

## **Meta Cognitive Strategies**

Several cognitive and meta-cognitive strategies can be used effectively. For example, (1992) recommends the use of six problem-solving strategies that students can monitor on an implementation sheet. Students verbalize the steps while completing the problem and note their completion of the steps on the monitoring sheet. The six steps are:

1. Read and understand the problem.
2. Look for the key questions and recognize important words.
3. Select the appropriate operation.
4. Write the number sentence (equation) and solve it.
5. Check your answer.
6. Correct your errors.

Further, Mercer (1992) identifies the components necessary for students to engage in successful problem-solving. According to Mercer, the problem-solving process involves 10 steps, which can be expanded into learning strategies to enable students with math disabilities to be more effective in solving word problem. The 10 steps are:

1. Recognize the problem.
2. Plan a procedural strategy (i.e., identify the specific steps to follow).
3. Examine the math relationships in the problem.
4. Determine the math knowledge needed to solve the problem.
5. Represent the problem graphically.
6. Generate the equation.
7. Sequence the computation steps.
8. Check the answer for reasonableness.
9. Self-monitor the entire process.
10. Explore alternative ways to solve the problem.

## **Techniques to enhance mathematics instruction**

For students with math disabilities, effective mathematics instruction is the difference between mathematics as a paper-and-pencil/right-answer type of task and an important real-life skill that continues to be used throughout their lifetime. This section examines effective instructional techniques that the general educator can incorporate into the classroom for all learners, and especially for students with math disabilities.

## **Increasing instructional time**

Providing enough time for instruction is crucial. Too often, "math time" according to Usnick and McCoy (cited in McCoy & Prehm, 1987) includes a long stretch of independent practice where students complete large numbers of math problems without feedback from the teacher prior to completion. Instructional time is brief, often consisting of a short modeling of the skill without a period of guided practice. By contrast, small-group practice where students with math disabilities complete problems and then check within the group for the correct answer, use self-checking computer software programs, and receive intermittent teacher interaction are positive modifications for increasing time for mathematics instruction. Additionally, time must be provided for students to engage in problem-solving and other math "thinking" activities beyond the simple practice of computation, even before students have shown mastery of the computational skills. Hammil and Bartel (cited in Polloway & Patton, 1993) suggest slowing down the rate of instruction by using split mathematics instructional periods and reducing the number of problems required in independent practice.

## **Using effective instruction**

Polloway and Patton (1993) suggest that the components of effective instruction play an important role in the success of students with disabilities in general education mathematics instruction. One suggested schedule for the class period includes a period of review of previously covered materials, teacher-directed instruction on the concept for the day, guided practice with direct teacher interaction, and independent practice with corrective feedback. During the guided and independent practice periods, teachers should ensure that students are allowed opportunities to manipulate concrete objects to aid in their conceptual understanding of the mathematical process, identify the overall process involved in the lesson (i.e., have students talk about "addition is combining sets" when practicing addition problems rather than silent practice with numerals on a worksheet), and write down numerical symbols or mathematical phrases such as addition or subtraction signs. Teaching key math terms as a specific skill rather than an outcome of basic math practice is essential for students with LD (Salend, 1994). The math terms might include words such as "sum," "difference," "quotient," and "proper fraction," and should be listed and displayed in the classroom to help jog students' memories during independent assignments.

## **Varying group size**

Varying the size of the group for instruction is another type of modification that can be used to create an effective environment for students with math disabilities. Large-group instruction, according to McCoy and Prehm (1987), may be useful for brainstorming and problem-solving activities. Small-group instruction, on the other hand, is beneficial for students by allowing for personal attention from the teacher and collaboration with peers who are working at comparable levels and skills. This arrangement allows students of similar levels to be grouped and progress through skills at a comfortable rate. When using grouping as a modification, however, the teacher must allow for flexibility in the groups so that students with math disabilities have the opportunity to interact and learn with all members of the class (see Rivera in this series for cooperative learning information).

## **Using real-life examples**

Salend (1994) recommended that new math concepts be introduced through everyday situations as opposed to worksheets. With everyday situations as motivators, students are more likely to recognize the importance and relevance of a concept. Real-life demonstration enables students to understand more readily the mathematical process being demonstrated (see Scott & Raborn in this series for additional ideas). Further, everyday examples involve students personally in the instruction and encourage them to learn mathematics for use in their lives. Changing the instructional delivery system by using peer tutors (see Miller et al. in this series for ideas about peer tutoring); computer-based instruction; or more reality-based assignments such as "store" for practice with money recognition and making change also provide real life math experiences (Hammill & Bartel cited in Polloway & Patton, 1993).

## **Varying reinforcement styles**

Adaptations and modifications of reinforcement styles or acknowledgment of student progress begin with teachers being aware of different reinforcement patterns. Beyond the "traditional" mathematical reinforcement style, which concentrates on obtaining the "right answer," students with mathematics disabilities may benefit from alternative reinforcement patterns that provide positive recognition for completing the correct steps in a problem regardless of the outcome (McCoy & Prehm, 1987). By concentrating on the process of mathematics rather than on the product, students may begin to feel some control over the activity. In addition, teachers can isolate the source of difficulty and provide for specific accommodations in that area. For example, if the student has developed the ability to replicate the steps in a long division problem but has difficulty remembering the correct multiplication facts, the teacher should reward the appropriate steps and provide a calculator or multiplication chart to increase the student's ability to obtain the solution to the problem.

*IRIS-Center at Vanderbilt University Dr. Judy Smith-Davis*