Developing Children's Number Sense

MCEC Conference, 2025

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Side by Side Educational Consulting

What is Number Sense?

- "Making friends with numbers" (Carlyle & Mercado, 2012)
- A child's "fluidity and flexibility with numbers" (Gersten & Chard 2001)
- Critical early learning skill best developed in the early years
- Strong predictor of school readiness
- Predictive of later student achievement. Number sense is linked to future math achievement in a manner similar to the way phonological awareness has been linked to reading achievement (Kosanovich, Weinstein, & Goldman 2009)
- Promotes confidence in mathematical thinking
- Effective counting skills are a critical first step in the number sense trajectory
- "Number Sense must be caught, not taught." (Tonavold)

- Number sense is "an ability to immediately identify the numerical value associated with small quantities, a facility with basic computing skills, and a proficiency in approximating the magnitudes of small numbers of objects and simple numerical operations" (2008, 27). More advanced forms of number sense involve understanding of place value, composition and decomposition of number, and the concept of basic arithmetic operations (NMAP 2008). For example, a young child with more advanced number sense may be able to turn simple addition facts into a more complex idea by breaking down or decomposing numbers. Instead of asking her to regurgitate the answers to basic number facts, ask a question like: "How many ways can you make the number 5?" She will be able to decompose the number 5 into number sentences and answer: "There are six ways to make the number 5 using addition: 5 + 0, 4 + 1, 3 + 2, 2 + 3, 1 + 4, and 0 + 5."
- Even though some children may memorize the basic facts and recite them, if they are unable to use those facts when they move to larger numbers, confusion may lead to difficulties with subsequent mathematics skills (Witzel 2003).

Number sense is "**good intuition about numbers and their relationships**. It develops gradually as a result of exploring numbers, visualizing them in a variety of contexts, and relating them in ways that are not limited by traditional algorithms."

-Howden, 1989

SELECTIVE CITATIONS

Children's informal number sense when they enter school provides a foundation for their school mathematics achievement and strongly predicts their mathematics competence later in school (Geary, 2015).

Number sense is linked to future math achievement in a manner similar to the way phonological awareness has been linked to reading achievement (Kosanovich, Weinstein, & Goldman 2009.)

Multiple analyses suggest that mathematics learning should begin early, especially for children at risk for later difficulties in school (Byrnes & Wasik, 2009; Clements & Sarama, 2014).

Children follow natural developmental progressions in learning and development. As a simple example, children first learn to crawl, which is followed by walking, running, skipping, and jumping with increased speed and dexterity. Similarly, they follow natural developmental progressions in learning math; they learn mathematical ideas and skills in their own way. When educators understand these developmental progressions, and sequence activities based on them, they can build mathematically enriched learning environments that are developmentally appropriate and effective. These developmental paths are a main component of a learning trajectory (Clements & Sarama, 2009).

Counting and numeracy skills—especially advanced counting skills—are more predictive of later achievement than early geometry, patterning, and measurement skills (Nguyen, Watts, Duncan, Clements, Sarama, Wolfe, Spitler, 2016)

Preschoolers with stronger EF show greater gains in mathematics and reading achievement over the first 3 years of elementary school than their peers with weaker early skills (Bull et al., 2008).

As the demands of early mathematics skills become more complex, working memory requirements increase (Geary, Hoard, & Nugent, 2012). Specifically, verbal working memory is related to the components of early mathematics that require multiple steps or maintaining information in memory (i.e, calculation, number order), but not it is not related to the more basic components (i.e, verbal counting, one-to-one correspondence) (Lan et al., 2011; Purpura & Ganley, 2014).

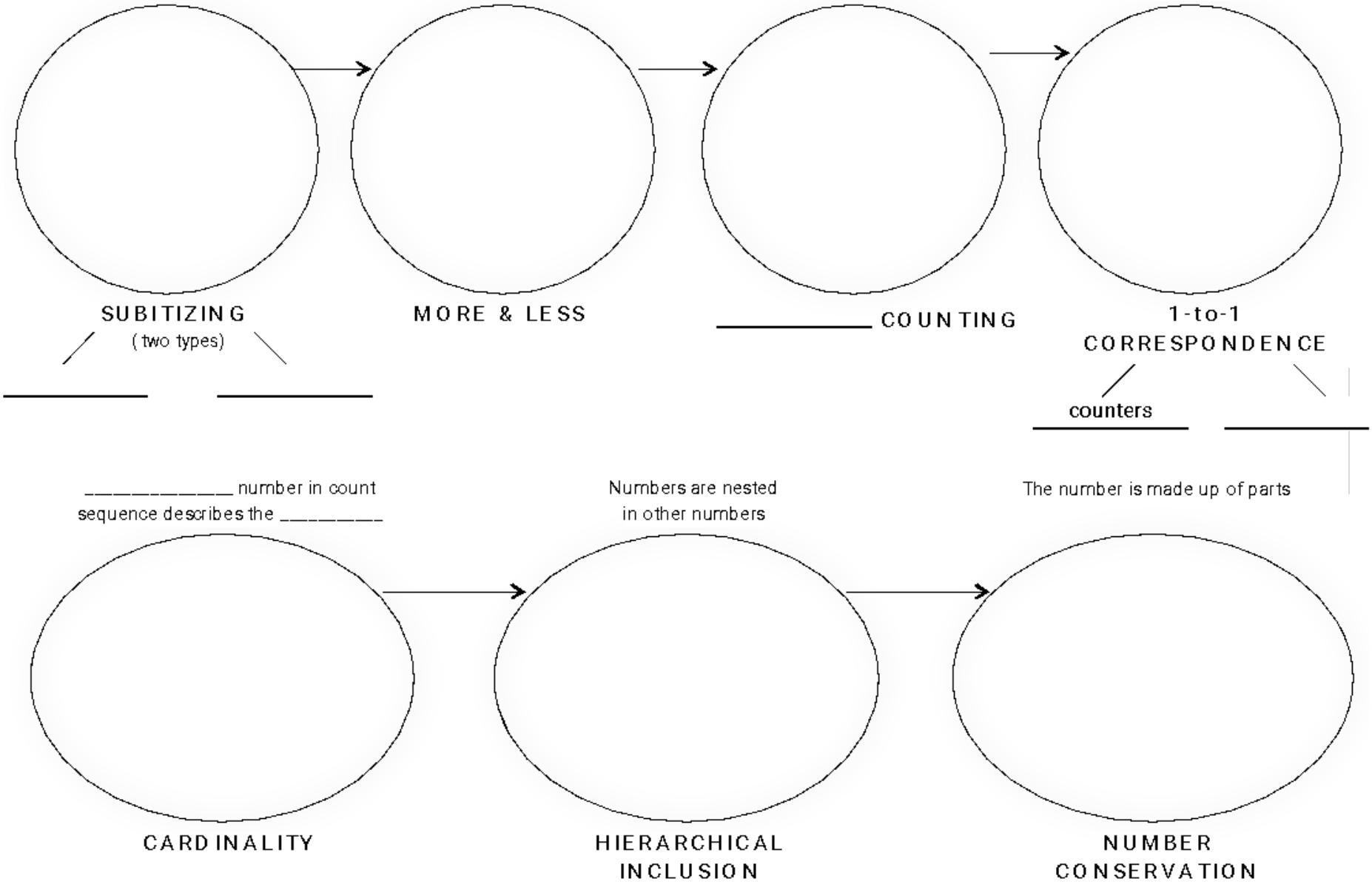
Cognitive flexibility is related to both early counting and calculation skills (Lan et al., 2011). Specifically, cognitive flexibility is related to two abstract areas of academic skills: cardinal number knowledge and print-related skills (both numerals and letters) (Purpura, Schmitt, Ganley, 2017).

Write two things you learned:

_____

_____

GRAHAM FLETCHER PROGRESSION VIDEO



LEARNING PROGRESSION

Counting and Beginning Number Sense

SUBITIZING	COMPARISON	COUNTING	ONE-TO-ONE CORRESPONDENCE	CARDINALITY	HIERARCHICAL INCLUSION	NUMBER CONSERVATION
Being able to visually recognize a quantity of 5 or less	Being able to compare quantities by identifying which has more and which has less	The rote procedure of counting. Includes both verbal counting and object counting. The actual meaning attached to counting is developed through one-to-one correspondence	Being able to connect one number with object and then count each object with understanding	Begin able to tell how many objects are in a set—understanding that the last word in the counting sequence names the quantity for that set	Understanding numbers are nested inside each other and the number grows by one each count. For example, 3 is inside 4 or 4 is the same as 3+1 more	The number of objects remains the same when they are rearranged spatially. For example, 5 can be… 4 and 1 OR 3 and 2 OR 2 and 3, etc.

Development of abstraction and order irrelevance →

progression of development

Based on Clements, D.H. & Sarama, J. (2009) *Learning and teaching early math: The learning trajectories approach*; Van de Walle, J.A. & Lovin, L.H. (2006) *Teaching student-centered mathematics*; Fletcher, G. (2017) The progression of early number and counting. [Blog post]. Retrieved from https://gfletchy.com/2017/03/26/the-progression-of-early-number-and-counting/

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FIVE PRINCIPLES OF EARLY COUNTING

1. _____
2. _____
3. _____
4. _____
5. _____

FIVE REKENREK ACTIVITIES

1. _____
2. _____
3. _____
4. _____
5. _____

HAZEL COUNTS 30 PENNIES

1. What do you notice about Hazel's use of counting principles?

2. What does her number sequence show she is beginning to understand about the structure of the number system? Think about (1) the sequence of number names, (2) the one-to-one principle, and (3) the cardinal principle.

3. As a teacher, how could you plan ways to intentionally support Hazel's number sense development?

EXPERIENCES TO DEVELOP SUBITIZING

EXPERIENCES TO DEVELOP VERBAL COUNTING

EXPERIENCES TO DEVELOP OBJECT COUNTING and CARDINALITY

EXPERIENCES TO DEVELOP NUMERAL IDENTIFICATION