

Developing Number Sense in Pre-kindergarten and Kindergarten Children

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Young children enter formal schooling curious about the world around them. They like to touch, explore, and talk about the many things they encounter in their daily lives. As part of these experiences, children interact with numbers and mathematical ideas. Children notice numbers on clocks, televisions, and elevators, and they see geometric shapes on street signs, recycling containers, and automobile emblems. As a result of these early opportunities, young children begin school with a significant amount of informal mathematics knowledge (Clements, 2001; Fuson, Grandau, & Sugiyama, 2001). For example, many children can state how old they are, can count small collections of objects, can recognize and name shapes like circles and triangles, and can even tell you the channel for their favorite television program. It is through these everyday explorations of their worlds that children learn. Thus, pre-kindergarten and kindergarten classrooms are ideal settings to develop number sense in young children.

Number sense, as Howden (1989) writes, "is an intuition about number and its relationships" (p. 11). Number sense develops over time as children engage in activities that encourage them to think about, explore, and discuss mathematical ideas. Children with number sense are able to understand numbers and use them effectively in their daily activities. Number sense builds on children's natural perceptiveness and helps them believe that mathematics makes sense (Howden, 1989). Fostering number sense in pre-kindergarten and kindergarten children provides a strong foundation for learning elementary school mathematics. Children's every day activities, interests, and questions provide an excellent context in which to explore numbers.

According to the National Council of Teachers of Mathematics (2000), children develop number sense and "learn mathematical concepts through everyday activities: sorting (putting toys away or groceries away), reasoning (comparing and building with blocks), representing (drawing to record ideas), recognizing patterns (talking about daily routines, repeating nursery rhymes, and reading predictable books), following directions (singing motion songs such as "Hokey Pokey"), and using spatial visualization (working with puzzles)" (p. 74). While these tasks are not yet mathematical in the mind of a child, "they become mathematical when they are reflected on, discussed, abstracted, and represented" (Clements & Sarama, 2000, p. 39). That is, children need the assistance of teachers and adults to help them extract the mathematics in their activities and to build upon and extend their informal mathematical knowledge.

Teachers, and the classroom environments they create, are fundamental in developing children's number sense. In pre-kindergarten and kindergarten classrooms, teachers help children develop

number sense by posing questions as children play, eat, and interact with each other throughout the day. How many crayons do we need at this table? How many more crackers would you like? Who is second in line? Shall we count how many steps to the cafeteria? With such questions, teachers help children think about and use mathematics. Teachers foster number sense by creating classroom environments that encourage children to think about numbers and discuss how and why they use numbers, and by nurturing children's inquisitive nature and sense making.

Teachers should be mindful that young children's mathematical ideas are often quite different than those of adults (Clements, 2001). It is therefore necessary that teachers attempt to see what a child is doing and thinking from the child's perspective. Sitting at a learning center with a group of children, for example, allows teachers to learn how children are conceptualizing mathematical ideas. By asking children questions about how they are thinking or manipulating materials, teachers help children reflect on the activities and extend their thinking. Observation of students as they work and play with each other is another way teachers may examine how students are developing number sense. These observations allow teachers to monitor the children's development as they interact with materials and utilize mathematical language to converse with their peers.

Exploring numbers and their relationships should be a natural part of pre-kindergarten and kindergarten classroom routines. As Clements (2001) suggests, mathematics in preschool should invite "children to experience mathematics as they play in, describe, and think about their world" (p.270). It is through a variety of experiences through out the day that children learn mathematics. In particular, specific opportunities to practice the mathematical concepts of sorting, patterning, and counting are an important part of the pre-kindergarten and kindergarten experience. These activities form the solid foundation upon which later mathematics development is built.

Sorting

Sorting objects is a common activity in most pre-kindergarten and kindergarten classrooms. Children have a natural interest in sorting objects and materials, and tend to engage in this activity when given the opportunity. For example, children may separate objects by color, size, or texture. Blocks, buttons, dramatic play materials, rocks, etc. are all objects that may be sorted. Sorting activities help children make sense of things around them and help them become flexible thinkers (Reys, Lindquist, Lambdin, Smith, & Suydam, 2001).

When children sort, they examine various characteristics of the objects and make decisions about those characteristics. As children sort, they should be encouraged to talk about and describe their sorting selections and resulting collections. By asking children to explain their sorting selections, teachers encourage children to reflect on the objects and engage in reflective discourse.

Sorting activities allow teachers to naturally introduce the language of mathematics with words such as *more*, *few*, *many*, *most*, *least*, and *none* to describe children's collections. Once children complete a sorting activity, they are often interested in how the groups relate to each other. Children may be over heard saying, "This group has more" or "This group is bigger" As children discuss their collections with one another, teachers should observe and decide when to enter the children's interactions (Clements, 2001). For example, if two children are comparing blocks they

may argue about whose block is bigger, when what they are really talking about is whether one block is *taller* or *wider*. Children need help understanding that objects can have many different characteristics and they need help learning how to distinguish among them. The role of the teacher is to extend the children's concepts about the material's attributes.

Sorting is also important because it prepares children to count. "Classification allows us to reach general agreement on what is to be counted" (Reys et al., 2001, p. 110). For example, if a child wants to know how many blue cars are in a set of red, blue, and green cars, he or she first must sort out or distinguish which cars are blue.

Patterns

Patterns are intellectually inviting and stimulating for young children (Reys et al., 2001).

Patterning activities help children look for regularities among objects and numbers. Children need help understanding what patterns are, as it is not a term that they use often. Teachers may help children understand patterns by pointing to each object in a pattern and encouraging the children to describe out loud what they see. Seeing and hearing a pattern helps children focus on the regularities in the set.

Pattern activities, like sorting activities, may use several different objects and people. In pre-kindergarten and kindergarten, patterning activities usually involve objects and follow AB/AB patterns or ABC/ABC patterns. For example, an AB/AB pattern using red and blue blocks would be red, blue, red, blue, or blue, red, blue, red. The children themselves may demonstrate patterns in the classrooms based on their physical characteristics. For example, one pattern could be boy, girl, boy, girl, or sit, stand, sit, stand. Patterns also may be found in children's songs and nursery rhymes.

AB/AB and ABC/ABC patterns are the most simple type of patterns for young children to copy and extend. A more complicated pattern for pre-kindergarten and kindergarten children to grasp is the AB/BA pattern. In this pattern (e.g., red, blue, blue, red), children have a hard time distinguishing when one series ends and another begins because the objects are the same in the middle (i.e., blue, blue). Therefore, care must be taken when selecting patterns for children to copy and extend.

"Creating, constructing, and describing patterns require problem-solving skills and constitute an important part of mathematical learning" (Reys et al., 2001, p. 113). Because mathematics is the science of patterns, early work with patterns helps children with more advanced mathematics, such as looking for patterns in multiplication tables. Once children are comfortable copying and extending patterns, they need experience transferring patterns to other contexts and constructing their own patterns. For example, an AAB/ AAB pattern made with blocks (red, red, blue, red, red, blue) may be transferred to a clapping pattern (clap, clap, pause, clap, clap, pause). Creating their own pattern is a skill that teachers need to help children conceptualize. Children will sometimes arrange objects, with no regularity, in what they think is a pattern. For example, a child may make the following pattern: blue, green, red, yellow, blue, yellow, red, green, etc. By having children describe their patterns and asking them extension questions, teachers help children think about their patterns. However, young children need to work extensively copying patterns and use fewer choices (e.g., color of blocks) before they should be expected to make complicated patterns.

Counting

A natural extension of sorting and patterning activities is counting. Pre-kindergarten is a time when children are developing an understanding of counting and number words. Some children can state the number word list or how old they are without knowing what these constructions mean. Counting activities with young children should focus children's attention on how many things have been counted. As children count objects (1, 2, 3, 4, 5), teachers should ask, "So how many do you have?" Some children may start to count over because they do not realize that the last number stated names the number of objects. Teachers may help children by summarizing the child's efforts (e.g., "So you have 5 blocks").

By the time children reach kindergarten, many are ready to learn mathematical ideas, like "break apart partners" for small numbers and for the number 10 (Fuson et al., 2001). For example, break-apart partners for 5 are 4 and 1 and 2 and 3. By modeling the breaking apart concept through storytelling, dramatic play or drawings, children see how numbers behave. In the case of 5, the teacher might have children act out how one group of 5 apples (total) may be broken into two groups (partners); for example, one group of 3 apples for Danielle and the other group of 2 apples for Marcus. Children then should talk about and model other break-apart partners for 5. These activities help children learn the additive concept for numbers and prepare them for part-part-whole conceptions of addition.

Pre-kindergarten and kindergarten is also a time when children may practice writing numerals to symbolically represent their constructions. As students begin to act out number scenarios, teachers need to model how to record mathematical ideas. In pre-kindergarten, children should practice matching numerals with collections of objects. These matching activities reinforce students' understanding of one-to-one correspondence. As children become more proficient in matching numerals to sets, they learn to match numerals to number words and eventually learn to write numerals on their own. All these activities should be in the context of counting actual objects and hands-on activities in order for children to connect their informal mathematical knowledge and language to the symbols and language of mathematics.

Conclusion

Young children's natural curiosity and intrinsic motivation to learn about the world around them make pre-kindergarten and kindergarten classrooms excellent settings in which to develop number sense. Encouraging children to explore numbers through sorting, patterning, and counting activities provides them with rich and rewarding experiences that foster the development of their number sense. Unfortunately, too many children do not develop a strong enough foundation of number sense in the early grades to do well in mathematics in later grades. Therefore, all children need opportunities to explore numbers and mathematical ideas in a variety of diverse contexts. Teachers, and the classroom environments they create, play a central role in developing children's number sense. By providing mathematically rich environments where all children are engaged in mathematical activities and discussions, pre-kindergarten and kindergarten teachers help children develop a strong foundation for further mathematical learning, and they support children's natural abilities and allow children's confidence to flourish.

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