The *Solve It!* Instructional Approach Yields Evidence-Based Results for Math Students

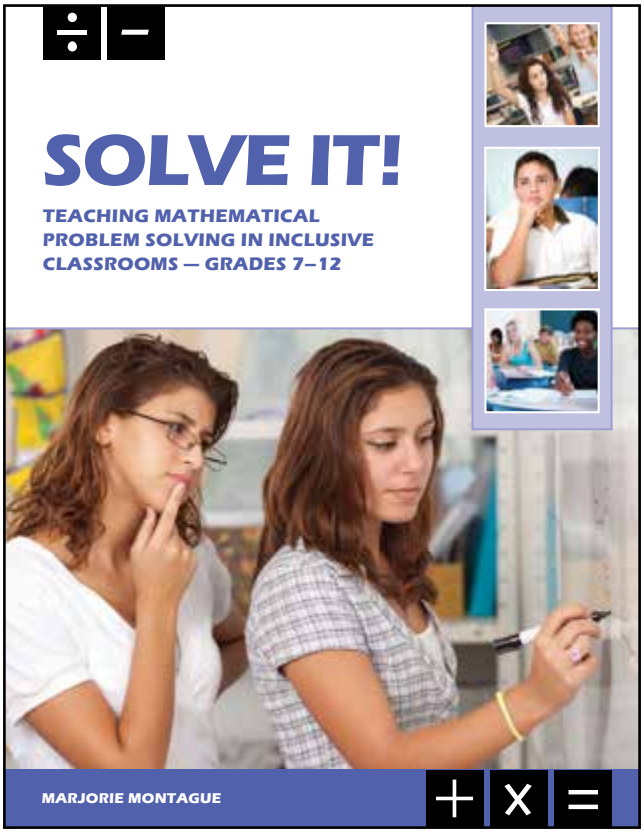
For more than two decades, a major focus of math reform efforts has been improving students' math problem-solving skills, particularly for those students who typically perform poorly in math. While there have been some gains, students in general continue to perform poorly on standardized tests that measure math problem-solving ability. With the advent of new Common Core State Standards that many states have adopted, the focus on problem-solving proficiency will continue to increase and will raise the stakes for teaching math problem-solving skills to *all* students.

More than 25 years ago, Dr. Marjorie Montague began researching math problem-solving skills (Montague, 1985). She determined that students who are poor problem solvers do not know or do not use the types of strategies that support problem-solving proficiency. She found that students need to be taught problem-solving processes explicitly—both critical cognitive processes and metacognitive strategies—and shown how to apply those processes when solving math word problems (e.g., Montague & Applegate, 1993).

With more than a decade of research in hand, in 2003 Dr. Montague developed the *Solve It!* instructional approach, designed to improve math problem solving in students with math difficulties and students with learning disabilities. It was field tested extensively in both special education and general education classrooms. Recently, a new version of *Solve It!* has expanded the approach to general education inclusive mathematics classrooms. Research on the new version of *Solve It!* has shown that students in inclusive classrooms can quickly and efficiently be taught how to solve math word problems.

What the Research Says About *Solve It!*

Solve It! was validated and refined in three separate intervention studies with a total of 84 students with mathematical learning disabilities between 12 and 18 years of age (Montague, 1992; Montague, Applegate, & Marquard, 1993; Montague & Bos, 1986). In these intervention studies, five scripted lessons were sequenced to ensure that students learned and understood the cognitive processes and self-regulation strategies associated with effective mathematics problem solving. Following *Solve It!* instruction, students with learning disabilities performed at the same level as average achieving students on math problem-solving tests and maintained performance over a four-month period. Further, they were able to generalize the problem-solving routine to more complex math problems. Generally, across studies, students maintained strategy use and problem-solving performance for several weeks following instruction. After several weeks, some student performance tended to decline; however, a Booster Session consisting of review and practice helped these students quickly return to their previous level of mastery.



More recently, *Solve It!* was validated in two large intervention studies with a total of 1,059 students, conducted in general education math classes with average-achieving students, low-achieving students, and students with learning disabilities (Montague, Enders, & Dietz, 2011; Montague, Krawec, Enders, & Dietz, in press). In these studies, instruction consisted of three initial scripted lessons and weekly practice sessions that used word problems drawn directly from the district curriculum. Student progress was monitored using curriculum-based measures consisting of 10 one-, two-, and three-step word problems. Results indicated that students who received *Solve It!* instruction embedded in the district curriculum:

- Showed significantly greater growth in math problem solving than the comparison group students who received only the district curriculum.
- Experienced greater growth and improvement on the state math assessment than the comparison group students. [Note: Although these findings were not statistically significant, the researchers caution that because the state assessment produced only one score for mathematics that included several skills in addition to problem solving, there is no way to know the extent of students' growth on problem-solving skills alone on this assessment. The statistically nonsignificant improvement, however, still translates into important practical gains in performance on a high-stakes test that determines grade promotion, eligibility for certain courses, and even graduation.]

Further, the research showed significant improvement in the performance of students across ability levels. As such, *Solve It!* might well turn out to be a viable solution for embedding problem-solving instruction into the curriculum of inclusive classrooms. The research demonstrates that when the *Solve It!* program is embedded in the general education math curriculum it is effective for learning disability, low-achieving, and average-achieving populations of students—a most desirable result for today's inclusive classrooms.

Teachers typically like *Solve It!* because they see that students experience immediate success and show improvement (Montague, Warger, & Morgan, 2000). They find it both feasible and practical to implement in the context of the required curriculum. Additionally, teachers observe that students' self-efficacy, motivation, and interest in mathematics also improve following *Solve It!* instruction (Montague, Applegate, & Marquard, 1993). Students' improved mathematics performance generally has a positive impact on their middle and secondary mathematics grades, which has a significant impact on overall success in school, on graduation rates, and—ultimately—on postsecondary outcomes. The *Solve It!* research of more than two decades continues to demonstrate that we *can* succeed in teaching problem-solving skills to students, that those skills *do* improve math performance, and that we can teach problem-solving skills in a way that helps students show improvement *across* ability levels.

Why Does *Solve It!* Work?

Focus on Problem-Solving Processes Plus Cognitive Strategy Instruction

Successful problem solvers usually have knowledge of and utilize problem-solving *processes*. Two processes they know well are:

- **Problem representation**—needed to understand and assimilate problem information, maintain mental images of the problem in memory, and develop a feasible solution path. Students transform linguistic and numerical descriptions into verbal, symbolic, and visual representations that show how the quantitative problem information is related (Montague & Applegate, 1993; van Garderen & Montague, 2003).
- **Problem execution**—needed to perform the appropriate calculations and check for accuracy.

While it has been around for more than 20 years, the concepts promoted in the *Solve It!* instructional program are still quite innovative. With its focus on teaching cognitive processes *Solve It!* is different from the typical instructional approach for math (i.e., didactic instruction and worked examples). *Solve It!* places an emphasis on teaching students how to comprehend, represent, and plan to solve mathematical problems. *Solve It!* identifies the processes and strategies successful problem solvers use and provides a systematic instructional program, based on cognitive strategy instruction, to improve students' problem-solving performance (Montague, 2003; 2013).

Solve It! provides explicit instruction in mathematical problem solving in lessons that teach critical cognitive processes and metacognitive strategies and improve students' motivation to solve problems. While cognitive strategy instruction has been shown to improve the academic performance of students of varying disabilities (e.g., Coughlin & Montague, 2010), it has been observed to be particularly effective for students with learning disabilities who do not know or do not use the types of strategies that support problem-solving proficiency (Montague & Dietz, 2009).

Solve It! addresses the following cognitive processes and activities: reading (reading, rereading, and identifying relevant/irrelevant information); paraphrasing (putting the problem into one's own words without changing the problem meaning); visualizing (transforming problem information to a representation that shows the relationships among problem parts); hypothesizing (setting up a plan to solve the problem by deciding on the type and order of operations); estimating (predicting the outcome based on the question/goal); computing (conducting the basic calculation operations needed for solution); and checking (reviewing the accuracy of the process, procedures, and computation). The ultimate goal of *Solve It!* is to have students *internalize* the cognitive processes and strategies so that using those processes and strategies becomes automatic during problem solving.

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