CHAPTER 15

The Elusive Search for Teachable Aspects of Problem Solving

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Introduction

The ideas just presented serve to motivate the present chapter and its central question, "Can problem solving be taught?" These quotes are, respectively, from the National Education Association's (1961) The Central Purpose of American Education, the introduction to Lochhead and Clement's (1979) Cognitive Process Instruction, and Norman's (1980) chapter in Tuma and Reif's (1980) Problem Solving and Education. These quotes point to both the promise and the pitfalls of research on problem solving. The promise refers to the possibility of raising expectations about the teachability of problem solving that can only be met by a yet another wave of educational fads and cults.

Emphasis on "good habits of mind" is, of course, not a new goal in education. Rippa (1980) points out that as early as 1712 the curriculum of the Boston Latin School required that students read, write, and speak Latin as well as have some knowledge of Greek and mathematics. The Latin School approach, which was still strong a century ago, was based on the idea that learning Latin and Greek and geometry would foster the traits of mental discipline and logical thinking. The demise of the Latin School approach was brought about by the practical demands of an emerging technological and democratic society and by the growing body of educational research indicating that skills learned from Latin did not transfer easily to practical situations. Although they give lip service to the development of the mind, today's schools refer to the possibility of raising expectations about the teachability of problem solving that can only be met by a yet another wave of educational fads and cults.

The purpose which runs through and strengthens all educational purposes—the common thread of all education—is the development of the ability to think.

We should be teaching students how to think; instead we are primarily teaching them what to think.

It is strange that we expect students to learn yet seldom teach them anything about learning.
stress the teaching of objectively measurable behaviors. However, current research in the psychology of problem solving has again raised the possibility of succeeding where the Latin Schools failed. While retaining the Latin School's goal of teaching "good habits of mind," current attempts to teach problem-solving skills are bolstered by one hundred years of scientific research on problem solving.

The study of problem solving traditionally has had a modest but consistent place in educational psychology. For example, much of the early work concerning transfer of training actually involved studies of the teachability of problem-solving skills (e.g., Thorndike, 1923). More recently, a review of the contents of the Journal of Educational Psychology, Contemporary Educational Psychology, and the Educational Psychologist reveals a consistent interest in problem solving. Problem solving is not heavily represented in undergraduate texts in our field (see Ash & Love-Clark, 1985), but there continues to be a broad interest in problem solving and the development of problem-solving skills.

The purpose of this chapter is to determine whether there are aspects of problem solving that might be learnable (Gagne, 1979). In order to address this question, this chapter first provides some basic definitions and a brief historical overview of the problem-solving literature. Then, this chapter explores classic issues concerning the teaching of problem-solving ability, such as whether to use discovery or direct instruction, whether to focus on the product or the process of problem solving, whether to teach general skills applicable in many domains or specific skills applicable in more restricted domains, and whether to teach a wholistic approach to solving problems or an analytic approach that focuses on the component processes. Finally, the chapter closes with a discussion of implications for future research.

Definitions

In order to study human problem solving, it is useful to agree on the definitions of key terms, such as problem, problem solving, types of problems, and reasoning. The information processing approach to problem solving (Mayer, 1983) yields the following definitions.

A problem consists of: (a) a given state, that is, certain conditions or objects are present at the beginning, (b) a goal state, that is, certain conditions or objects are desired at the end, and (c) obstacles, that is, certain difficulties prevent the problem solver from directly transforming the given state into the goal state. Thus, a problem occurs when some situation exists, the problem solver desires the situation to be changed into a different one, but there is no direct or obvious way to accomplish the change. A task that is a problem for one person may not be a problem for another person; for example, finding an answer for "What is 3 + 5?" is a problem for a preschooler who has not yet memorized all the number facts but not for a normal adult.

Problem solving is (a) cognitive, but is inferred from behavior, (b) a process that involves a series of manipulations on knowledge in a person's mind, and (c) directed towards to solution of a problem. Thus, problem solving involves what Polya (1968) calls, "finding a way out of a difficulty, a way around an obstacle, attaining an aim that was not immediately obtainable." Hayes (1981) analyzes problem solving into two major parts: representing the problem and searching for a way to solve the problem. For example, if a person is presented with an algebra story problem, the person might represent the problem as an equation and then search for a solution by applying the rules of algebra and arithmetic.

It should be noted that behaviorists and cognitivists differ with respect to the definition of problem solving. The behaviorists content that empirically observable behavior must be the primary data of psychology; because internal cognitive processes cannot be directly observed, they have no place in psychology. The cognitivist position is that behavior is just the result of thinking but internal cognitive processes can be inferred from behavior; thus, the goal of psychology should be an understanding of the mechanisms that underlie behavior.

There are many different types of problems. For example, Greeno (1978a) has distinguished among (a) problems of inducing structure, such as series completion or analogy problems, (b) problems of transformation, such as chess and checkers, and (c) problems of arrangement, such as anagram or cryptarithmetic problems. Reitman (1965) has listed four types of problems, based on the specificity of the given and goal states: (a) well-defined given state and well-defined goal state, such as, "How can you turn a sow's ear into a silk purse?" (b) well-defined given state and poorly defined goal