher can refer to quantities of objects in the young DLL's home environment as she engages him/her in informal conversations (e.g., "You have three perros/dogs at your house. Let's count how many stuffed perros/dogs we have in our cozy corner."). The teacher can gather the background information needed for this type of conversation by establishing a friendly, collaborative relationship with the young DLL's family, conducting informal interviews with them about the child's home life, and/or making one or more visits to the young DLL's home. It is most effective for the young DLL to learn the number word list (i.e., one, two, three, four, five, etc.) first in his/her home language, and then the teacher can help the child learn to count in English. Since the

English number names (i.e., one, two, three, four, five, etc.) typically do not share cognates or linguistic roots with other languages, it will likely take a great deal of practice for the young DLL to associate the English number list with that of his/her home language. The teacher can help the child begin to associate the number list with quantities by using props and gestures. Fingers are especially helpful when teaching cardinal numbers. For example, the teacher can count the child's fingers first in the DLL's home language and then in English (e.g., "How many fingers am I holding up? Let's count them in español! Uno, dos, tres, cuatro, cinco, seis. Now let's count them in English. One, two, three, four, five!"). Visual cues in the environment also can support the young DLL's understanding of cardinal numbers. For example, a colorful, attractive number list with pictorial representations and the number names in English and Spanish can be referenced by the young DLL, peers, and teachers, and family members. The teacher also can support a young DLL's mastery of cardinal numbers by selecting one or more high quality children's books that are written in English and the child's home language (e.g., *Mouse Count/Cuenta de ratón* by Ellen Stoll Walsh). Repeated dialogic readings in small and large group can allow the teacher, young DLL, and peers to discuss cardinal numbers, while referring to examples in the book. For further information, see the microteach guide, *Supporting Mathematical Learning of Young Dual Language Learners* (Beneke, 2016).



Table 2. Examples of teacher language that supports children’s mathematical processes* with cardinality

Representing
<p>How many are there?</p> <p>Can you show me how many there are?</p> <p>Let’s draw a picture that shows how many are in the set.</p> <p>Can you show me how many with your fingers?</p> <p>How can we use these counters to show how many are in the set?</p>
Problem-Solving
<p>Can you use the counters to keep track of how many we have?</p> <p>Can you count them to see how many we will need?</p> <p>I wonder how we can figure out how many we will need?</p> <p>How many are there? How do you know?</p> <p>How many do we need?</p>
Reasoning & Proof
<p>How do you know we need that many?</p> <p>What makes you think there are _____ of them?</p> <p>Can you make a mark on your paper for each one? Then we’ll count them.</p> <p>What if the bowl is empty? How many will we have, then?</p> <p>How did you know there were three dots on the side of the die? You didn’t count them!</p> <p>There are so many—how will we figure out how many there are?</p>
Connecting
<p>How far can you count? Do you think there are that many in our pile? How can we find out?</p> <p>Which pile has more?</p> <p>How can we give everyone the same amount?</p> <p>Why are you touching them when you count?</p>
Communicating
<p>Miss Julie says there are seven babies in the housekeeping area. Is she right?</p> <p>There are lots of oranges in this bowl—how can we count them? Should we take them out?</p> <p>How can we arrange these stickers so we can count them better? Why?</p> <p>We had five, and I just found another one. Now how many do we have?</p> <p>There are fifteen children here today. How many napkins will we need for snack?</p>

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

Blocks
<p>Unit blocks</p> <p>Table-top blocks</p> <p>Legos®</p>
Table Toys
<p>Spinners</p> <p>Dice</p> <p>Path games</p> <p>Counters</p> <p>Linking chains</p> <p>Pop beads</p> <p>Unifix cubes</p> <p>Ten-frames</p>
Boards
<p>Flannel-board sets</p> <p>Path games that require subitizing and moving a game piece along a path</p> <p><i>Connect Four</i> and other games that encourage counting sets of items</p>
Books
<p><i>12 Ways to Get to 11</i> by Eve Maerriam</p> <p><i>Anno’s Counting Book</i> by Mitsumasa Anno</p> <p><i>Fish Eyes</i> by Lois Ehlert</p> <p><i>Mouse Count</i> by Ellen Stoll Walsh</p> <p><i>Ten Black Dots</i> by Donald Crews</p> <p><i>The Button Box</i> by Margarette Reid</p> <p><i>Press Here</i> by Harve Tulletth</p>

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

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 cardinality (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 cardinality 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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