Chapter IX: Problem Solving and Creativity

1. The Problem-Solving Cycle

The problem-solving cycle includes: problem identification, problem definition, strategy formulation, organization of information, allocation of resources, monitoring, and evaluation (Bransford & Stein, 1993), as illustrated in figure (01).

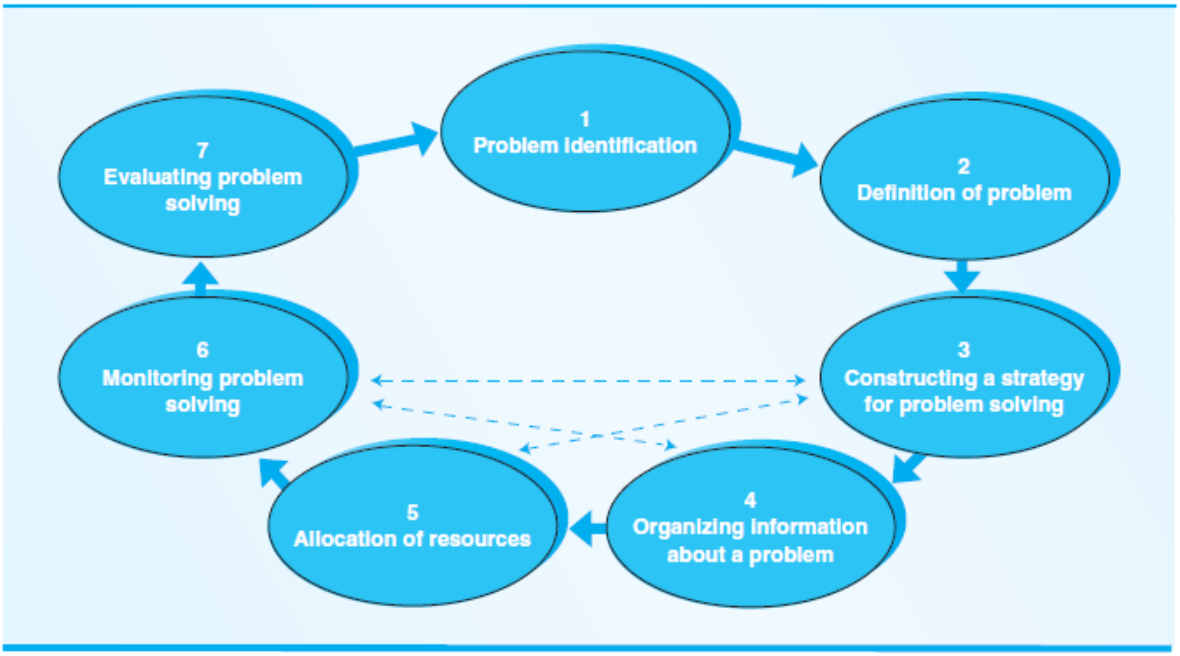

Figure (01): The Problem-Solving Cycle (Bransford & Stein, 1993)

Following is a description of each part of the problem-solving cycle.

1. Problem identification: Do we actually have a problem?

2. Problem definition and representation: What exactly is our problem?

3. Strategy formulation: How can we solve the problem? The strategy may involve

analysis—breaking down the whole of a complex problem into manageable elements.

Instead, or perhaps in addition, it may involve the complementary process of **synthesis**—putting together various elements to arrange them into something useful.

Another pair of complementary strategies involves **divergent and convergent thinking.** In divergent thinking, you try to generate a diverse assortment of possible alternative solutions to a problem. Once you have considered a variety of possibilities, however, you must engage in convergent thinking to narrow down the multiple possibilities to converge on a single best answer.

4. Organization of information: How do the various pieces of information in the problem fit together?

5. Resource allocation: How much time, effort, money, etc., should I put into this problem?

6. Monitoring: Am I on track as I proceed to solve the problem?

7. Evaluation: Did I solve the problem correctly?

In considering the steps, flexibility in following the various steps of the cycle is important. Successful problem solving may involve occasionally tolerating some ambiguity regarding how best to proceed. Rarely can we solve problems by following any one optimal sequence of problem-solving steps. We may go back and forth through the steps. We can change their order, or even skip or add steps when it seems appropriate.

2. Types of Problems

Problems can be categorized according to whether they have clear paths to a solution

2.1. Well-structured problems

they have clear paths to solutions. These problems also are termed well-defined problems. An example would be, "How do you find the area of a parallelogram?"

2.2. Ill-structured problems

they lack clear paths to solutions (Shin et al., 2003). These problems are also termed ill-defined problems. For example, "How do you tie together two suspended strings, when neither string is long enough to allow you to reach the other string while holding either of the strings?"

3. Obstacles and Aids to Problem Solving

Several factors can hinder or enhance problem solving. Among them are mental sets as well as positive and negative transfer. Incubation plays a role in problem solving as well.

3.1. Mental Sets, Entrenchment, and Fixation

One factor that can hinder problem solving is **mental set**—a frame of mind involving an existing model for representing a problem, a problem context, or a procedure for problem solving. Another term for mental set is **entrenchment.** When problem solvers have an entrenched mental set, they **fixate** on a strategy that normally works well in solving many problems but that does not work well in solving this particular problem. For example, in the two-string problem, you may fixate on strategies that involve moving yourself toward the string, rather than moving the string toward you.

3.2. Negative and Positive Transfer

Often, people have particular mental sets that prompt them to fixate on one aspect of a problem or one strategy for problem solving to the exclusion of other possible relevant ones. They are carrying knowledge and strategies for solving one kind of problem to a different kind of problem. **Transfer** is any carryover of knowledge or skills from one problem situation to another (Detterman & Sternberg, 1993)

3.2.1. Negative transfer

It occurs when solving an earlier problem makes it harder to solve a later one. Sometimes an early problem gets an individual on a wrong track. For example, police may have difficulty solving a political crime because such a crime differs so much from the kinds of crime that they typically deal with. Or when presented with a new tool, a person may operate it in a way similar to the way in which he or she operated a tool with which he or she was already familiar (Besnard & Cacitti, 2005).

3.2.2. Positive transfer

It occurs when the solution of an earlier problem makes it easier to solve a new problem. That is, sometimes the transfer of a mental set can be an aid to

problem solving. For instance, one may transfer early math skills, such as addition, to advanced math problems of the kinds found in algebra or physics (Bassok & Holyoak, 1989)

3.3. Incubation

Putting the problem aside for a while without consciously thinking about it is called incubation. This offers one way in which to minimize negative transfer. It involves taking a pause from the stages of problem solving. For example, suppose you find that you are unable to solve a problem. None of the strategies you can think of seem to work. During incubation, you must not consciously think about the problem. You do, however, allow for the possibility that the problem will be processed subconsciously. Some investigators of problem solving have even asserted that incubation is an essential stage of the problem-solving process (Cattell, 1971), because people continue to process, below consciousness, information about a problem on which they are incubating at the same time that they are attending to other matters.

4. Neuroscience and Planning during Problem Solving

The frontal lobes and in particular the prefrontal cortex are essential for planning for complex problem-solving tasks. A number of studies have highlighted activation in this region of the brain during problem solving (Unterrainer & Owen, 2006). Additionally, both the left and right prefrontal areas are active during the planning stage of complex problem solving (Newman et al., 2003). Further evidence for the importance of the prefrontal regions in problem solving can be seen in cases of traumatic brain injury. Both problem solving and planning ability decline following traumatic brain injury (Catroppa & Anderson, 2006).

5. Creativity

Creativity is defined as the process of producing something that is both original and worthwhile. It might be a theory, a dance, a chemical, a process or procedure, a story, a symphony, or almost anything else. Creative individuals produce inventions, insightful discoveries, artistic works, revolutionary

paradigms, or other products that are both original and worthwhile. Conventional wisdom suggests that highly creative individuals also have creative lifestyles. These lifestyles are characterized by flexibility, non-stereotyped behaviors, and non-conforming attitudes.

5.1. The characteristics of creative people

Creativity involves producing something that is both original and worthwhile. Several factors characterize highly creative individuals. One is extremely high motivation to be creative in a particular field of endeavor (e.g., for the sheer enjoyment of the creative process). A second factor is both non-conformity in violating any conventions that might inhibit the creative work and dedication in maintaining standards of excellence and self-discipline related to the creative work. A third factor in creativity is deep belief in the value of the creative work, as well as willingness to criticize and improve the work. A fourth is careful choice of the problems or subjects on which to focus creative attention. A fifth characteristic of creativity is thought processes characterized by both insight and divergent thinking. A sixth factor is risk taking.

The final two factors in creativity are extensive knowledge of the relevant domain and profound commitment to the creative endeavor. In addition, the historical context and the domain and field of endeavor influence the expression of creativity.

5.2. Neuroscience and Creativity

The examination of creative thought and production has led researchers to identify brain regions that are active during creativity. The prefrontal regions are especially active during the creative process, regardless of whether the creative thought is effortful or spontaneous
(Dietrich, 2004). Previous research has indicated that Brodmann's areas are involved in verbal working memory, task switching, and imagination (Blackwood et al., 2000).