Lecture Notes

# Chapter 11: Thinking and Problem Solving

## Learning Objectives

* Define thinking, well-defined problems, and ill-defined problems
* Apply general, domain-independent techniques to classic problems
* Describe factors that impede problem solving
* Compare the differences between solving problems as a novice and as a subject matter expert
* Explain how the problem space hypothesis is used in problem solving
* Discuss the creation of expert systems and provide an example of such a system
* Analyze how unconscious processing and everyday mechanisms can explain creative insight
* Summarize various studies that demonstrate use of critical thinking

## Outline

**I.** Setting the Stage

**A. Thinking** has been defined in many ways, suggesting that the term is used to refer to more than one specific activity.

**1.** *Focused* thinking begins with a clear starting point and has a specific goal.

**2.** *Unfocused* thinking has the character of daydreaming.

**B.** Psychologists study thinking through the use of problems and puzzles, in part because everyday thinking requires background knowledge that varies widely from one individual to another.

**1. Well-defined problems** have a clear goal, start with a small set of information, and usually present a set of rules or guidelines for solution.

**2. Ill-defined problems** do not have clear goals, starting information, or rules.

**3.** Psychologists tend to focus on well-defined problems because they are easy to present and score, they don’t take weeks to solve, and they are easy to change.

**4.** However, some researchers suggest that performance on well-defined problems is not correlated with performance on ill-defined problems.

**II.** Classic Problems and General Methods of Solution

**A.** The **generate-and-test technique** involves generating possible solutions and then testing them until a solution is found.

**B. Means-ends analysis** involves comparing the goal with the starting point, thinking of various ways of overcoming the distance and choosing the best one; the task is broken down into manageable steps through the creation of subgoals.

**1.** Newell and Simon’s **General Problem Solver (GPS)** is a computer program that uses means-ends analysis to solve problems in cryptarithmetic and logic.

**2.** Means-ends analysis is not always the optimal way to reach a solution, however, as some problems require a temporary step backward or further from the goal.

**C.** Another general problem-solving technique is **working backward** to analyze the last step needed to achieve a goal, and then the step before that one, and so on.

**1.** Like means-ends analysis, this involves forming subgoals.

**2.** Working backward is most effective when the backward path is unique, which makes the process more efficient than working forward.

**D. Backtracking** involves keeping track of assumptions that were made in problem solving, so that you can “back up” and start over if those assumptions turn out to be wrong.

**E. Reasoning by analogy** involves using the solution to a problem you have solved in the past in order to find the solution to a new problem.

**1.** The two problems need to be similar in underlying structure, and the problem-solver must recognize that structural similarity.

**2.** Research suggests that most people do not tend to do this on their own, without a hint or without exposure to multiple analogous problem structures.

**III.** Blocks to Problem Solving

**A.** Sometimes people have trouble solving a new problem because they have developed a **mental set** that leads them to see things in a certain way instead of other, equally plausible ways.

**1.** Mental set is analogous to **perceptual set,** the tendency to perceive an object in a certain way on the basis of your immediate perceptual experience.

**2.** Like perceptual set, mental set can be induced by even short amounts of practice and can make it harder to see new, more effective ways of solving a problem.

**3.** A related phenomenon, **functional fixedness,** occurs when we adopt a rigid mental set toward an object and how it can be used.

**B.** A related difficulty in problem solving involves misunderstanding the problem or focusing on the wrong information in the problem; this is known as using an incomplete or incorrect representation.

**C.** Another block to problem solving is the lack of problem-specific knowledge or expertise.

**1.** Experts pick up on more perceptual information and can sort relevant and irrelevant information more easily than novices can.

**2.** Expert knowledge is domain-specific.

**3.** Experts perceive larger, more meaningful patterns than novices do.

**4.** Experts are faster than novices at performing skills in their domain of expertise.

**IV.** The Problem Space Hypothesis

**A.** Researchers often think about problem solving in terms of mentally searching a **problem space,** which is like a mental graph representing every possible state of affairs within a problem.

**1.** If it is possible to move from one state to another by means of some operation, then a connection is drawn between nodes in the problem space.

**2.** A solution is represented by a path connecting the starting state with the goal state.

**3.** Good problem solving is thought to be the creation of efficient paths that take as few detours as possible.

**B.** Burns and Vollmeyer discovered some surprising findings about problem space searches.

**1.** Participants with nonspecific goals developed more knowledge about the problem space than participants with more specific goals.

**2.** Participants with nonspecific goals also performed better on transfer problems with new goal values.

**3.** Having a specific goal can cut down the amount of effort devoted to searching the entire problem space—which can have its costs, depending on the task.

**V.** Expert Systems

**A.** The problem space hypothesis has been used to create **expert systems,** computer programs designed to model the judgment of human experts in a particular field.

**1.** Expert systems contain a knowledge base, which stores facts relevant within that field

**2.** They also contain a set of **inference rules**, of the form “If X is true, then Y is true,” a search engine that searches the knowledge base, and some interface to interact with a human user.

**B.** Creating expert systems is a complex undertaking, because it is often difficult for an expert to state all of his or her knowledge.

**VI.** Finding Creative Solutions

**A. Creativity** has to do with appropriate novelty—that is, originality that suits some purpose.

**B.** Some people feel that creative insight occurs as a result of **unconscious processing,**or **incubation.**

**1.** Smith and Blankenship showed that solutions to tricky picture-word puzzles could be found more easily after taking a break and working on something else.

**2.** However, other studies fail to find positive effects of incubation and sometimes show that participants do consciously think about the problem during the “break” periods.

**C.** An alternative view of creativity suggests that it results from ordinary cognitive processes.

**1.** *Directed remembering*, channeling your memory in order to think about a past experience or knowledge that meets some criteria, is one ordinary cognitive process that goes on in creative invention.

**2.** A second relevant cognitive process is *noticing* where the problems are or noticing similarities between one problem and another.

**3.** *Contrary recognition* is the ability to recognize objects not for what they are but as something else; this also plays a role in creative problem solving.

**VII.** Critical Thinking

**A. Critical thinking** involves the active, persistent, and careful consideration of a belief or supposed form of knowledge, in light to the grounds that support it and the further conclusions that follow from it.

**B.** Good critical thinking has a number of important features.

**1.** It requires a knowledge base and some means of using it efficiently.

**2.** It requires the thinker to raise objections, actively questioning himself or herself and constructing counterexamples.

**3.** Mental laziness often hampers critical thinking; a mentally lazy person stops thinking whenever an answer is reached, without considering the quality of the answer.

**4.** Studies indicate that college students do improve their critical thinking abilities in college, both in terms of skills and attitudes.