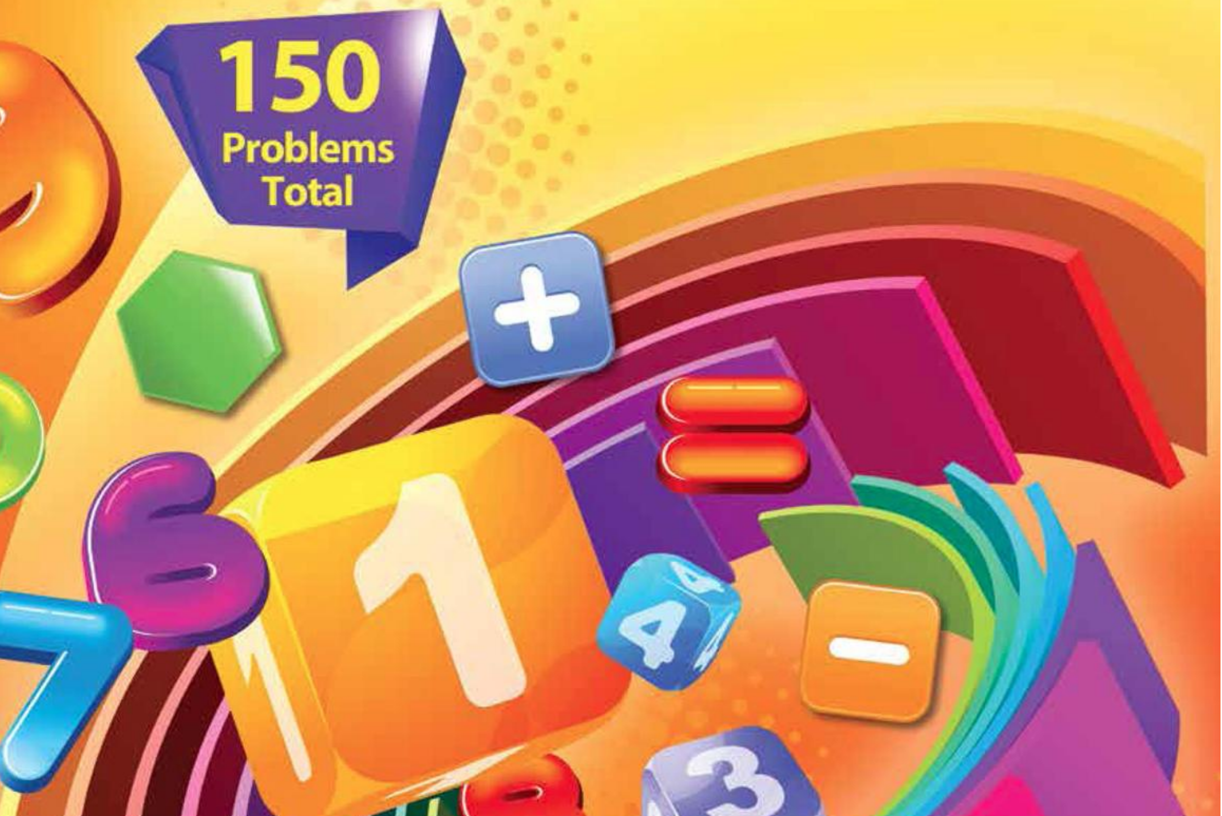
Shell Education

Interactive Whiteboard-Compatible CD

Level 1

50 Leveled Math Problems



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Problem Solving in Mathematics Instruction

If you were a student in elementary school before the early 1980s, your education most likely paid little or no attention to mathematical problem solving. In fact, your exposure may have been limited to solving word problems at the end of a chapter that focused on one of the four operations. After a chapter on addition, for example, you solved problems that required you to add two numbers to find the answer. You knew this was the case, so you just picked out the two numbers from the problem and added them. Sometimes, but rarely, you were assigned problems that required you to choose whether to add, subtract, multiply, or divide. Many of your teachers dreaded lessons that contained such problems as they did not know how to help the many students who struggled.

If you went to elementary school in the later 1980s or in the 1990s, it may have been different. You may have learned about a four-step model of problem solving and perhaps you were introduced to different strategies for finding solutions. There may have been a separate chapter in your textbook that focused on problem solving and two-page lessons that focused on particular problem-solving strategies, such as guess and check. Attention was given to problems that required more than one computational step for their solution, and all the information necessary to solve the problems was not necessarily contained in the problem statements.

One would think that the ability of students to solve problems would improve greatly with these changes, but that has not been the case. Research provides little evidence that teaching problem solving in this isolated manner leads to success (Cai 2010). In fact, some would argue that valuable instructional time was lost exploring problems that did not match the mathematical goals of the curriculum. An example would be learning how to use logic tables to solve a problem that involved finding out who drank which drink and wore which color shirt. Being able to use a diagram to organize information, to reason deductively, and to eliminate possibilities are all important problem-solving skills, but they should be applied to problems that are mathematically significant and interesting to students.

Today, leaders in mathematics education recommend teaching mathematics in a manner that integrates attention to concepts, skills, and mathematical reasoning. Referred to as *teaching through problem solving*, this approach suggests that problematic tasks serve as vehicles through which students acquire new mathematical concepts and skills (D'Ambrosio 2003). Students apply previous learning and gain new insights into mathematics as they wrestle with challenging tasks. This approach is quite different from introducing problems only after content has been learned.

Most recently, the *Common Core State Standards* listed the need to persevere in problem solving as the first of its Standards for Mathematical Practice (National Governors Association Center for Best Practices and Council of Chief State School Officers 2010):

> **Make sense of problems and persevere in solving them.**
> *Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain*

Problem Solving in Mathematics Instruction *(cont.)*

> *insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, "Does this make sense?" They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.*

This sustained commitment to problem solving makes sense; it is the application of mathematical skills to real-life problems that makes learning mathematics so important. Unfortunately, we have not yet mastered the art of developing successful problem solvers. Students' performance in the United States on the 2009 Program for International Student Assessment (PISA), a test that evaluates 15-year-old students' mathematical literacy and ability to apply mathematics to real-life situations, suggests that we need to continue to improve our teaching of mathematical problem solving. According to data released late in 2010, students in the U.S. are below average (National Center for Educational Statistics 2010). Clearly we need to address this lack of success.

Students do not have enough opportunities to solve challenging problems. Further, problems available to teachers are not designed to meet the individual needs of students. Additionally, teachers have few opportunities to learn how best to create, identify, and orchestrate problem-solving tasks. *50 Leveled Math Problems* is a unique series that is designed to address these concerns.