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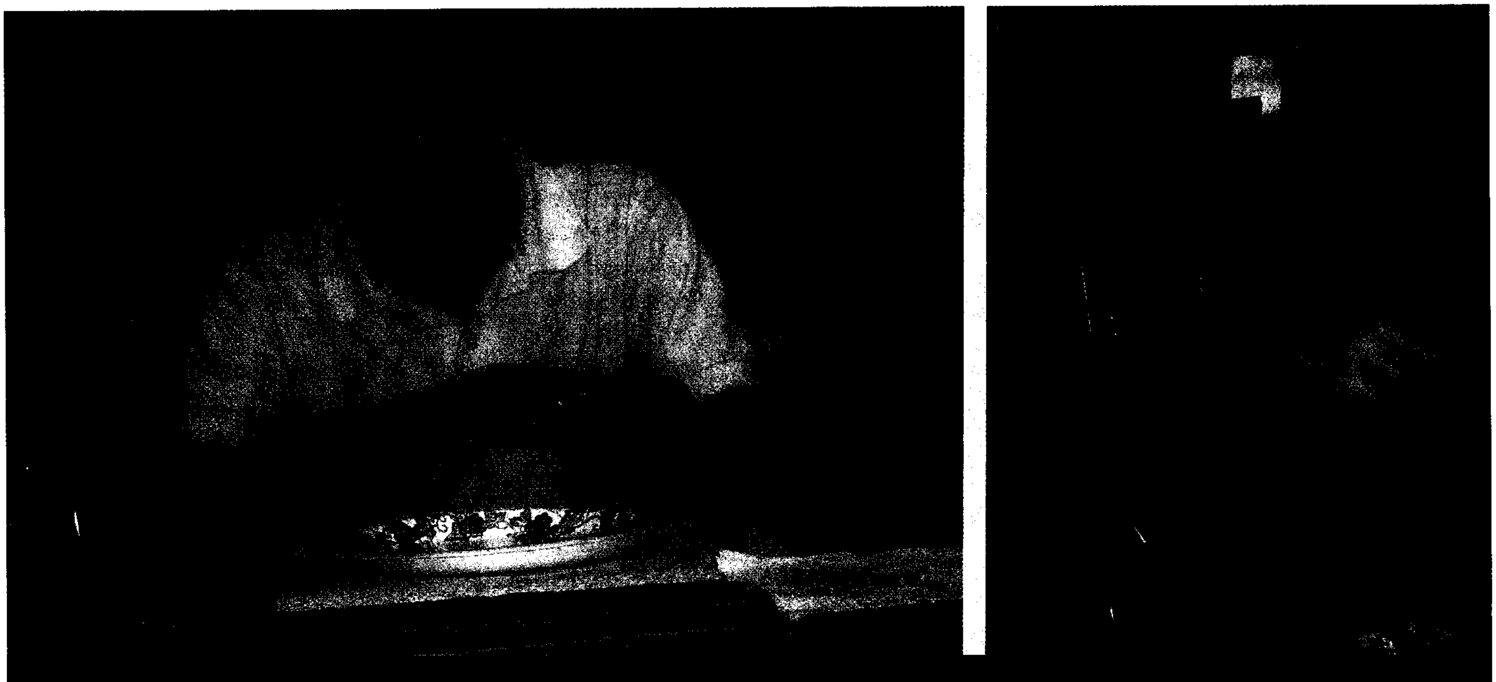

# Dynamic Concrete Instructio

Bradley S. Witzel and David Allsopp

NCTM advocates the use of multiple representations and manipulatives for building mathematical understanding (NCTM 2000). Engaging students in mathematics using manipulatives can have a powerful effect on learning. The use of manipulatives is especially effective for students with high-incidence disabilities, such as learning disabilities (LD), attention deficit hyperactivity disorder (ADHD), and mild to moderate mental disabilities (MD). Allowing students to use manipulatives gives them the opportunity to experience multisensory learning, which helps promote success for students with high-incidence disabilities. Experiences with manipulative objects can help students develop conceptual understanding. If used appropriately, manipulatives can also help those with high-incidence disabilities connect conceptual understandings of mathematics to the process of doing mathematics (i.e., using effective problem-solving strategies) throughout their K–12 education.

Unfortunately, this important connection between understanding mathematics and doing mathematics does not often occur for middle school students with high-incidence disabilities. Middle school teachers are less likely to incorporate the use of manipulatives in mathematics instruction than their colleagues in elementary settings (Howard, Perry, and Lindsey 1996). Although the use of manipulatives in middle-grades education has led to consistently positive results for general education students, research is beginning to show the benefits of the effective use of manipulatives with students who have learning problems (e.g., see Maccini and Hughes 2000; Miller and Mercer 1993; Witzel, Mercer, and Miller 2003).

This article highlights how teachers can effectively implement three instructional strategies that use manipulatives to achieve mathematics success for students with high-incidence disabilities. These strategies are (1) linking prior knowledge to new concepts, (2) emphasizing thinking-aloud modeling, and (3) applying multisensory cueing. These strategies will be illustrated


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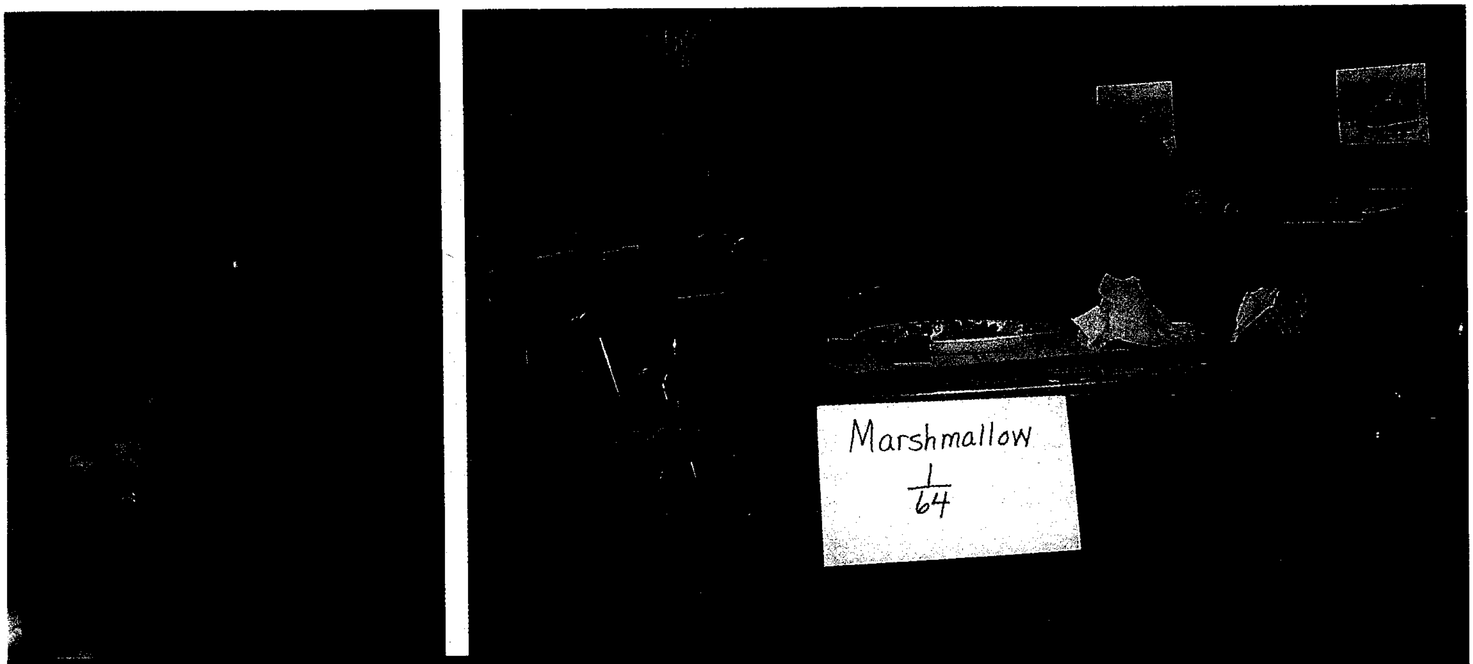



# an Inclusive Classroom

through separate vignettes depicting an inclusive sixth-grade mathematics classroom that was co-taught by a general education and special education teacher. An introduction to the class is provided, followed by vignettes of how the teachers implemented each of the three instructional strategies.

## MS. DOBBINS' AND MRS. LENTZ'S CLASS

Laura Dobbins teaches a mathematics class of twenty-three sixth graders who have a wide range of mathematical knowledge and skills. Six students have been diagnosed with learning disabilities, three with attention concerns (ADHD, both impulsive and hyperactive), and the rest have scored below average on end-of-grade exams. Like many new teachers, she understands the content but is nervous as to how she will present it so that every student can succeed. Her co-teacher for this class, Debra Lentz, is a special education teacher. They collaborate on the lesson plans for teaching mathematics. Their current unit is computation of fractions.

## DYNAMIC CONCRETE INSTRUCTIONAL STRATEGIES

A clear and engaging teacher model can create powerful learning experiences for students with high-incidence disabilities. Dobbins and Lentz want to teach in a way that helps every child in their class succeed. Although several instructional techniques promote these powerful learning experiences, these teachers focused on linking prior knowledge through manipulations, emphasizing think-aloud modeling, and using multisensory cueing. Dobbins and Lentz decide to target their instruction on addition of fractions with like denominators. Their students have already been exposed to this topic and have shown some conceptual understanding but need further support.

### *Linking prior knowledge through manipulations*

Dobbins and Lentz believed that starting with a concept and skill for which their students already had prior experience (representing fractions and adding fractions with like denominators) would support them to scaffold students' learning experiences to the target goal (adding fractions with unlike denominators). Having participated in vertical planning meetings with elementary school teachers from feeder schools, they knew that students had learned to use fraction circles and brownie or cake-pan representations of fractions. Therefore, Dobbins and Lentz decided to help students build on their prior experiences by linking the use of fraction circles to add like denominators with a new representation, fraction strips. They thought that allowing students to experience multiple forms of concrete representations could only benefit them when new representations were directly related to familiar ones.

During instruction, students revisited working with fraction circles. The teachers wanted students to be able to hear, see, and feel how fraction strips and fraction circles both represent fractions using the area model despite their different geometric shapes (circle versus rectangle). The teachers had agreed earlier that the primary connection they wanted students to make between the different representations was that the proportional relationship between the areas of the fractional part and the whole were the same, even though the geometric shapes were different. Students examined representations of the fraction 1/2 using both types of manipulatives, mentally responding to the questions:

- Is the fraction the same?
- How do you know?

As students examined the representations, the teachers monitored their work, provided cueing as needed, and guided students to touch the manipulative and feel the defining attributes of each representation (e.g., running a finger along the perimeter of the whole and then along one-half). This technique engages students to use two important learning modalities, touch and movement, to better understand the proportional relationships between the parts and the whole for each type of manipulative. Incorporating multiple ways for students to "input" these distinguishing features can help students to better understand how manipulatives with different shapes can represent the same fraction. By using this simple technique, the teachers believed that their students would be more likely to generalize their prior understandings of fractions with circles to new understandings of fractions using strips. Students were also asked to review previously learned fraction applications (e.g., representing fractions, comparing fractions with like denominators) using the fraction-strip manipulative.

### *Emphasizing think-aloud modeling*

After students demonstrated that they understood the concept of fractions using strips and showed that they could relate this knowledge to prior fraction knowledge, Dobbins modeled how to use fraction strips to add fractions with like denominators. She used several important teaching strategies as she modeled, one of which was called *think-alouds.* This strategy required Dobbins to verbalize the thinking process as she moved through each step to solve the problem. Because of the student population in the room, both teachers decided to emphasize the two most important thinking processes. For the students who impulsively begin solving equations, they emphasized thinking about the equation and what the equation represented. Dobbins modeled the action by reading the problem aloud first, then stating that she was working with fractions. Third, she explained what operation would be performed. Her think-aloud went like this:

> Hmm, I have a problem here. Let me read it to myself first. Two-fourths plus one-fourth equals something. Well, I know I am working with fractions, because I have a numerator and a denominator for each number. The next thing I need to do is discover what I need to do with the fractions. I know; I need to look at the sign. The sign is an addition sign. OK. That means I need to add, or combine the two fractions.

The teachers also wanted students to think about how the fraction strips related to the written fractions in the equation. Expanding on the previous class discussion, Dobbins wanted students to recognize the importance of knowing that fractions represent parts of equivalent wholes.

> Now that I know I need to add these fractions, I can use fraction strips to help me. Let me take a look at some of them. They are all the same length and the same width. Since their length and width are the same, then I also know they represent the same area. Each strip represents one whole, and each whole has the same area. I know that having strips all the same size is important because to add fractions accurately they have to be parts of the same whole. The same thing is true when I used fraction circles.

Think-alouds should be followed by student practice of the thinking process. Students need opportunities to verbalize their thinking. Incorporating language experience into mathematics study is a powerful tool for students to learn to rationalize mathematical processes.

### *Applying multisensory cueing*

During guided practice with the class on the 2/4 + 1/4 problem, Lentz folded one strip in half and asked how many parts the strip represented.

*Students:* Two.
*Lentz:* Is this enough to complete this problem?
*Students:* No, you need four.
*Lentz:* Why?
*Students:* You need four parts of the whole to match the fractions.
*Lentz:* Should the parts be equal?
*Students:* The parts should be equal parts of the whole.

Then Lentz folded the strip in half again to represent four equal parts, and the students agreed that the strip was ready. Lentz integrated the use of multisensory cueing to emphasize the *key features* of adding fractions with like denominators. Before class, Lentz and Dobbins determined the features of adding fractions using fraction strips that they thought were most important for understanding. Both teachers believed that cueing those aspects of the manipulative that emphasize the meaning of written fractions was important (i.e., how the written symbols related to the concrete representation). This cueing included color coding the numerators and denominators with the fraction strips and incorporating frequent language experiences. Each written numerator was coded blue, and each denominator was coded red. Likewise, the fraction strips were shaded similarly. The four squares were outlined in red. Lentz pointed to each written fraction, and said, "What is the first fraction?" She shaded two rectangles in blue to represent 2/4. Then she asked what the second fraction was and shaded one rectangle to represent 1/4. As she shaded each fraction, she prompted students to think about what the blue shading and what the red outline represented. She then asked, "What is 2/4 + 1/4, and how do you know?" Students answered 3/4 and said that this was the answer because they were adding the fractions. See **figure 1**'s fraction strip.

Dobbins concluded by modeling language that reflected the meaning of each fraction (i.e., 2/4 + 1/4 = 3/4: "two out of four equal parts combined with one out of four equal parts totals three out of four equal parts") and displayed the strip on the board. She also wrote the words that the shaded areas represented underneath the fraction strip. By combining color coding, kinesthetic cueing (e.g., pointing), and language, the teachers provided multisensory cueing that enabled students to better process and therefore cognitively access an important conceptual feature of adding fractions with like denominators.

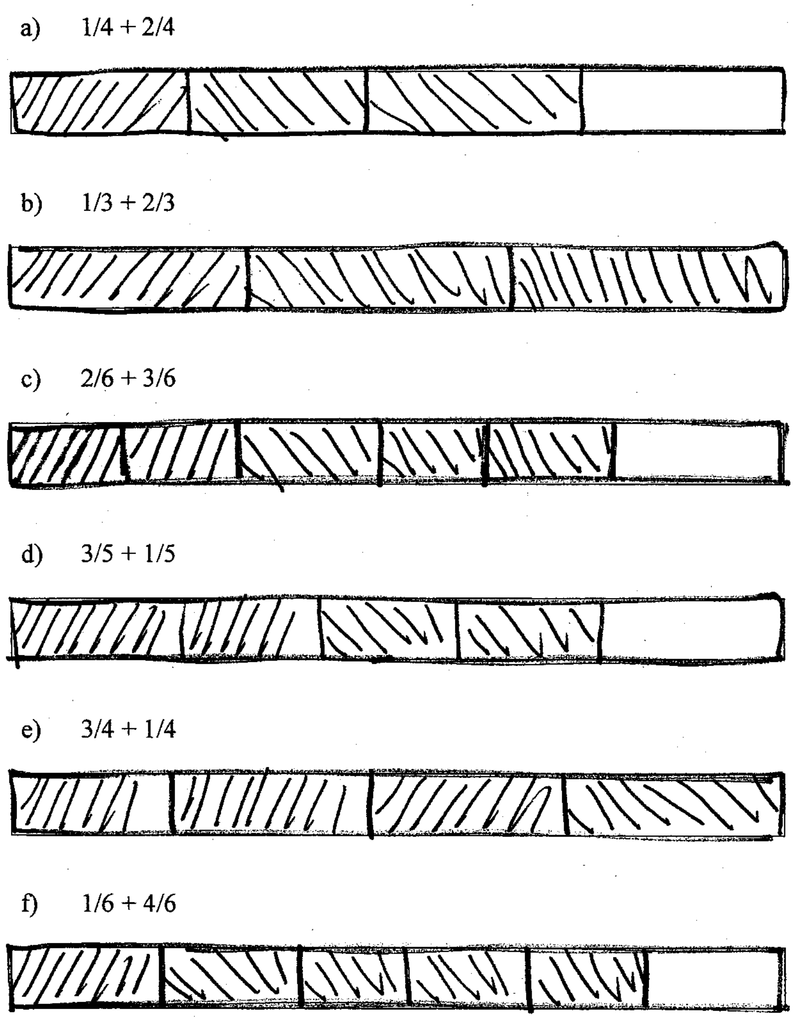
The next day, the teachers divided the class into two groups. A group of students who needed additional help worked with Lentz on how to relate fraction strips and concrete representations to the addition of fractions. At the same time, the other group of students worked with Dobbins on pictorial representations. Students were given sheets of paper containing drawings of blank fraction strips. They were asked to follow the same procedures

**Fig. 1** Adding fractions with like denominators on a single fraction strip

2/4 + 1/4 = 3/4

**Fig. 2** Students were given sheets containing blank fraction strips and asked to color code the solution to the problem.

Directions: Outline the denominator in red and shade in the numerator in blue for each addition problem.



to color code and shade these strips instead of using an actual fraction strip. See **figure 2** for an example of the pictorial representation work. The color coding allowed students to transition from physical manipulation to pictorial representation using the same steps.

## CONCLUSION

The concrete instructional strategies described in this article are not meant to supplant other good teaching practices that occur in any mathematics class. Students with learning problems still need *statements of relevance* (teachers helping students to understand the relevance of the topic or concept to their lives through verbal, visual, or other ways), proper modeling with examples and nonexamples, followed by a chance to explore the topic; pictorial representations tied to abstract procedures; and specific corrective feedback and positive reinforcement for both effort and accuracy. Teaching practices that enhance instruction using manipulatives will, however, give more students with learning problems an opportunity to experiment with mathematics concepts and to develop greater conceptual understanding. Using manipulatives also makes mathematics fun, which is important for students with learning problems. All too often, learning is not enjoyable for them. By incorporating the teaching strategies and tips described, you will be well on your way to helping students with learning problems experience success with mathematics. Success leads to confidence. Confidence provides motivation for learning. All students deserve that.

*Authors' note*: Readers are encouraged to learn more about teaching students with learning problems using manipulatives as well as other instructional strategies by visiting the MathVIDS Web site (coe.jmu.edu/mathvidsr). This site provides numerous strategies and ideas for teaching mathematics to students with learning problems. Digital video models of real teachers in real classrooms implementing these research-supported effective instructional strategies for students with learning problems is a special feature of the Web site. Also included are teaching plans that describe how these strategies can be integrated to teach particular mathematics concepts in the areas of whole-number operations, place value, and fractions.



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For more on a related topic, see the October 2004 Focus Issue of *TCM* titled "Teaching Mathematics to Special Needs Students."