

## Research Brief

### Problem Solving

#### Question:

How can we help students become better problem solvers?  
What strategies might help students become better at solving problems?

**Summary of Findings:** No longer solely the domain of Mathematics, problem solving permeates every area of today's curricula. Ideally students are applying heuristics strategies in varied contexts and novel situations in every subject taught. The ability to solve problems is a basic life skill and is essential to understanding technical subjects. Problem-solving is a subset of critical thinking and employs the same strategies. Although the line between the two is fuzzy, in general, the goal of problem-solving is to adduce correct solutions to well-structured problems, whereas the goal of critical thinking is to construct and defend reasonable solutions to ill-structured problems. Basically, problem-solving is the process of reasoning to solutions using more than simple application of previously learned procedures.

Much of the writing now is not so much about teaching problem solving skills as it is about how problem solving can become the rich context for learning material. For example, as the emphasis has shifted in Math education from teaching problem solving to teaching *via* problem solving, many writers have attempted to clarify what is meant by a problem-solving approach to teaching mathematics. The focus is on teaching mathematical topics through problem-solving contexts and enquiry-oriented environments which are characterized by the teacher helping students construct a deep understanding of mathematical ideas and processes by engaging them in doing mathematics: creating, conjecturing, exploring, testing, and verifying.

#### Online Resources:

**Teaching Math Grades 9-12: Session 3 – Problem Solving.**

An extensive multimedia resource from the Annenberg/CPB Foundation. Problem solving is at the heart of mathematics. Formulating problems, finding ways to work on them, learning from both errors and solutions, and making connections between and among problems is a key task for the mathematics teacher and student. It is also a deeply rewarding and stimulating human activity. Inherent in the idea of problem solving is learning how to skillfully apply techniques and strategies to familiar problems; but it is equally important to learn how to extend a problem-solving disposition to

new problems and new subjects. Problems are both a means to engage what we have already learned, but also to extend that learning, both in the mathematics classroom and outside of it.

[http://www.learner.org/channel/courses/teachingmath/grades9\\_12/session\\_03/index.html](http://www.learner.org/channel/courses/teachingmath/grades9_12/session_03/index.html)

### **Brief Introduction to Roles of Computers in Problem Solving**

Dave Moursund

This booklet provides an introductory overview of the field of problem solving as well as an introduction to roles of computers in problem solving.

<http://darkwing.uoregon.edu/~moursund/SPSB/>

### **The Big6**

The Big6 is an information literacy model. Some people call it a metacognitive scaffold, or an information problem solving strategy. Developed by Mike Eisenberg and Bob Berkowitz, the Big6 is the most widely-known and widely-used approach to teaching information and technology skills in the world. When you apply the Big6 steps, you have an essential framework to approach any information-based question.

<http://www.big6.com/>

### **Teaching Values Through A Problem Solving Approach To Mathematics**

Margaret Taplin

For many reasons, the state of society has reached a stage where it is more critical than ever to educate people in the traditional values of their culture. In recent years there has been considerable discussion about whether it is the responsibility of schools to impart values education. There is growing pressure for all teachers to become teachers of values, through modeling, discussing and critiquing values-related issues.

[http://www.mathgoodies.com/articles/teaching\\_values.html](http://www.mathgoodies.com/articles/teaching_values.html)

### **Problem-Solving Strategies: Mapping and Prescriptive Methods**

Dave Van Domelen

In most research into introductory-level science education, it has been realized that for students to gain conceptual understanding, the instructor must teach conceptual understanding. Hence, the focus of much recent physics education research has concentrated on what concepts students have of the world around them, and on finding ways to bring these concepts in line with those held by physicists. However, it is important that problem-solving skills not be neglected in the search for improved physics education.

<http://www.physics.ohio-state.edu/~dvandom/Edu/thesis.html>

### **Thayer Problem Solving Cycle**

The Thayer Problem Solving Cycle was developed by Dr. John P. Collier at Dartmouth College as a method for teaching the scientific method to introductory Engineering Students. In the years since it has been revised and improved and is now used in colleges around the world. In 1990 a summer course, "Engineering Concepts for the High School Classroom", was first offered in the summer at Dartmouth's Thayer School of Engineering. As a result, the Thayer Problem Solving Cycle is now taught in many high schools across the United States.

<http://www.ccds.charlotte.nc.us/curtin/ProbSolvPage.html>

### **Future Problem Solving**

Future Problem Solving is a strategy for helping students develop skills for analyzing a problem. Working through a six-step process can help them decide - from a futures perspective - what should be done about a problem.

[http://www.unesco.org/education/tlsf/theme\\_d/mod23/uncom23.htm](http://www.unesco.org/education/tlsf/theme_d/mod23/uncom23.htm)

### **Math Is Everywhere: A Problem Solving Teaching Unit**

Joseph A. Montagna

This unit on problem solving is intended for use with middle school students. However, the material herein may be appropriate for students in elementary or high school. In the final analysis, it is the teacher who can best judge its usability in his/her classroom.

<http://www.yale.edu/ynhti/curriculum/units/1980/7/80.07.10.x.html>

### **Teaching Problem-Solving, Hypothesis Testing, Evolution, and the Meaning of Life Through the Marine Insects Question**

The question of why insects are not as dominant at sea as they are on land is ideal for teaching how to form and evaluate scientific questions (and other sorts of questions, come to that). More specifically, it provides a great opportunity to explore how evolutionary arguments are made and assessed. Because the hypotheses involve questions about chemistry, evolution, entomology, and marine biology, this problem illustrates how many subjects and perspectives may be necessary to address a single issue. Of course, given that we haven't been around to study this issue over the past 300 million years, we can't know the correct answer. But we can look at different hypotheses (or guesses, if you prefer), and decide which are most likely to be true.

[http://entomology.unl.edu/lgh/marine\\_insects/teaching.html](http://entomology.unl.edu/lgh/marine_insects/teaching.html)

### **Problem Solving Activities**

#### **Teaching Thinking**

These activities help students develop creative problem solving skills, engineering skills, mechanical reasoning, and conceptual understanding while discovering and creating.

<http://www.madison.k12.wi.us/toki/probsolv.htm>

### **21<sup>st</sup> Century Problem Solving**

Includes an extensive sequence of algebra problems listed in the order of grade level from 3rd to 12th grade.

([http://www2.hawaii.edu/suremath/k4\\_12dir/k4\\_12menu.html](http://www2.hawaii.edu/suremath/k4_12dir/k4_12menu.html))

<http://www2.hawaii.edu/suremath/>

### **Your Teaching: Problem Solving Activities**

A number of the pupil activities that have been developed by the National Schools' Observatory, have a strong problem solving element.

<http://www.schoolsobservatory.org.uk/staff/yorteach/maths/teacher/probsolv.htm>

### **Teaching Tips for TAs: 10 SUGGESTIONS FOR TEACHING PROBLEM SOLVING**

"The worst thing that can happen is to go along through a full hour without any questions. That might mean two things: a very remote possibility that you are extremely clear, but more often than not that you are not clear at all." --Dr. Umran Inan

<http://www.oic.id.ucsb.edu/TA/tips/prob.html>

### **Critical Thinking & Problem Solving Skills**

Welcome to the Internet School Library Media Center (ISLMC) Critical Thinking Page which is part of the school library section. This page has general information, lesson plans and bibliographies to help educators interested in higher order thinking skills.

<http://falcon.jmu.edu/~ramseyil/critical.htm>

### **ERIC Resources:**

(**Note:** The Education Resource Information Center (ERIC) went through a major technological restructuring. For a while, it was difficult to connect to ERIC resources through some general source – as opposed to a local (often password protected) ERIC server. That transition seems to be complete. You can now find ERIC resources at <http://www.eric.ed.gov/>, but there is no longer a “Permanent Link” associated with an ERIC resource – i.e. I cannot provide you a direct URL. Instead, I have listed the ERIC ID number with each ERIC article so that you may find it on ERIC’s new Web site.)

### **Problem Solving and Comprehension. Sixth Edition.**

Whimbey, Arthur; Lochhead, Jack

This book shows students how to increase their power to analyze problems and comprehend what they read. First it outlines and illustrates methods that good problem solvers use in attacking complex ideas, then it provides practice in

applying these methods to a variety of comprehension and reasoning questions. The "Whimbey Method" of teaching problem solving is now recognized as an invaluable means of teaching people to think. One chapter is particularly interesting to the history of problem solving. Chapter 13, "Meeting Academic and Workplace Standards: How This Book Can Help," describes changes in the educational system in the past 20 years and shows how the techniques taught in this book relate to the new educational standards and tests.  
ERIC Number: ED451077

**Metaphors in the Teaching of Mathematical Problem Solving.**

Chapman, Olive

Educational Studies in Mathematics v32 n3 p201-28 Mar 1997

Reports on a study that focused on three teachers and their ways of teaching problem solving. Findings indicate that the participants unconsciously constructed personal metaphors that became the basis of their conceptualization of problems. "Community", "adventure" and "game" were the key metaphors. The outcome suggests that such metaphors could be promising in enhancing mathematics teacher education and in problem-solving research.  
ERIC Number: EJ543496

**Teaching Problem-Solving Strategies for Word Problems to Students with Learning Disabilities.**

Kelly, Bernadette; Carnine, Douglas

LD Forum v21 n3 p5-9 Spr 1996

Methods for teaching problem-solving strategies for word problems to students with learning disabilities are described in the context of the 1989 National Council of Teachers of Mathematics Curriculum and Evaluation Standards. Examples are given for using the specific strategies of diagrams, ratio equations, tables, and inverse operation equations.  
ERIC Number: EJ530768

**Report on the WPI Conference: "Teaching Problem Solving and Critical Thinking in Chemistry".**

Beall, Herbert

NEACT Journal v14 n1 p16-19 Sum-Fall 1995

Reports on the Seventh Annual Conference on Chemical Education which explored the assumption that science courses focus too much on the product of science and not enough on the process. Problem solving was examined as a possible route toward developing the necessary critical-thinking skills. Covers the keynote address, Problems versus Exercises, and a workshop on alternative modes of instruction.  
ERIC Number: EJ578367

**Problem Solving--What Doesn't Work.**

Woods, Donald R.

Journal of College Science Teaching v23 n1 p57-58 Sep-Oct 1993

Describes problems in teaching problem solving and summarizes research in this area. Presents Guided Design or Guided Decision Making as a problem-solving approach in which groups of students work their way through a model of the problem-solving process as they wrestle with a discipline-specific situation

ERIC Number: EJ474934

**Teaching Problem Solving without Modeling through "Thinking Aloud Pair Problem Solving."**

Pestel, Beverly C.

Science Education v77 n1 p83-94 Jan 1993

Reviews research relevant to the problem of unsatisfactory student problem-solving abilities and suggests a teaching strategy that addresses the issue. Author explains how she uses teaching aloud problem solving (TAPS) in college chemistry and presents evaluation data. Among the findings are that the TAPS class got fewer problems completely right, but they also got fewer problems completely wrong. ERIC Number: EJ458317

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