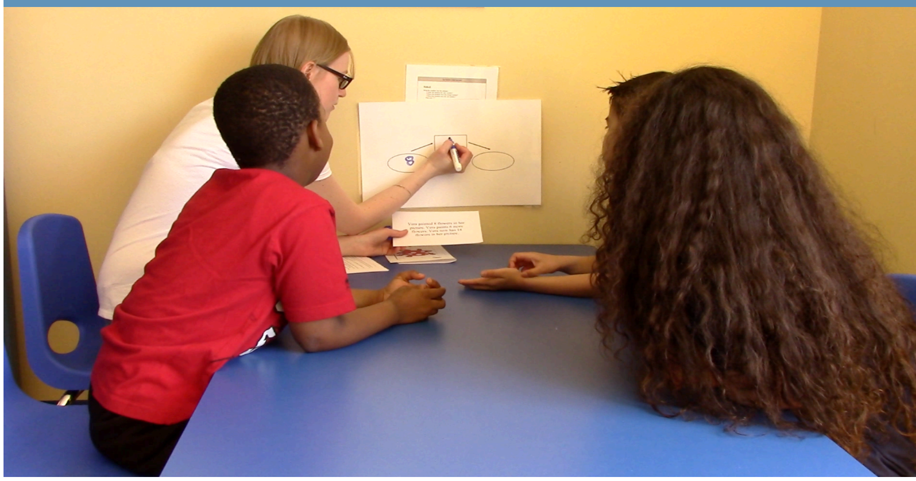
SCHEMA BASED INSTRUCTION (SBI)



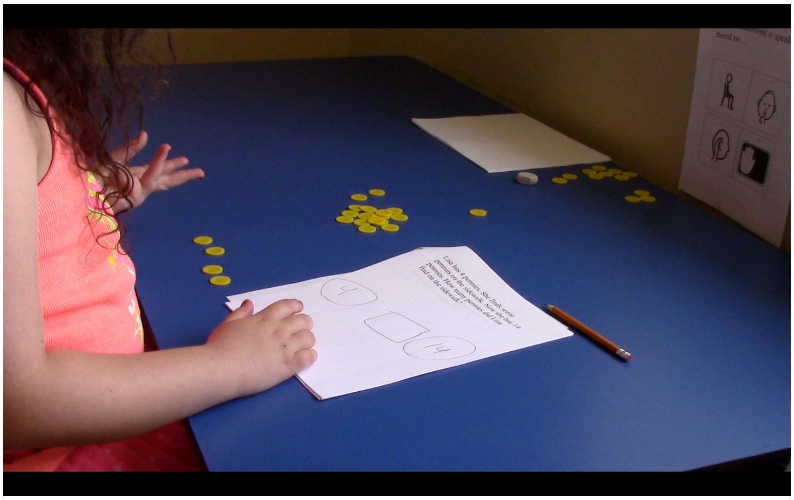
Schema Based Instruction uses diagrams to teach children the underlying structure of word problems, helping them identify appropriate problem solving strategies.

WHAT IS SBI?

SBI is a strategy that uses visual representations to teach children the underlying structure of word problems. When children are able to understand the underlying structure, they can see the relationship between the numbers in a given problem, which helps them to solve it. SBI has been used with a variety of different children: youth with learning disabilities, children at-risk for mathematics failure, and typically developing children (Fuchs, Fuchs, Finelli, Courey, & Hamlett, 2004; Jitendra & Star, 2011).

SBI is taught in two phases: *Schema Phase* and *Solution Phase*. During the *Schema Phase*, children are taught where to place the numbers of a word problem into the diagram of the word problem structure (refer to Figure 1). The goal is for the children to work with different diagrams until they are internalized. When children have internalized the diagrams, they are called, "schemas". Schemas help children see the relationships between the quantities in a word problem. In the *Solution Phase,* the instructor encourages the children to come up with their own strategies and to share them with their peers. This is based on best practice research that has shown that children use a variety of problem solving strategies and that instruction should build on their existing knowledge to lead them to use more sophisticated strategies (Carpenter, Franke, & Levi, 2003).

A recent study was conducted in May 2014 (Desmarais, 2014). Three first-grade students who had autism and a mild intellectual disability received 3 hours of SBI on single-step, addition and subtraction word problems. Results demonstrated an increase in their problem solving skills. Two children went from guessing or repeating numbers in the problem to using manipulatives to act out the problem and solve it. Children were able to correctly identify the word problem structure and were even with able to successfully identify the structure of new and unfamiliar problems.



CHILDREN WITH LEARNING DIFFICULTIES

Mathematical word problems can be a source of difficulty and anxiety for many students. Children with learning difficulties have particular difficulty understanding and correctly solving mathematical word problems. These children have difficulty visualizing the word problem structure and identifying the relevant information in the problem (Oznoff & Schetter, 2007). As a result, children often fail to generate a useful equation necessary to solve the problem (Hutchinson, 1993).

One of the reasons children with learning disabilities have difficulties is because they often present with deficits in their executive functioning. One of the bigger deficits that has been observed in this group is a deficit of working memory. Working memory is the ability to hold information in one's mind while simultaneously using other mental processes (Geary, Hoard, Byrd-Craven, Nugent, & Numtee, 2007). Children with learning difficulties will rely on immature problem solving strategies, such as fingers counting because they are unable to keep relevant information in their working memory (Geary, 2004). Counting errors can also be attributed to working memory deficits (Geary, 2004). In addition to working memory deficits, these children often have difficulty selecting strategies that match the type of problem at hand. Children with learning difficulties will often use the same strategy repeatedly, regardless of what the problem requires (Ostad, 1997).

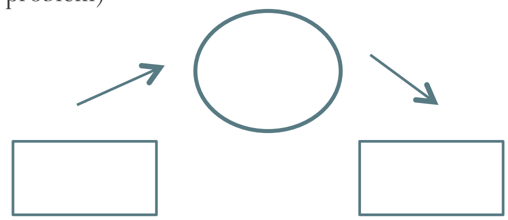
Best teaching practices in mathematics for children with learning include instruction that is clear and provides many opportunities for practice. It should explain why strategies work and build on the child's strengths and informal knowledge (Clements & Sarama, 2009). Mathematical activities should shift from simple calculation activities to those that blend problem solving and mathematical reasoning. Large amounts of information should be broken down into small units and extra time should be given to help bridge the gap with their peers (Clements & Sarama, 2009). Finally, teaching should include the use of concrete objects and visuals, be explicit and clear, encourage discussion and collaboration among students, and explicit corrective feedback from the instructor (Clements and Sarama, 2009). The reason SBI is so successful is because it addresses the working memory deficits of children with learning difficulties, while at the same time incorporates best teaching practices.

SBI RESEARCH

Previous studies on SBI have shown promising results across a variety of different groups of children such as youth with learning disabilities, children at-risk for mathematics failure, and typically developing children (Fuchs, Fuchs, Finelli, Courey, & Hamlett, 2004; Jitendra & Star, 2011). Jitendra and Star (2011) argued that, especially for children with learning difficulties, SBI offers a level of concreteness that helps students understand the underlying concepts. The use of diagrams (Figure 1) helps children visualize the underlying structure of the problem, helping to show the relationships between the quantities in the problem. When children are able to understand the underlying structure, they are able to identify solution strategies. Research has also shown that children taught to solve problems through SBI are better able to solve new problems they have never seen before (Fuchs, Fuchs, Prentice, Hamlett, Finelli, & Courey, 2004).

Figure 1. Visual representations of word problem structures used in SBI.

a. There are 20 apples in a bin. 5 fall out. How many apples are left in the bin? (Action problem)



b. Katie has 52 stickers in her collection. 25 are hearts and the rest are stars. How many star stickers does Katie have? (Part-Whole problem)

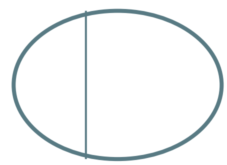
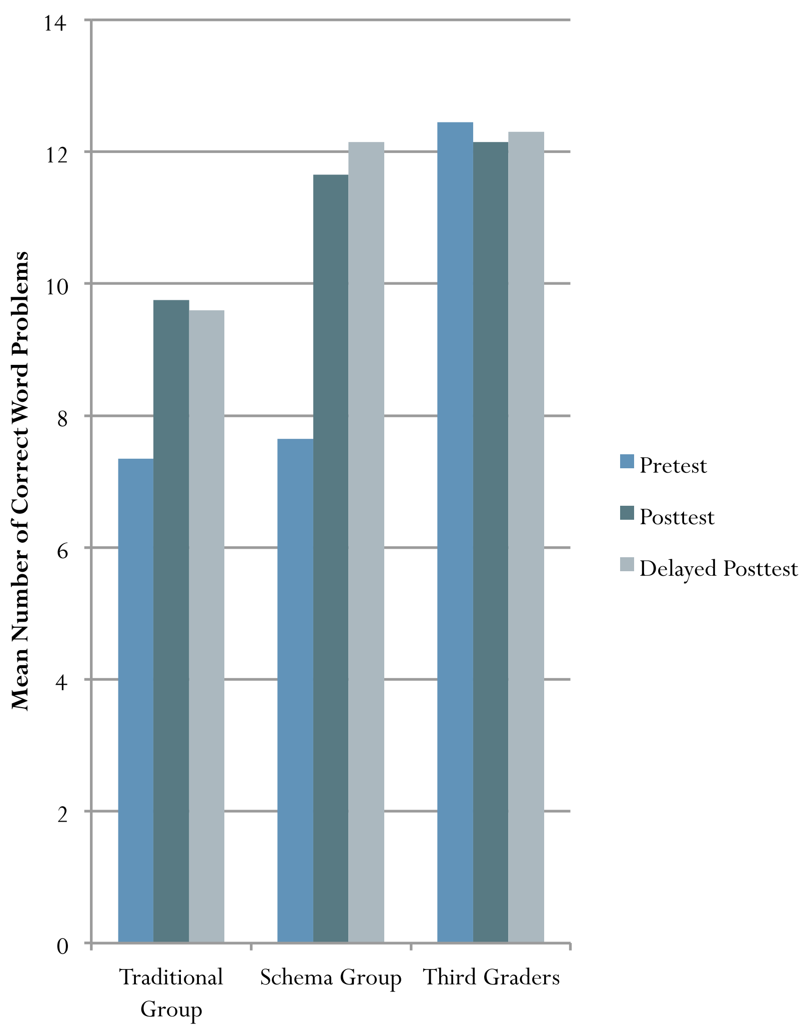


Figure 2. Mean Scores on Pretest, Posttest, and Delayed Pottest



In a study done by Jitendra and colleagues (1998), 34 students identified as having mild disabilities or at-risk for mathematics failure were randomly assigned to one of two groups who would receive instruction on how to solve single step addition and subtraction word problems. The Traditional Group received traditional instruction using a standard math text. The Schema Group received SBI. A comparison group of high-achieving third graders were used as a normative sample since the instruction for the other groups were of a third-grade level. Results (Figure 2) demonstrated that children in the Schema Group had higher scores on their posttest than the Traditional Group, and did comparably to the third graders (77% to 81%, respectively). Two weeks later, the scores on the posttest of the Traditional Group decreased, whereas there was a gain by those in the Schema Group (64% to 81%, respectively). These results are encouraging for possible programming for children with learning disabilities.

IN CLOSING

More and more students with learning difficulties and special needs are being integrated into mainstream classrooms. Given the large numbers of students being integrated into classrooms, it is of utmost importance that appropriate programs are put into place to help support their conceptual understanding of mathematics. Current mathematics programming for these often focuses on teaching the children procedures and "short cuts" to solving word problems. Contrary to these programs, SBI emphasizes both conceptual and procedural understanding of word problems. It is a simple adaptation that can made in every classroom that would help all students understand the underlying word problem structure, thus helping them to identify appropriate problem solving strategies. MSBI builds upon existing Schema Based Instruction program to incorporate more components of best practices in mathematics, and allows instructors to determine what are the problem solving strategies currently being used by their students. In understanding this, teachers can build on children's existing knowledge to help them use more sophisticated problem strategies and become more efficient problem solvers (Carpenter & Moser, 1984).

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