1) Title: Laying the Foundation for Computational Fluency in Early Childhood

Source: Griffin, S. (2003). Laying the foundation for computational fluency in early childhood. *Teaching Children Mathematics, NCTM.*

Summary:
Number sense (a deep understanding of the different representations of numbers) and computational fluency (the ability to calculate the number of items in a set) go hand in hand. As children develop number sense, their ability to compute numbers also improves. Therefore, it is important to not treat these two aspects as different areas of mathematics. In the article, the author describes five levels of strategy choice used by children between 3-6 years old when trying to solve a computation problem. As their strategies evolve, the children show stronger number sense and better computational skills. When teaching number sense and computational fluency, it is advised that teachers focus on the following objectives:

- Helping students know the number sequence from 1-10
- Understanding that each number in the sequence refers to a set of a particular size
- Knowing that the next highest number in the sequence means that a set has increased by one

Furthermore, children should be encouraged to count out loud, use their fingers or other manipulatives to help them, and articulate the reasoning behind their solutions. Although the computational activities in the early years classroom appear simple, they help children develop a knowledge base that will serve as the foundation for developing more complex computational skills.

2) Title: Developing "Five-ness" in Kindergarten

Source: Novakowski, J. (2007). Developing "five-ness" in kindergarten. *Teaching Children Mathematics, NCTM.*

Summary:
The essence of number sense is the ability to visualize and represent a number in a variety of ways. Five is recognized as an important benchmark for children in the early years. In this article, the author describes different strategies used in the classroom to help children in the composition and decomposition of this number. For example, children were asked to make five in different ways using snap cubes. They were

also asked to use five wooden sticks to make designs and pictures and this task helped them to see how 'five' can be decomposed into multiple parts. Across all strategies, the author found that giving a pretend context (e.g., labeling snap cubes as candies or other real world items) limited the children's ability to represent 'five' in different ways. The children were too preoccupied with drawing out all five candies (or animals, etc.) instead of paying attention to combinations of parts that make up five. Finally, the author also noted the important link between subitizing and the children's ability to decompose 'five' into different parts. She found that having children work on composing/decomposing the number five with materials such as sticks and cubes improved their ability to subitize smaller groups within the total amount.

3) Title: Subitizing. What Is It? Why Teach It?

Source: Clements, D. (1999). Subitizing. What is it? Why teach it? *Teaching Children Mathematics, NCTM.*

Two Types of Subitizing:

1) **Perceptual Subitizing:** recognizing a number without using other mathematical processes such as counting

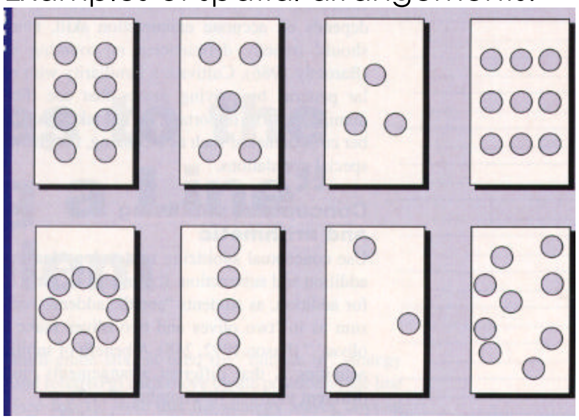
2) **Conceptual Subitizing:** recognizing a number pattern as **both parts of a whole and as the whole**
    - ❖ For example, the ability to recognize a set of eight dots as both two sets of four and one set of eight
    - ❖ This is the type of subitizing involved in ***COMPOSING AND DECOMPOSING NUMBERS***
    - ❖ As children recognize numbers in different arrangements, they are better able to identify the different parts that make up a whole (e.g., 1 dot and 3 dots make 4 dots; 2 dots and 2 dots make 4 dots), which improves their ability to decompose and compose numbers

What Affects Students Ability to Subitize and Work with Part-Whole Relationships?

- ❖ The ***SPATIAL ARRANGEMENT*** of units affect children's ability to subitize and compose/decompose numbers
- ❖ Rectangular arrangements are easiest (e.g., Five and ten frames) followed by linear, circular, and scrambled arrangements
- ❖ The arrangement must lend itself to **grouping** so children can easily see parts in the whole

❖ Larger sets are also harder to subitize

Examples of spatial arrangements:

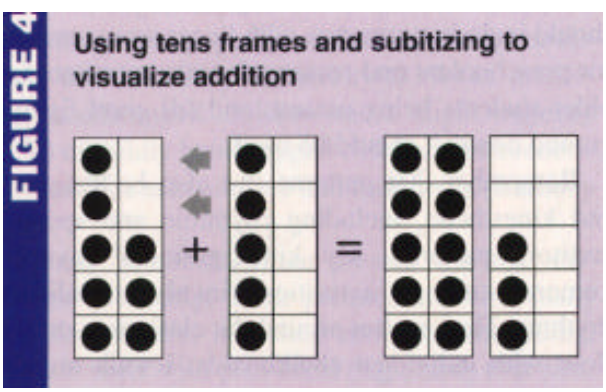


Implications for Teaching
Different Ideas to Practice Subitizing & Composing/Decomposing Numbers:

1) Give each child cards with zero through ten dots in different arrangements. Have students spread the cards in front of them. Then announce a number. Students find the matching card as fast as possible and hold it up. Have them use different sets of cards, with different arrangements, on different days. Later, hold up a written numeral as their cue.

2) Place various arrangements of dots on a large sheet of poster board. With students gathered around you, point out one of the groups as students say its number as fast as possible. Hold the poster board in a different orientation each time you play.

3) Using ten-frames to help students visualize different combinations of adding up to ten or greater



4) Title: Why Children have Difficulties Mastering the Basic Number Combinations and How to Help Them

Source: Baroody, A. 2006. Why children have difficulty mastering the basic number combinations and how to help them. *Teaching Children Mathematics.* NCTM.

Summary:
Computational fluency is a necessary component in attaining mathematics proficiency. It is defined as the "efficient, appropriate, and flexible application of single-digit and multi-digit calculation skills" (p. 22). The author introduces the conventional wisdom and the number-sense approaches that explain how children learn computational fluency. From a conventional wisdom perspective, mastery of basic number combinations stem from the memorization of number facts through well-designed drilling. Children who struggle with computational fluency have deficits that are inherent in the learner rather than the instruction. From a number-sense approach, computational fluency grows from understanding the patterns and relationships between basic number combinations. Children's deficits in computational fluency are attributed to conventional instruction.

5) Title: One Teacher, 20 Preschoolers, and a Goldfish: Environmental Awareness, Emergent Curriculum, and Documentation

Source: Lewin-Benham, A. (2006). One teacher, 20 preschoolers, and a goldfish: Environmental awareness, emergent curriculum, and documentation. *Beyond the Journal-Young Children on the Web,* 1-7.

Summary:
In this article, the author describes how a preschool teacher uses the emergent curriculum approach to cultivate environmental awareness among her students. Social constructivist theory underlies the emergent curriculum and supports the notion that students are encouraged to explore their deep interests through teacher scaffolding. As part of the emergent approach, documentation of student questions and interests is integral to their learning progress and the author describes how teachers can create a documentation panel to do so.

Why this article is important for us:
The public lesson and most of the exploratory lessons were developed from children's interests. The teachers who designed the lessons are practicing the emergent curriculum and one of them recommended this article as a source of inspiration.

6) Title: Teaching Number Sense

Source: Griffin, S. (2004). Teaching number sense. *Educational Leadership, 61,* 39-42.

Summary:
From a conventional perspective, number sense has been narrowly defined as the manipulation of numbers through rules and algorithms. In actuality, it should be perceived as "a set of conceptual relationships between quantities and numerical symbols" (Griffin, 2004 p. 39). The author explains that mathematics is comprised of three worlds (actual quantities, spoken counting numbers, and formal written symbols). In order to have a strong number sense foundation, students must understand the intricate relationships between these three worlds. In the article, the author outlines the development of number sense from infancy into early childhood. She also emphasizes the need for research-based mathematics programs such as the one she co-developed called Number Worlds. The purpose of these research-based programs is to ensure students are introduced to concepts in a developmentally appropriate sequence, making rich connections, and have the opportunity to explore and discuss the concepts.

7) Title: Number Concepts and Special Needs Students: The Power of Ten-Frame Tiles

Source: Losq, C.S. (2005). Number concepts and special needs students: The power of ten-frame tiles. *Teaching Children Mathematics,* 310-315.

Summary:
Ten-frame tiles help students, especially those with special needs, develop understanding of number, place value, and computation. It is a rich visual tool that shows the configurations of each number from 0-10 and thus allows children to identify the "shapes" of the numbers to improve their number recognition. Ten-frame tiles help children construct an understanding of groups of ten by allowing them to explore the different parts that make ten. On the other hand, when using base ten blocks, students may have come to identify the 'rod' as being 'ten' simply due to repeated exposure rather than a true understanding of what makes ten. Throughout the article, the author provides specific examples of how the ten-frame tile can act as a thinking tool for students as they work on subitizing, counting, computation, and basic algebra.