UNIT 1 NATURE OF PROBLEM SOLVING

Structure

Problem Solving

"Solving a problem means finding a way out of a difficulty, a way around an obstacle, attaining an aim that was not immediately understandable. Solving problem is the specific achievement of intelligence and intelligence is the specific gift of mankind. Solving problems can be regarded as the most characteristically human activity."

George Polya (1962)

1.0 INTRODUCTION

In our day to day life we usually solve problems be it the classroom, family, or workplace. It is nearly inescapable in everyday life. We use problem solving when we want to reach a certain goal, and that goal is not readily available. It involves situations in which something is blocking our successful completion of a task. To study problem solving satisfactorily, a good way will be to start the chapter by solving some problems. Give these ones a try:

Problem1: *What one mathematical symbol can you place between 2 and 3 that result in a number greater than 2 and less than 3?*

Problem2: *Rearrange the letters NEWDOOR to make one word.*

Problem3: *How many pets do you have if all of them are birds except two , all of them are cats except two, all of them are dogs except two.*

There are many different kinds of problems, including many kinds of recreational problems, career and school oriented problems (such as the problem of how to get promoted or the problem of how to study for a test), personal problems (such as the problem of who to marry or whether to have a child), and scientific problems (such as how to find a cure for cancer or how to prove a particular theorem) etc.

We all solve many problems like these or others every day. Problem solving can be as commonplace as finding out how to prepare a meal or as significant as developing a psychological test.

1.1 OBJECTIVES

After completing this unit, you will be able to :

- Define the basic nature of problem solving;
- Enlist the different kinds of problems;
- Describe types of thinking involved in problem solving; and
- Analyse and explain the Insight Problem Solving.

1.2 TYPES OF PROBLEMS

Problems vary from ill defined to well defined. In a well defined problem such as a mathematical equation or a jigsaw puzzle both the nature of the problem and the information needed to solve it are available and clear. Thus, one can make straightforward judgments about whether a potential solution is appropriate. With an ill defined problem, such as how to bring peace, not only may the specific nature of the problem be unclear, the information required to solve the problem may be even less obvious.

Greeno (1978) suggested one method of classifying well defined problems based on the general kinds of psychological skills and knowledge needed to solve different problems. Typically, well defined problems falls into one of the three categories viz., (i) Arrangement (ii) Inducing Structure and (iii) Transformation.

Solving each of these types of problems requires somewhat different type of psychological skills and knowledge.

i) Arrangement of problems requires that the problem solver must rearrange or recombine elements in a way that will satisfy a certain criteria. Usually, several different arrangements can be made but only one or few arrangements will produce a solution. For example, one can say that Anagram problems and jigsaw puzzles are examples of arrangement problems.

ii) In Problems of inducing Structure, a person must identify the existing relationships among the elements presented. He then should construct a new relationship among them, so that the problem could be solved. In such a problem, the problem solver must determine not only the relationships among the structures but also the structure and sise of elements involved.

iii) In Transformation Problems, one takes into consideration. An attempt is made to change the initial state to a goal state. The Tower of Hanoi is an example of this kind of problem where the initial state is the original configuration, the goal state is to have the three disks on the third peg, and the method is the rules for moving the disks. According to *Greeno* 1978 solving transformation problems primarily requires skills in planning based on a method called means end analysis. Means end analysis requires identifying differences that exist between the current state and the goal state and selecting operations that will reduce these differences.

1.3 CHARACTERISTICS OF DIFFICULT PROBLEMS

Some of the typical characteristics of difficult problems are as given below:

- Intransparency (lack of clarity of the situation)
- Commencement opacity. (confusion regarding how to start stating the problem)
- Continuation opacity (Continuing confusion in regard to the problem as there is no clarity)
- Polytely (The problem has multiple goals and so reaching and selecting a particular goal is difficult)
- Inexpressiveness (inability to express the problem clearly)
- Opposition
- Transience (the problem keeps changing)
- Complexity (The problem is in large numbers of items, too many interrelationships and decisions)
- Enumerability (It is not possible to list it or quantify it)
- Connectivity (There are hierarchy of problems in relation to relationship, communication and allocation)
- Heterogeneity (The problem is not homogeneous and so difficult to handle)
- Dynamics (time considerations)
- Temporal constraints (There is limitation to time factor as it has to be got done within a time period)
- Temporal sensitivity (The problem is influenced and affected by time factor)
- Phase effects (There are changes in different phases of the problem and these affect the problem from being solved)
- Dynamic unpredictability (The problem is complex and consists of high degree of unpredictability)

The resolution of difficult problems requires a direct attack on each of the above mentioned characteristics encountered.

In reform mathematics, greater emphasis is placed on problem solving relative to basic skills, where basic operations can be done with calculators. However some “problems” may actually have standard solutions taught in higher grades, like for instance multiplying rather than adding. For example, kindergarteners could be asked how many fingers are there on all the gloves of 3 children. Normally they will add the fingers in each glove of the three children and say 15. But at a higher level $5 \times 3 = 15$, which is done quickly and solved by applying multiplication.

Self Assessment Questions

1) Define problems

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2) Define problem solving

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3) What are the different types of problems?

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4) What is meant by difficult problems?

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5) What are the characteristics of difficult problems.?

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1.4 NATURE OF PROBLEM SOLVING

The nature of human problem solving methods has been studied by psychologists over the past hundred years. There are several methods of studying problem solving, including introspection, behaviourism, simulation, computer modeling and experiment.

Beginning with the early experimental work of the Gestaltists in Germany and continuing through the 1960s and early 1970s, research on problem solving was typically conducted in relatively simple, laboratory tasks that appeared novel to participants (e.g. Mayer, 1992). In these tasks, they had clearly defined optimal solutions which were solvable within a relatively short time frame, and researchers could trace participants' problem-solving steps, and so on.

The researchers made the underlying assumption that simple tasks such as the Tower of Hanoi captured the main properties of "real world" problems, and that the cognitive processes underlying participants' attempts to solve simple problems were representative of the processes engaged in when solving "real world" problems. Thus researchers used simple problems for reasons of convenience.

Simple laboratory based tasks can be useful in explicating the steps of logic and reasoning that underlie problem solving. However, they omit the complexity and emotional valence of "real-world" problems. In clinical psychology, researchers have focused on the role of emotions in problem solving, demonstrating that poor emotional control can disrupt focus on the target task and impede problem resolution (Rath, Langenbahn, Simon, Sherr, & Diller, 2004).

Human problem solving consists of two related processes, viz.,(i) problem orientation, and (ii) problem-solving skills which, if While problem orientation deals with the motivational/attitudinal/affective approach to problematic situations, the problem solving skills deal with the actual cognitive behavioural steps. If cognitive skills are successfully implemented, it will lead to effective problem resolution.

Problem solving is a mental process and is part of the larger problem process that includes problem finding and problem shaping. Considered the most complex of all intellectual functions, problem solving has been defined as higher-order cognitive process that requires the modulation and control of more routine or fundamental skills.

Problem solving occurs when an organism or an artificial intelligence system needs to move from a given state to a desired goal state. Problem solving is one of the many forms that thinking or cognition may take.

By cognition one refers to the mental representation of information which can be manipulated and used to solve problems. Problem solving is a major cognitive behaviour.

Problem solving becomes necessary when an individual wants to reach a goal but that goal is not easily available. It is a state in which there are some obstacles to reach the goal. Various psychologists have defined problem solving.

According to *Baron* (2001) problem solving involves efforts to develop or choose among various responses in order to attain desired goals.

Witting and Williams III (1984) defined problem solving as the use of thought processes to overcome obstacles and work towards goals.

1.4.1 The Stages of Problem Solving

The situation that prevails at the beginning of the problem solving task is the initial state. The system then moves through a series of different, intermediate states, designed to lead to the goal. When the goal is achieved, the system is said to have attained the goal state. Thus there are four molar components of any problem solving activity and these are given below:

- The initial state: How the starting conditions are defined
- The Operators: Moves or operations to move from one state to another
- Intermediate Problem States: Any states that are generated by applying an operator to a state on the way to final goal.
- The goal state: How the final state or goal conditions are described.

The internal representation (or mental model) of these four states of a problem is called "Problem Space". This problem space varies from one individual to another. It must be kept in mind that each individual's problem space is unique and depends also on the nature of the problem. The initial state of a problem is critical to problem solving and some problem's initial state may lead to efficient problem solving while another may end up in high complexity.

Problem solving strategies	**Creative problem solving**
Group problem solving	Problem solving approach
Management problems solving	Elementary problem solving
Problem solving activities	Problem solving worksheets
Teaching problem solving	Problem solving lesson plans
Problem solving skills	
Art Problem solving	

Self Assessment Questions

1) Describe the nature of problem solving.

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2) What are real world problems? Give suitable examples.

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3) What are the two processes in human problem solving.

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4) Describe the stages of problem solving.

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5) What are the four molar components of any problem solving activities?

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6) What is meant by "Problem Space"?

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1.5 TYPES OF THINKING INVOLVED IN PROBLEM SOLVING

According to Wertheimier (1959) effective problem solving requires:

i) Productive thinking

ii) Being sensitive and open to structural requirements

iii) Going beyond the knowledge learnt from previous problem solving tasks

For productive thinking there is a need to have a grasp of the general principles that apply in the particular problem situation. Since individuals do have a tendency to reproduce thinking appropriate for other situations, they need to think beyond

that solution and look for unique solutions. It is important to keep in mind the structure of the problem without which solutions may not come about.

1.5.1 The Kinds of Thinking Processes

The kinds of thinking processes involved in problem solving are:

1) Analytical Thinking
2) Synthetic Thinking.

In analytic thinking, there is nothing more in solution than in the premise. For example if the problem is a simple question like "how many doors are there in your house", then the answer is simple counting of the doors and adding it up. There can be no other answer and there can also be no other solution.

In contrast, Synthetic Thinking does not contain the conclusion in the premise itself because the solution is not needed in the construction of the mental object. For example, we know that 2 is a divisor of 4, 4 is a divisor of 8, and 2 is also a divisor of 8. In general, it is true that a divisor of a divisor of a number is a divisor of that number.

Such solutions are best reached by constructing mental model like images like number lines.

The importance of synthetic thinking is that you can get out more than you put into it.

After you construct a mental model, you can see relationships that were not evident before you constructed it. Seeing these new relationships is what comprises problem solving through synthetic thinking.

In other words, one is synthesizing the available information and facts to derive new solution. This is also termed as developing insight.

Newell is one of the most influential cognitive psychologists who made computer stimulation approach to the study of problem solving.

Newell stated that the goal is to construct a mental model. From this model one will find answers to a problem by inspecting that model itself. To do this, one writes parts of the problem mentally on the model. Once the model has been constructed one can read the results of what has been written. It is important to note that in order to read these results one needs the "mind's eye".

The mind's eye has traditionally been a controversial issue in cognitive psychology. Another word for it is "homunculus" meaning "little man in the head". Most cognitive psychologists disapprove of this concept of Mind's eye on the premise that it reflects nonscientific theories of behaviour that were largely based on soul.

Self Assessment Questions

1) What types of thinking are involved in problem solving?

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2) What are the kinds of thinking processes?

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3) Describe Newell's Mental Model.

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1.6 CONCEPT OF INSIGHT PROBLEMS

There are two types of solutions to problems and these are (i) Insightful solutions and (ii) solutions without involving insight.

The essential characteristics of an insight solution to a problem is that the solution appears suddenly, without warning.

By contrast, problems solved without insight are solved gradually rather than suddenly. The solution process here involves a stepwise progression towards the solution.

For example, arithmetic and algebraic problems fall into the category of problems solved without insight. In this, the subjects themselves must be able to distinguish between these two types of solutions.

As the subjects solve a non insight problem, they should be able to tell that they are getting closer to the solution. For non-insight problems subjects generally have a greater feeling of warmth as they get closer and closer to the solution. This is because non-insightful problems are solved step by step and with each step the subject gets closer to the solution and thus warmer in each step.

As for insight problems there is no gradual approach to the solution and so subjects do not feel warmer until the solution actually appears.

Feeling of knowing and feeling of warmth reflect judgments that subjects make about their own knowledge. Such judgments are examples of metacognition. Metacognition refers to what one knows about the technique of how accurately one can assess one's own cognitive processes.

It has been shown that people's metacognitive assessments of their performance on noninsight problems are quite accurate. However, their metacognitive assessments of their performance on insight problems are not accurate, because an insight is not something that can be planned.

An insight is something that happens to the person, not something that a person decides to have. In insight solution, the problem is solved by the sudden illumination characteristic of insight.

Insight is preceded by a gradual process whereby relevant parts of the problem are identified. However, solvers may not be aware that this process is leading toward an insight.

Another aspect of insight problems is that the source of difficulty in some insight problems is the inability to see that something you already know is needed for the solution. Hints given within the context of the problem are fairly effective in facilitating subsequent insight As the Gestalt psychologists often observe, people are generally not efficient at realising that a new problem can be solved with information already at their disposal.

People differ in their ability to select information that is relevant to the problem at hand. This ability to discover what is essential about situation is important as well as the ability to remember information that is relevant to the problem. This ability is called sagacity. Sagacity differs from learning in that it involves a sensitivity to detail, a discernment of what is important in a situation. Sagacity is the ability to see into the situation and to discriminate the important aspects of it.

The format in which the information is presented makes a difference in insightful problem solving. That is, one can give the information in a puzzle format or in a declarative format. The information given in the puzzle format leads the subject to discriminate the relevant information better than when the information is in declarative format. This is so because, the puzzle format leads the subject to process the relevant information in a way that makes it accessible for later use. On the other hand the declarative format leads to the acquisition of the relevant information, but in a way that makes it possible for the person to see its relevance for subsequent problem solving.

Select a word that can be interpreted in different ways. For example, the word *lake* can refer to a frozen or unfrozen body of water. Most people interpret the word to refer to an unfrozen body of water. A riddle can be constructed by requiring the problem solver to come up with the less accessible meaning in order to make sense of what is being described. If the subject is presented with a clue that the stone rested on the surface of the lake for 3 months, after which it sank to the bottom some 10 meters below., this would provide the solution that lake here refers to frozen one for 3 months and then running water lake afterwards.

1.7 LET US SUM UP

Problem solving is an important part of thinking processes. In general a problem is any kind of conflict or difference between one situation and another that one wishes to to produce, that which is the goal.

Problem solving typically involves three major stages: preparation, production of solutions and evaluation of solutions that have been generated.

Problem solving can be done either with or without insight and utilises analytical, synthetic thinking along with metacognition.

This it can be said that, like many other cognitive processes, problem solving is a dynamic and complex process and involves many different types of thinking processes depending on the nature of the problem.

1.8 UNIT END QUESTIONS

1) What are the various categorisations of problems? Can you categorise your day to day problems into these categories?

2) What is the role of various types of thinking involved in solving diferent kinds of problems ?

3) Describe the four molar stages of problem solving.

4) Compare and contrast the role of productive thinking and structurally blind thinking in problem solving.

5) Emotional states can affect many cognitive processes. What can be the affect of these various emotional states on problem solving ?

6) Critically discuss the concept of insight problems and insightful solutions.

7) Solutions involving insight and solutions without involving insight – Differentiate.

1.9 SUGGESTED READINGS

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