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Solve It! A Mathematical Problem Solving Instructional Program

Did I receive the correct change at the market?

How much gasoline will I need to drive to the amusement park?

How much is a 15% tip on \$13.85?

If I save \$3.00 per week, when will I have enough money to buy the new video game?

If we split the bill three ways, how much do Janice and Sean each owe me?

How many dozen cookies will we need if every person at the party eats four?

These are typical, everyday questions that require mathematical problem solving skills. Even though these problems seem simple, many students have not acquired the necessary skills and strategies for solving them. In some cases, students may have developed the skills, but they have not learned how to apply them outside of the classroom.

Mathematical problem solving is essential for success in school, on the job, and in the community. How can we ensure that students develop these lifelong skills? One proven way is to teach problem solving skills directly.

About Solve It!

Solve It! is a curriculum designed to improve the mathematical problem solving skills of students in the upper elementary, middle, and secondary school grades—including those students who are having difficulties in mathematics. **Solve It!** is designed for students who are developmentally ready to engage in complex, higher-order skills that require metacognitive processing.

The purpose of **Solve It!** is to teach students to be good problem solvers. Good problem solvers:

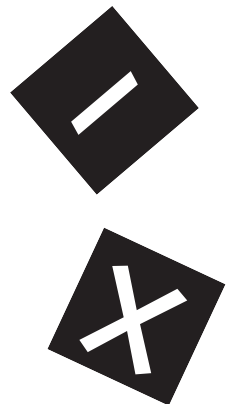
- Comprehend linguistic and numerical information in math problems.
- Translate and transform that information into mathematical notations, algorithms, and equations.
- Observe relationships among the elements in the math problems.
- Formulate plans to solve the problems.
- Predict outcomes.
- Regulate the solution paths as they are executed.
- Detect and correct errors while solving the math problems.

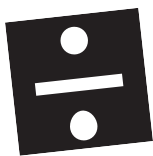
Using **Solve It!**, teachers help students understand, analyze, solve, and evaluate

mathematical problems. They do this by helping students develop the processes and strategies used by good problem solvers.

The cognitive processes and strategies (see the sidebar, **Solve It! Processes**) that make up the **Solve It!** program were identified through a review of problem solving research and later validated in a series of studies (Montague & Warger, 2000). Cognitive processes enable the problem solver first to represent and then to solve problems.

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, 1997). In these intervention studies, scripted lessons were sequenced to ensure that students learned and understood the cognitive processes and self-regulation strategies associated with effective problem solving. Results indicated that, following instruction, students with learning disabilities performed similarly to the average achievers who were not given instruction but who had demonstrated problem solving ability. Generally, across studies, students maintained strategy use and problem solving performance for several weeks following instruction. After several weeks, student performance tended to decline; however, a booster session consisting of review and practice helped students return to their previous level of performance. [See the sidebar, *Read More About Solve It!*, for a listing of publications that attest to the success of **Solve It!**]





Solve It! Processes

Read (for understanding)

Paraphrase (your own words)

Visualize (a picture or a diagram)

Hypothesize (a plan to solve the problem)

Estimate (predict the answer)

Compute (do the arithmetic)

Check (make sure everything is right)



This research-based program is designed for easy inclusion in a standard mathematics curriculum. Explicit instruction in mathematical problem solving is provided in lessons that:

- Teach critical cognitive and metacognitive processes and strategies.
- Improve students' motivation to solve problems.

Solve It! lessons also are designed to address factors associated with successful mathematical problem solving. They include:

- A positive attitude toward mathematics and problem solving.
- Interest in solving problems.
- Independence.
- Confidence in the ability to solve problems.

Getting Started

Everything you need to use **Solve It!** is contained in this instructional guide. The program provides:

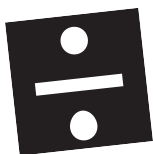
- Guidelines for teaching mathematical problem solving and related mathematics skills.
- Methods to assess the problem solving performance of students.
- Directions for individual and group instruction in specified components of the program.
- Techniques to promote strategy and performance maintenance and generalization.
- Extension activities to promote transfer to novel and real life problems.
- Materials and techniques to evaluate student progress and program effectiveness.

The videotape located in the inside cover

Read More About Solve It!

- Montague, M. (in press). Teaching students how to divide: A constructivist approach. *Focus on learning problems in mathematics*.
- Montague, M., & Applegate, B. (2001). Middle school students' perceptions, persistence, and performance in mathematical problem solving. *Learning Disability Quarterly*, *23*, 215-228.
- Montague, M., & Warger, C. (2000). *Solve it!* Strategy instruction to improve mathematical problem solving. *Learning Disabilities Research and Practice*, *15*, 110-116.
- Montague, M. (1998). Research on metacognition in special education. In T. Scruggs & M. Mastropieri (Eds.), *Advances in learning and behavioral disabilities*. (Vol. 12, pp. 151-183). Greenwich, CT: JAI Press.
- Montague, M. (1998). Mathematics instruction in diverse classrooms. In K. Harris, S. Graham, D. Deshler, & M. Pressley (Eds.), *Teaching every child everyday: Learning in diverse schools and classrooms*. Cambridge, MA: Brookline Books.
- Montague, M. (1997). Student perception, mathematical problem solving, and learning disabilities. *Remedial and Special Education*, *18*, 46-53.
- Montague, M. (1997). Cognitive strategy training in mathematics instruction for students with learning disabilities. *Journal of Learning Disabilities*, *30*, 164-177.
- Montague, M. (1996). Assessing mathematical problem solving. *Learning Disabilities Research and Practice*, *11*, 228-238.
- Montague, M. (1995). Cognitively based instruction for mathematics: Implications for students with disabilities. *Focus on Learning Problems in Mathematics*, *17*, 34-48.
- Montague, M., Applegate, B., & Marquard, K. (1993). Cognitive strategy instruction and mathematical problem-solving performance of students with learning disabilities. *Learning Disabilities Research and Practice*, *29*, 251-261.
- Montague, M., & Applegate, B. (1993). Mathematical problem-solving characteristics of middle school students with learning disabilities. *The Journal of Special Education*, *27*, 175-201.
- Montague, M. (1993). Student-centered or strategy-centered instruction: What is our purpose? *Journal of Learning Disabilities*, *26*, 433-437.
- Montague, M., & Applegate, B. (1993). Middle school students' mathematical problem solving: An analysis of think-aloud protocols. *Learning Disability Quarterly*, *16*, 19-32.
- Montague, M. (1992). The effects of cognitive and metacognitive strategy instruction on mathematical problem solving of middle school students with learning disabilities. *Journal of Learning Disabilities*, *25*, 230-248.
- Montague, M. (1991). Gifted and gifted-learning disabled students' knowledge of mathematical problem solving. *Journal for the Education of the Gifted*, *14*, 393-411.
- Montague, M., Bos, C., & Doucette, M. (1991). Affective, cognitive, and metacognitive attributes of eighth-grade mathematical problem solvers. *Learning Disabilities Research and Practice*, *6*, 145-151.
- Montague, M., & Bos C. (1990). Cognitive and metacognitive characteristics of eighth grade students' mathematical problem solving. *Learning and Individual Differences*, *2*, 371-388.
- Montague, M. (1989). Strategy instruction for mathematical problem solving. *Journal of Reading, Writing and Learning Disabilities*, *4*, 275-290.
- Montague, M. & Bos, C. (1986). The effect of cognitive strategy training on verbal math problem solving performance of learning disabled adolescents. *Journal of Learning Disabilities*, *19*, 26-33.
- Montague, M., & Bos, C. (1986). Verbal mathematical problem solving and learning disabilities: A review. *Focus on Learning Problems in Mathematics*, *8*, 7-21.
- Montague, M. (1985). Teaching verbal mathematical problem-solving skills to students. In C. Simon (Ed.), *Communication skills and classroom success: Therapy methodologies for language-learning disabled students* (pp. 365-377). San Diego, CA: College-Hill Press.





of the notebook provides an overview of the *Solve It!* approach. It features *Solve It!* developer Marjorie Montague conducting *Solve It!* lessons in both a general education and a special education middle school classroom setting. In addition to providing an excellent visual of how the *Solve It!* approach looks in action, the videotape also can be used in orientation sessions with teachers, administrators, and family members.

The instructional guide is organized into two sections. First-time users are encouraged to read through Section One prior to moving to Section Two.

Section One provides background information and materials for the program. It is organized as follows:

- Chapter 1 presents a rationale for teaching mathematical problem solving. The *Solve It!* program purpose and content are described here.
- Chapter 2 presents the instructional components, procedures, and materials. Detailed directions for organizing and leading groups during the instructional sessions are found here.
- Chapter 3 provides several useful approaches to assessing students' mathematics performance. An informal assessment procedure for determining students' mathematical problem solving strengths and weaknesses is presented here.
- Chapter 4 offers suggestions for strategy and performance maintenance and generalization.

Section Two presents scripted *Solve It!* mathematical problem solving lessons. The section also includes:

- An overview of the instructional approach.
- Discussion of the role of assessment. *Solve It!* encourages teachers to conduct both pretests and posttests.
- Directions for facilitating individual and group instruction. The lessons are designed for explicit instruction of the cognitive and metacognitive processes and strategies necessary for effective problem solving.
- Booster lessons for ensuring that students maintain improved performance.
- Application exercises, error monitoring activities, and extension activities.

You will find Appendices at the back of the *Solve It!* manual:

- **Section 3:** Assessment Tools.
- **Section 4:** Instructional Tools.
- **Section 5:** Student Activity Sheets.

Appendices contain blackline masters of instructional tools. Included are:

- Assessment tools, including pretests, posttests, and the Mathematical Problem Solving Assessment-Short Form (in both English and Spanish) used to determine students' understanding of problem solving processes (**Section 3**).
- Master class charts that list the processes and strategies that students learn. These charts are used for group recitation and cueing (**Section 4**).
- Individual student cue cards that can be sent home with students. Students can use them to study and practice the

problem solving strategies and processes (**Section 4**).

- Practice math word problems to be used during instruction (**Section 4**).
- Student activity sheets that contain math word problems (**Section 5**).

The tools found in the Appendices may be duplicated for classroom use. Any other duplication is strictly prohibited.

References

- Montague, M., & Warger, C. (2000) *Solve it!* Strategy instruction to improve mathematical problem solving. *Learning Disabilities Research and Practice, 15*, 110-116.
- Montague, M. (1997). Cognitive strategy training in mathematics instruction for students with learning disabilities. *Journal of Learning Disabilities, 30*, 164-177.

