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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UNIT 2 STAGES OF PROBLEM SOLVING

Structure

2.0 INTRODUCTION

In this unit, we will examine the basic steps and strategies involved in problem solving – the ways to reach to solutions of the problems, and the various methods to solve different kinds of problems. For this, in particular, the following topics are discusses in detail. We will deal with Stages of Problem Solving, Techniques of problem solving, Creativity and Problem solving and the role of Artificial Intelligence in Problem Solving

2.1 OBJECTIVES

After completing this unit, you will be able to:

- Define problem solving and problems;
- Describe the various stages in problem solving;
- Analyse the various solutions; and
- Explain the steps to reach the best solution.

2.2 NATURE OF THE PROBLEM

The first step to solve the problem is to understand its different aspects and nature i.e. to figure out just what issues, obstacles and goals are involved. According to Greeno (1977), Understanding involves constructing an internal representation. For e.g. If you understand a sentence, you create an internal

representation or pattern in your head so that concepts are related to each other in the same way that they are related to each other in the original sentence.

In order to create this pattern in your head you must use background knowledge, such as the meaning of the various words in the sentence. In order to understand a problem you must pay attention to the important information in a problem. Furthermore, you must ignore the information that is irrelevant. As soon as the problem solver has decided which information is essential and which can be disregarded the next step is to find a good way to represent the problem. The representation can be done by using symbols, lists, matrices, graphs and visual images.

2.3 GENERATING SOLUTIONS

The next stage is finding variety of potential solutions for the problem. For this one can use one's past experiences and/or present resources and thinking critically about the problem. Several strategies can be used to solve the problems. Some methods are very time consuming but they will yield an answer. Other methods are less wasteful of time, but they may not produce a solution. These strategies are discussed in another section of the unit.

2.3.1 Judging the Best Among the Likely Solutions

At this stage we must evaluate each alternatives and outcomes of the problem. The objective of this step is to move closer to goal and learn about major obstacles and hidden costs of the particular solution and choose the best solution.

Carrying out the best solution

This stage involves actually working out the best solution. Various strategies can be adopted in reaching the solution. Algorithms and heuristics are the strategies which can be used depending upon the requirements of the problem. These are being dealt in the next section.

Evaluation of solution

In this the problem solver compares the solution with the representation of the problem. The path taken from the initial state to the goal state is checked as to whether it is specified as legal or not. Sometimes the evaluation stage leads to the conclusion that the problem has not been solved adequately, and thus one starts from an earlier stage, depending upon the source of the inadequacy.

2.3.2 Strategies for Problem Solving

An individual uses various kinds of methods or strategies to solve problems. Some strategies when used take a long time but definitely give an answer. On the other hand, there are some other strategies which take lesser time but do not always guarantee success. These strategies can be mainly classified under two categories, viz., (i) algorithm and (ii) heuristics. These two are discussed in the following section.

Algorithm

An algorithm is a specific procedure for solving a type of problem. An algorithm invariably leads to the solution if it is used properly, that is. It is a procedure of

steps that does guarantee a solution if one follows the steps correctly. The rules of multiplication constitute an algorithm because a correct answer is guaranteed if one follows the rules.

Consider anagram problems in which we try to reorganise groups of letters into words. Examples of algorithms are systematic and unsystematic random search techniques. Unsystematic random search means that we try out all kinds of possible answers but make no attempt to be orderly in our search and keep no record of our previous attempts. As a consequence we may repeat a response that has already proved to be wrong. In systematic random search we try out all possible answers using a specified system. This method is somewhat more efficient than unsystematic random search, but it is highly time consuming when there are many alternative answers. If you are given a 3 letter anagram, YBO, with instructions to unscramble it, proceed with a systematic random search: YOB, BYO, BOY, ! However, notice how time consuming it would be to use a systematic random search to solve a longer anagram, such as LSSTNEUIAMYOUL.

Heuristics

In this strategy an individual does not go for all the alternatives to solve problems but choose some most relevant alternatives. This is kind of short cut rule which takes lesser time but does not guarantee success. Heuristics are rules of thumb that help us simplify and solve problems.

Heuristics do not guarantee a correct solution to a problem but when they work, they permit more rapid solutions. A heuristic device for solving the anagram problem would be to look for familiar letter combinations. For e.g. how many words can you make from the pool of letters DWARG? In this anagram we can find the familiar combinations *dr* and *gr*. We may then quickly find draw, drag, and grad. The drawback to this method, however, is that we might miss some words.

Psychologists have paid more attention to how humans use heuristics than how they use algorithms. Let us look at some of the heuristics as strategies in solving problems. Problem solvers can use one or more of these heuristics as they attack a problem.

Self Assessment Questions

1) Define problem and problem solving.

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2) Discuss the nature of the problem.

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3) How do we generate solutions to the problem?

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4) Discuss strategies for problem solving.

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5) What is algorithm?

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6) What is heurisitcs?

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2.3.3 Some Specific Techniques of Problem Solving

The way to solve a problem depends to a great extent on the nature of the problem itself. For example, if you want to go from New Delhi to Chennai you will call various travel agents for information regarding the various available options for traveling and staying. However, if you want to know your bank balance you will not call a travel agent for assistance but go to your bank or nearest ATM or use net-banking. This is called domain specific problem solving approaches, that is the solution that work only for a limited class of problems. In the following section, a certain class of general, domain independent techniques of problem solving is discussed.

2.3.3.1 Generate and Test Techniques

To understand this let us begin with a simple problem:

"Think of ten words beginning with letter c that you eat or drink."

The process that most of us use to arrive at the solution to such a problem generally involves what is called generate and test technique. It consists of generating possible solutions and then testing them. For example, for the above problem of generating a list of things to eat or drink beginning with letter c, some of the names that often come to our mind that sound as if beginning with c but which actually do not (like ketchup) and some that start with c but are not names of eatables/drinks (like cable, can) might have come to your mind a s a solution but on thinking you would have discarded these words. This explains the process of thinking of possible solutions (generating) and then seeing if those possibilities met all the criteria (testing).

Generate and test is a technique that loses its effectiveness very rapidly when there are many possibilities and when there is no particular guidance over the generation process. For example, if you forget your ATM pin, the technique might eventually work but your frustration level by that time might exceed beyond your willingness to work on the task. Moreover, if we do not have a way to keep track of the possibilities that we have already tried, along with the ones that we still have to try, we might be further frustrated.

Generate and test can be useful when there aren't a lot of possibilities to keep track of. If you have lost your keys somewhere between your classroom and college cafeteria the technique can be easily used to help search the keys.

2.3.3.2 Means-ends Analysis

It is a strategy in which the problem solver divides the problem into a number of sub problems, or smaller problems. Each of these sub problems is solved by detecting the difference between the original state and the goal state and then reducing the difference between these two states. The name means ends analysis fits the process, because it involves figuring out the "ends" you want and then figuring out what "means" you will use to reach those ends. Every day we all solve problems by using means ends analysis. Means ends analysis involves subgoals to eliminate the difference between the current state and the condition for applying desired operator.

Our original state at one point is an equation

$$2s - 10 + 5 = s + 5 + 8$$

and our goal state is an equation with a single s alone one side. We reduced the difference between the two states by adding +5 to each side of the equation and subtracting s from each side of the equation.

This strategy repeatedly compares states and seeks operators, establishing subgoals and finding ways to reach the sub goals, all on the way to finding a path to the final goal.

2.3.3.3 Backward Search

With the backward search heuristic, the problem solver starts at the goal state. Sometimes it is useful to start at the goal state of a problem and attempt to work backward to the initial state. In solving a paper-pencil maze, it may be easier to see the correct path by starting at the end. Working backwards can be a very useful heuristic, particularly for problems that contain a uniquely specified goal state. For example, a backward search would be ideal for a maze with many paths out of the beginning point yet only one path leading form the goal.

The reason working backward helps lies in the subgoals that one begins to see by starting with the final goal. Once the problem solver can envision a string of subgoals projecting backward from the goal state, then going about solving the subgoals in a forward direction can be readily accomplished. Working backward is only viable when the goal state is uniquely well defined (Wickelgren, 1974).

2.3.3.4 Planning Strategy

In this heuristic, the problem is divided into two simple aspects and complex aspect. First, the simple aspect of the problem is solved leaving behind the complex one, and thereafter the complex aspect is taken and is solved. It is particularly useful if the aspects that are ignored can easily be worked into the solutions to the complicated problems.

One common kind of planning strategy is analogy. In analogy, a solution to an earlier problem is used in order to help with an original problem. The current problem is solved on the basis of past experience of solving similar problems. This heuristic looks for similarities between a current problem and one solved in the past. Try to solve the anagram BODUT. By thinking of words D, O, U will simplify the problem information. The usefulness of the planning strategy depends on the extent to which the solution to the simple problem will be helpful when the complex problem is considered.

2.3.3.5 Thinking Aloud

Ericsson and Simon referred to the method of thinking aloud as a Method for Studying Human Problem Solving is referred too as concurrent verbalisation, that is verbalisation of information at the time the subject is attending to it. This is to be distinguished from *retrospective verbalisation*, in which the subject is asked about cognitive processes that occurred at an earlier point in time.

Concurrent verbalisation relies on short-term memory whereas retrospective verbalisation relies on long-term memory.

When subjects think aloud, they put into words a process that normally takes place nonverbally. This provides a description of the subject's solution process. A verbal description *so* obtained is *called a protocol.* Although there may be omissions in these protocols, they still contain a great deal of useful information.

Newell (1977) recommended a series of steps in order to clarify the protocol.

1st Step: First, the protocol needs to be divided into phrases, which are descriptions of single acts.

2nd Step: Seconcd, the experimenter constructs a *problem behaviour graph*, a concrete description of the way in which the subject moves around in the problem space. This description can be used as the basis for a production system designed to model the subject's behaviour.

Although concurrent verbalisation is widely used, there is evidence suggesting that it may interfere with some aspects 'of the problem-solving process. For example, Schooler, Ohlsson, and Brooks (1993) did a study in which subjects were interrupted while trying to solve an insight problem.

One group was then asked to describe their problem-solving strategies, while another group engaged in an activity irrelevant to the problem. Subjects then resumed attempting to solve the problem.

The group that had verbalised their strategies were less likely to solve the problem than the group engaged in an irrelevant activity. Schooler, Ohlsson, and Brooks concluded that there are "non reportable or unconscious processes" that lead to insightful solutions, and these are interfered with by verbalisation.

These non reportable processes may be memory searches that lead to the recovery of the items needed for the solution. These processes may be disrupted by the attempt to verbalise the solution process. Therefore, researches using think-aloud techniques should also consider including silent control groups to determine whether verbalisation influencing performance.

2.3.3.6 Other Strategies

Some other strategies that people often employ in problem solving include:

Abstraction: This technique involves solving the problem in a model of the system before applying it to the real system.

Divide and conquer: While using this approach to problem solving, people break down a large, complex problem into smaller, solvable problems.

Hypothesis testing: This involves assuming a possible explanation to the problem and trying to prove (or, in some contexts, disprove) the assumption.

Lateral thinking: Many problems involve approaching solutions indirectly and creatively and this involves the use of lateral thinking.

Method of focal objects: This approach involves synthesizing seemingly non-matching characteristics of different objects into something new and reaching to a solution.

Reduction: Problem solving may also be done by transforming the problem into another problem for which solutions exist and this is called reduction.

Research: This involves employing existing ideas or adapting existing solutions to similar problems.

Root cause analysis: involves eliminating the cause of the problem.

Trial-and-error: This is one of the most widely studied methods in psychology and involves testing possible solutions until the right one is found.

Brainstorming: This approach is especially used among groups of people wherein a large number of solutions or ideas are suggested by various members of the groups and later these ideas are combined and developed until an optimum solution is found.

Self Assessment Questions

1) What are some of the specific techniques of problem solving?

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2) What is involved in "generate and test" technique?

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3) What do you understand by the term "Means Ends " analysis?

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4) What is backward search in problem solving?

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5) Discuss "thinking aloud" as a method for studying human problem solving.

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2.4 CREATIVITY AND PROBLEM SOLVING

As discussed in Unit1, many of the problems are called insight problems, and are believed to have a solution that comes from insight. The process by which insight comes is not well understood. However it is strongly believed that creativity plays a vital role in insight and vice versa.

Although the term is difficult to define precisely, many psychologists believe that creativity has to do with appropriate novelty, that is, originality that suits some purpose (Hennessey & Amabile, 1988).

Appropriate ideas that lack novelty are mundane; conversely original ideas that do not address some problem in a useful way are bizarre. Cognitive scientists refer to creativity as a combination, or recombination, of knowledge, information or mental representations. In other words the person who has created it knows about it, and also has depicted it.(Dartnall, 2002). Creative problem solving forms the essence of insight problem solutions. Insight seems to involve at least three separate problem-solving skills (Davidson, 1986; Davidson & Sternberg, 1984) and these are (i) selective encoding (ii) selective combination (iii) selective comparison. These are discussed below.

1) *Selective Encoding.* When we try to solve a new problem, we are often overwhelmed by large amounts of useless information. An insight arises when we determine which information is relevant for further consideration. Sir Alexander Fleming discovered penicillin through selective encoding. Fleming's attempts to grow bacteria had been disrupted by the appearance of a mold in his culture. Rather than dismissing this mold as irrelevant to his original experiments, he realised that the mold's bacteria has a killing ability that was relevant to a greater medical concern, that is the need for antibiotics to kill disease-causing organisms.

2) *Selective Combination:* When we have a problem to solve, we often have all the pieces of the solution, but we do not know how to put them together. An insight arises when we discover a novel way of combining the elements of the solution.

   For example, Darwin's construction of the theory of evolution involved selective combination. The various facts about natural history had been available to him for a long time. What Darwin did was to combine this information into an innovative and coherent theory.

3) *Selective Comparison.* When we solve a problem, we often use a model solution that we encountered in the past. Insight occurs when we discover that a more novel comparison leads to unforeseen consequences.

To give an example, Kekule's discovery of the structure of the benzene ring involved selective comparison.

In a dream Kekule saw a snake curl back on itself and catch its own tail. Upon waking, he realised that this was the structure he had been seeking. His insight was to discern the underlying similarity between his dream image and the benzene ring.

As the above examples suggest, insight is an important aspect of the creative process. Even though the laboratory puzzles and problems that we have been discussing in this Unit as examples bear little resemblance to the kinds of problems that Fleming, Darwin, and Kekule worked on, they all involve insight in that a solution suddenly comes to mind. They also share another property, that is, the person begins in the dark, not knowing what to do. What factors promote creative solutions to important problems?

2.4.1 Stages Involved in Creative Discoveries

Many creative discoveries seem to occur in these four stages:

1) Preparation

2) Incubation

3) Insight

4) Verification.

As discussed, Creativity is the ability to see something new in something quite ordinary.

Preparation: First a goal is set. Then potentially relevant information is gathered, sometimes deliberately, sometimes by accident.

Incubation: This preparation done, a period of apparent inactivity, that is incubation can set in. Incubation may involve unconscious mental activity, or it may simply be a period of waiting for some important missing link to fall into place.

Insight: The moment of insight (also called illumination) often involves familiar elements coming together in new ways. The mathematician Henri Poincare wrote, "To create consists of making new combinations of associative elements that are useful" (1929).

Verification: The final step, verification, tells whether a new combination is, in fact, useful. Two characteristics stand out in the creative person:

The first is a clear sense of purpose: An invention, a painting, a musical composition, or any other creative product is a solution to a problem. Without a clear goal, a clear problem to solve, nothing would be created. The second outstanding characteristic of creative people is their store of knowledge and techniques. Inventors have to know both the content and the techniques of their field, composers have to know music and the craft of composition, and scientists must know the facts and theories of their field and master the mathematical and technical tools of the trade. Because "creativity" has an almost mystical connotation, it is easy to forget how basic and indispensable purpose and knowledge are.

Self Assessment Questions

1) How are creativity and problem solving related?

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2) What are the 3 problem solving skills that insight involves? Give examples

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3) What are the various stages in creative discoveries?

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2.5 ARTIFICIAL INTELLIGENCE IN PROBLEM SOLVING

Researchers studying problem solving propose problem space hypothesis which states that "every possible state of affairs within a problem corresponds to a particular mental node and the entire set of nodes occupy some mental area and this area together with the mental graph is a problem space".

This problem space hypothesis has been used to create expert systems called computer programmes designed to model the judgments of one or more human experts in a particular field.

Expert systems contain a knowledge base that store facts relevant within that field. They typically also contain a set of inference rules, a search engine that the programme uses to search knowledge base using inference base and some interface or means of interacting with a human user who has a question or problem for which he/ she is consulting the expert system.

These are computer programmes that solve problems in ways that are similar to the intelligent way in which humans solve problems are called artificial intelligence approaches and have been found to be extremely influential.

2.5.1 Criticisms of the Computer Simulation Approach

Not all researchers agree that computer simulation can capture the way that people think when they solve problems. Some people argue that thinking is just too complex to be mimicked by a machine. However, as we know, computer programs can produce some solutions to very complicated problems. Current experience and researches suggest that there appear to be no reason, in principle, why computer program should not-approach (or surpass) the complexity of human thought.

Other criticisms derive from the belief that whatever it is that computer programs do it does not really count as thinking and problem solving. People who express this belief often ally themselves with the German philosopher Heidegger (1968).

The properties of computer programs that they can represent the chain of inferences leading from one state to another are not the essence of thinking for Heidegger who strongly propound that 'Computer programmes are good stimulators of such processes as reasoning and calculating. However, the essence of thinking lies behind such processes as reasoning and calculating and computer programmes are not reducible to them. It is the subjective origin of thinking-the

concern with the fundamental problem of being alive in the world which the computer programmes do not capture. Despite these arguments, in the current times artificial intelligence is widely used for problem solving and appears to have promising future.

Self Assessment Questions

1) How does artificial intelligence function in problem solving?

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2) What is meant by computer simulation approach in problem solving?

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3) What are the criticisms against computer simulation? Discuss

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2.6 LET US SUM UP

Problem solving involves both domain specific and general strategies that people may use. General strategies (like generate and test, means-ends analysis, reasoning by analogy) are believed to be general strategies of problem solving that people use in wide variety of situations. In contrast there are domain specific strategies that are suitable in one particular situation and problem but not for others.

Many expert systems that represent artificial intelligence are specially designed computer programmes that mimic a human expert in a specific field. However, there are many unanswered questions pertaining to the utility of artificial intelligence in problem solving. Insight problem solving has been found to be related to creativity. In summary, problem solving is a multi step process and may be facilitated by individual characteristics such as creativity.

2.7 UNIT END QUESTIONS

1) What are the stages in problem solving? Highlight the stages with a problem from your day to day life.

2) Compare and contrast the generate- test, the means ends and the backward search method of problem solving.

3) Discuss "thinking aloud as a method of studying human problem solving

4) Discuss "other strategies" in problem solving. For example, abstraction, divide and conquer etc.

5) Critically evaluate the utility of artificial intelligence in problem solving?

6) Compare and contrast the general stages of problem solving with the stages of creative problem solving.

7) Discuss the concept of thinking aloud approach of problem solving.

2.8 SUGGESTED READINGS

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UNIT 3 THEORETICAL APPROACHES TO PROBLEM SOLVING

Structure

3.0 INTRODUCTION

The different forms of thinking behaviour including problem solving vary along a number of dimensions. The degree to which we are conscious of our thought processes can vary considerably. We tend to be conscious of the products of problem solving rather than the processes themselves. Furthermore, even these conscious products may not be recalled accurately in retrospect by people. Problem solving tasks can also be more or less directed. Some problem solving tasks are directed towards specific, well-defined goals, whereas other forms are rambling and goal-less. Thinking episodes directed at problem solving also differ in terms of the amount of knowledge that comes into play to achieve .a goal and these may be knowledge-lean or knowledge-rich. Most of the early research on problem solving has examined directed thinking in knowledge-lean situations that have specific goals (i.e. puzzles). Later research considers more knowledge-rich situations (e.g. expert problem solving). In the present unit we focus on the various theoretical approaches to understanding the process and nature of problem solving.

3.1 OBJECTIVES

On completing this unit, you will be able to:

- Explain the theoretical aspects of problem solving;
- Give a historical account of problem solving; and
- Describe the various theories related to problem solving.

3.2 APPROACHES TO PROBLEM SOLVING

In this unit, we will examine the theoretical understandings of nature and process of problem solving from the traditional to the most recent viewpoints. The theoretical models that are discussed in detail include the traditional models of problem solving, Gestaltists Theories, Information processing and computer simulation, The General Problem Solver (GPS), Wickelgren's general problem solving strategies and Newell's approach to understanding Problem Solving.

3.2.1 Traditional Approaches

Traditional approaches explain problem solving in terms of principles of associative learning derived from the studies of classical and instrumental conditioning. According to some theorists an individual enters a problem situation with an existing complex of stimulus response associations as a result of prior experience. The problem is more likely to elicit some of these associations than others, with a clear implication that problem difficulty will depend on the strength of the correct association relative to the strength of other incorrect associations. In the course of problem solving, the associative complex gets rearranged as some tendencies are weakened through extinction (failure) and other strengthened through reinforcement (success). This viewpoint stresses the transfer of prior learning to the problem situation and to the learning which takes place during problem solving.

3.2.2 Gestalt Approaches

A different view of problem solving was proposed by the gestalt psychologists. These theorists emphasised the importance of the structure of the problem situations and the formation of new combinations of old ideas. They were particularly interested in how people solve problems by rearrangement of objects. A well known example is the problem described by Kohler (1925) in his book, The Mentality of Apes. Kohler hung some fruits from the top of a cage to reach it. The cage contained several sticks and crates. The solution depended on finding a correct way to rearrange the objects. According to the Gestalt analysis, solving the problem required the reorganisation of the objects into a new structure. Gestaltists argued that discovering the correct organisation usually occurred as a flash of insight. Insight is the sudden discovery of the correct solution following a period of incorrect attempts based primarily on trial and error. Insightful solutions seem to occur in a flash.

Gestalt psychologists distinguished between reproductive and productive thinking (Wertheimer, 1959). Reproductive thinking entails the application of tried and true paths to solution. The thinker reproduces a series of steps that are known to yield a workable answer by using rote memory. Productive thinking on the other hand, requires insight and creativity. According to gestalts view the thinker must see a new way of organising the problem, a new way of structuring the elements of thought and perception. A classic problem calling for productive insightful thinking is the nine dot problem shown below:

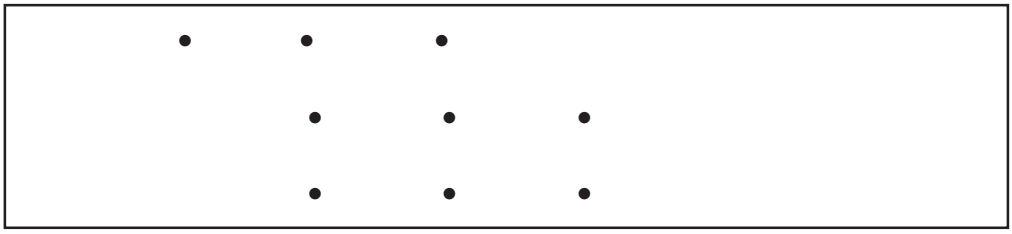

Fig. 1: The Nine dot problem

The task (problem) is to connect the nine dots with just four straight lines, without lifting your pencil from the paper in drawing the lines. To think productively in this problem situation one must restructure the problem, to throw off the unnecessary assumption that the lines must lie within the visual boundaries.

Self Assessment Questions

1) Describe traditional approaches to problem solving.

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2) Describe Gestalt approaches to problem solving.

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3) Compare and contrast the traditional and Gestalt approaches.

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3.2.3 Information Processing and Computer Simulation

A number of researchers have tried to program computer to perform tasks that human beings do. Such computer simulation research has had a profound influence on psychology of human cognitive processes. The method consists of programming a computer to work in a specified manner and comparing its performance to that of human subjects given the same tasks. Researchers employing computer simulation have made major contributions to the development of information processing view of problem solving.

A problem requires a person not only to register information from the environment but also to operate on, modify, or transform that information in some way in order to reach a solution.

Solving problem also requires the retrieval of both factual and procedural knowledge from long term memory. Especially for longer problems, reaching a solution might involve repeated storage and retrieval of information generated early in the problem for use in later stages. Even this brief listing clearly indicates

that problem solving is not a single cognitive process but rather involves a number of activities which need to be properly executed and organised to be successful.

The most promising kind of theory in the early 1980s involves computer simulation. In the last couple of decades a number of computer simulation theories of problem solving have emerged. The general problem solver (GPS) developed by Newell, Shaw and Simon (1958). It introduced a way of looking at problem solving which has influenced virtually all problem solving theories.

3.2.3.1 The General Problem Solver (GPS)

The program was equipped with the equivalent of:

A limited capacity working memory characterised by rapid storage and retrieval

A large capacity long term memory characterised by relatively low storage and retrieval

A serial processor that performs one operation at a time

A reliance upon heuristics, rather than algorithms that would require a large number of high speed calculations.

Newell and his colleagues collected verbal protocols that were used and kept as a record of people talking aloud as they solved problems. Then they transcribed these lengthy records carefully to see if they could find general heuristics that emerged. It introduced a way of conceptualising problem that is adopted in most contemporary theories of problem solving.

The General Problem Solver (GPS) assumes that the problem solver represents a problem as a problem space which consists of a set of nodes, each node corresponding to a state of knowledge about the problem. The problem solver begins at the initial state of knowledge and seeks to convert it into the goal state by applying operators, which are actions that are permitted in order to move from one state of another. Problem solving, then, requires a constructive search during which the solver builds up a problem space, which leads from the initial to goal state using a set of allowed operators.

3.2.3.2 Means End Analysis

This was recognised as a general problem solving heuristic which involves a search for operations that will reduce the difference between present state of knowledge and the goal state. In particular, means-end analysis involves the following steps:

Set up a goal

Look for a difference between the current problem state and the goal state.

Look for a method to decrease or eliminate the difference between the two stages.

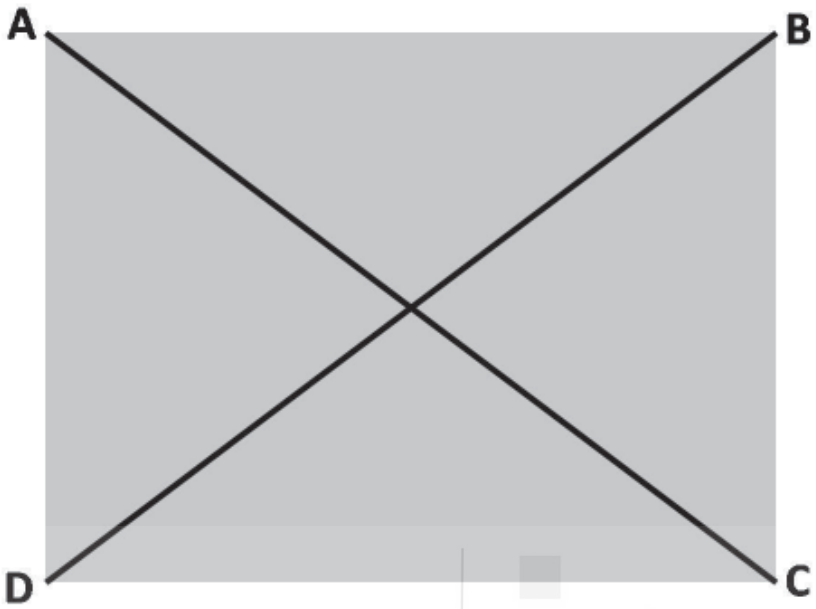
Set as a sub goal which is the application of that method.

If necessary apply means- ends analysis to apply to the sub goal.

Thus, the main heuristic used in GPS involves setting up goals and sub goals. In fact, this strategy can be expressed very precisely as a production system, that is, as a set of if – then pairs stored in the computers memory as production.

An illustrative geometric problem:

The problem is that ABCD is a rectangle; prove that AD and BC are same length.



Steps in problem solving:

Represent the problem as a proposition or in visual form

Determine the goal.

Break down the goal into sub goals.

Select a problem solving technique

Solution is:

It can thus be proven that triangles ACD and BDC are congruent if one could prove that two sides included angles are equal. (We reason from goal to sub goal, proving the triangles congruent, from the sub goal to another sub goal improving the sides and angle equal), and so on, until we reach a sub goal that we have a ready means of obtaining).

The 3 strategies that we can use to solve this problem are difference reduction, means-end-analysis, and working backwards and these three strategies are extremely general and can be applied to virtually any problem.

3.2.3.3 Wickelgren's General Problem Solving Strategies

Wickelgren's view of problem solving is based on information processing theories such as GPS. According to this view, a formal problem contains three types of information:

A statement of the initial state.

Description of the goal state.

Description of set of operation or transformations.

A solution can be defined as a sequence of state or actions which helps to represent in a diagram called the State Action Tree. The nodes or branch points on the tree represent all the possibly different problem states that could result from all the different action sequences.

The branches on the tree represent the possible actions that could be made at the particular state of knowledge. The given state is represented by the single node at the top level of the state action tree, and the goal state is represented by the indicated node in the lowest level of the tree.

For this schematic tree, we assume that from the goal state there are only two possible actions that the person can take. One of which starts the person on the path toward the goal, the other of which does not.

Having chosen one of these (thereby leading the person to state level 1), the person is then faced with a new set of possible actions. Here, we arbitrarily assume that there are three possible actions that could be taken at either of the state level 1 nodes.

This successive making of choices goes on and on until the person either reaches the goal state or finds himself at a dead end. Thinking about state action trees is the fact that as you get further into a problem (i.e. lower and lower levels in the tree) the number of possible action sequences increases rapidly. Wickelgren argues that there are seven general problem solving techniques for searching the state action tree.

i) *Inference:* Deducing from the explicitly stated goals givens, and operations stated in the problem

ii) *Classification of action sequences:* organising possible sequences of actions (or operations) that are equivalent as far as the problem is concerned. These are called equivalence classes.

iii) *State evaluation and hill climbing:* state evaluation involves defining a quantitative evaluation function that can be calculated for all possible problem states and hill climbing involves choosing the action to be taken next that will have an evaluation that is closest to the goal.

iv) *Subgoals:* This stage involves searching for sub goals involve breaking down the problem into sub goals to make it simpler.

v) *Contradiction:* deriving some inference from the givens that is inconsistent with the goal state to narrow down the state action tree in a systematic fashion by eliminating possibilities that could possibly not work.

vi) *Working backward:* It involves beginning with the goal state and working backward from it.

vii) *Finding relations between problems:* finding relations between the new problems and problems solved previously.

Self Assessment Questions

1) Describe and delineate the characteristic features of information and computer simulation approach to problem solving.

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2) What do you understand by the term General Problem Solver.?

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3) Describe the Menan end analysis with examples

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4) Put forward in detail the general problem solving strategies of Wickelgren.

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3.3 NEWELL'S APPROACH

It is very natural to think of problems as being solved through the exploration of different paths to a solution. Taker maze for example. In this, you start from a point outside the maze and then progress through it to the centre. On your way, you reach junctions where you have to choose between going straight on, turning to the left or right, or turning back. Each of these alternative paths may branch again and again so that, in the maze as a whole, there are hundreds of alternative paths (only some of which will lead to the centre). Different strategies can be used to find one's way through a labyrinth.

The strategies provide you with a systematic method for searching the maze and help you to select one from among the many alternative paths.

Newell and Simon used parallels to these basic ideas to characterise human problem solving behaviour.

They suggested that the objective structure of a problem can be characterised as:

i) a set of states, beginning from an initial state (e.g. standing outside the maze),

ii) involving many intermediate states (e.g. moving through the maze), and

iii) ending with a goal state (e.g. being at the centre of the maze).

The application of these operators (turn left, go straight etc.) results in a move from one state to another. In any given state there may be several different operators that apply (e.g. turn left, turn right, go back) and each of these will generate numerous alternative states. Thus, there is a whole space of possible states and paths through this space , and only some of these will lead to the goal state. *This problem space describes the abstract structure of a problem.*

3.3.1 Summary of The Problem Space Hypothesis

For any given problem there are a large number of alternative paths from an initial state to a goal state; the total set of such states, as generated by the legal operators, is called the basic problem space.

People's problem solving behaviour can be viewed as the production of knowledge states by the application of mental operators, moving from an initial knowledge state to a goal, knowledge state.

Mental operators encode legal moves that can be made. There are also restrictions which disallow a move if certain conditions hold.

People use their knowledge and various heuristic methods (like means-end analysis) to search through the problem space and to find a path from the initial state to the goal state.

All of these processes occur within the limits of a particular cognitive system. That is, there may be working memory limitations and limitations on the speed with which information can be stored and retrieved from long-term memory.

Newell's approach, which is based on this problem space hypothesis, propounds that the knowledge level rationalises behaviour in terms of the reasons that an agent has to believe that certain actions will lead to achieving certain goals. In this sense knowledge is a means to an end, a resource for behaviour.

The goal of problem solving is to select one of the possible actions.

3.4 PROBLEM SOLVING AS MODELLING

More recently, a different view is being explored, namely the view of problem solving as modeling.

The idea is that problem solving is the construction of situation specific model or case model.

From a knowledge level perspective the person's perception of the world is through knowledge alone. A goal therefore must correspond to the desired state of ones knowledge about the world.

Consequently this knowledge must refer to the specific systems that the goal is about. The case model thus summarises the person's understanding of the problem, and allows it to eventually conclude that the goal has been reached.

The actions are the means by which the person interacts with the world. Since at the knowledge level the person's perception is through knowledge, the interaction must be viewed as a way of obtaining knowledge about the reality. Thus one may say that actions of perception and interactions fit in this scheme.

In the problem solving as modeling, the actions are not the goal of problem solving but are themselves a means to an end. That end is the construction of a model which will help in eventually achieving the goals. Whether it is the domain model or task model the construction of the model should be such that it should lead to the goal.

For instance, in making a domain model, it is not just packaging statements about the domain, but it should involve augmenting statements with a series of assumptions about how the information about the systems is connected.

In regard to task model, it embodies assumptions about the meaning of goals. For example, if a diagnostic task is modeled as a process to generate and test over components of a system, then one implicitly assumes that the fault one is looking for can be localised in a component.

Thus, modeling a task corresponding to a goal is to make more precise what one *assumes* that goal to mean.

The role of the problem solving method is to tie domain and task models together in an argument on what accomplishing the task means in terms of the available models. This is termed as competency theory.

To give an example, a heuristic classification problem solver assumes that the solution to its problem is within the differential and it is what the problem solver believes that it can say about the problem. This actually defines its competence.

In addition the competence theory also talks about what rationality means. A heuristic classification problem solver will use the knowledge and actions pertaining to rationality to reduce the sise of the differential. This is called *specialised principle of rationality*. It contains the basis for all "why" questions about the system's behaviour.

This model is the case model and it is obtained from the competence theory through actions. Specific control regimes (e.g., data-driven or hypothesis-driven heuristic classification) correspond to different ways of operationalising the specialised principle of rationality.

The configuration of models, tasks and methods entails a set of assumptions that together can be interpreted as a model of the problem. The goal of problem solving is to instantiate this model by making it realistic.

This can be done by making derivations from

i) the case-specific knowledge obtained by the person's actions and

ii) the assumptions embodied in the domain and task models.

The form of the case model is determined by the selection of problem solving method.

In this view problem solving is no longer an input-output process (as in KADS-I). It is also not a means to select actions (as in Newell's knowledge level theory). It is also not a model transformation process (as in Components of Expertise). It is in fact a process of organising knowledge by making assumptions (i.e., constructing a model) that allow one to conclude (in effect, only assume) that the task is accomplished.

Successful problem solving is a matter of making the right assumptions and exploring their consequences.

Problem solving is thus viewed as the 'creation' of a suitable case model and the interaction with the world is only a resource for this. It is almost a side-effect in the process of maintaining an internal organisation and identity.

Self Assessment Questions

1) Describe Newell's approach to problem solving.

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2) What do you understand by the term problem space hypothesis?

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3) Summarise the Problem space hypothesis.

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4) What is problem solving as modeling?

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5) Discuss successful problem solving.

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3.5 LET US SUM UP

Like most of the psychological and cognitive constructs problem solving has also been construed in different light by different researchers following different schools of psychology. The more traditional approaches explained problem solving in terms of principles of associative learning derived from the studies of classical and instrumental conditioning.

Gestaltists viewed it differently and emphasised the importance of the structure of the problem situations and the formation of new combinations of old ideas. Since then we have observed many different approaches to understanding problem solving in terms of the Information Processing and Computer Simulation approach, the General Problem Solver (GPS) approach, Wickelgren's general problem solving strategies and Newell's approach which is based on problem space hypothesis.

As knowledge and research progresses it is likely that one may come up with more comprehensive theories of problem solving.

3.6 UNIT END QUESTIONS

1) What are the traditional approaches to understand problem solving? Think of some problems that you can explain based on these approaches.

2) Explain Wickelgren's approach of general problem solving strategies.

3) Compare the Gestallt approach of problem solving with information processing approach to problem solving.

4) Newell's problem solving approach rests on a famous hypothesis in the literature of problem solving. Name and explain this hypothesis.

5) Critically discuss Newell's approach to problem solving.

6) What do you understand by the term "General Problem Solver". Explain with examples.

7) Do you think that a single approach amongst the approaches discussed in this chapter is sufficient to explain all kinds of problems and problem solving that we face.

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UNIT 4 IMPEDIMENTS TO PROBLEM SOLVING

Structure

4.0 INTRODUCTION

You might have come across many situations when your attempts at problem solving may have failed. This is largely because the problem space is not adequately searched or because it is not represented well in the first place. There are numerous factors that are influential impediments to problem solving.

Einstellung (or set or mental set) and functional fixedness are classic obstacles to both proper representation and search identified by the Gestalt psychologists. However, there are other impediments to problem solving also. In this chapter we will study some of these impediments to problem solving.

4.1 OBJECTIVES

After completing this unit, you will be able to :

- Define probles;
- Differentiate between problems and dilemmas;
- Define and describe Mental Set;
- Describe Luchin's Water Jar Problem;
- Explain impediments to problem solving;
- Define Functional Fixedness;
- Explain Incomplete or Incorrect Representations; and
- Analyse Lack of Problem Specific Knowledge or Expertise.

4.2 EFFECTIVE PROBLEM SOLVING

Depending on the kind of dilemma or problem, there are a number of models that can help people to think through their approaches to decision-making.

Haynes' model

This suggests a 3-step approach in the form of reflective questions, for dealing with ethical decision-making dilemmas and problems

When working out a solution to the problem, there are a few questions one should pose to oneself and these are for instance, "If this particular solution is considered what will be the consequences and would there be more benefits vis a vis harmful effects?"

Hall's model (2001)

Alan Hall (University of Waikato) offers a set of questions that educators can use to help consider all things before deciding what they ought to do when confronted with an ethical problem, and how they will do it:

What is the basic issue concerned with the problem?

What principle is at risk?

Who will benefit?

Will benefits be more than harm?

4.3 OTHER METHODS FOR PROBLEM SOLVING

4.3.1 Einstellung

It is the term used by the Gestaltists to describe the tendency to set the mind into a routine approach to problem solving. When we considered Wertheimer's laboratory problems, we noted that sometimes previous experience can blind a person to simple solutions. The experiments of Luchins (1942; Luchins & Luchins, 1950, 1994a, 1994b) are among the most interesting demonstrations of the way in which repeating a particular problemsolving method can make a person blind to alternative ways of solving the problem.

Luchins (1942) discovered set or Einstellung effects with the water jar problems. In this problem it is required to measure out a desired quantity of water using three jars with different capacities. Jars used have no gradations on them so they have to be filled up to the top to measure amounts that result in the desired quantity.

Luchin's Water Jar Problems

	Jar Sizes			
	A	**B**	**C**	**Goal**
Problem 1	21	127	3	100
Problem 2	14	163	25	99
Problem 3	18	43	10	5
Problem 4	9	42	6	21
Problem 5	20	59	4	31
Problem 6	23	49	3	20

For instance, suppose the desired quantity was 5 cups and Jar A held 10 cups, Jar B held 4 cups, and Jar C held 1 cup, the solution would be to fill A first. Next from A pour into B once, and then pour from B into C once (A-B-C). Try all six problems in above Table before proceeding.

Luchins found that problem solvers adopt a set in solving these problems. After solving the first two or three, they automatically try the solution B-A-2C without searching the problem space for an alternative solution. Take a look at problem 6 again. Although B-A-2C works fine, it entails much more effort than A-C. Yet because of Einstellung, people typically overlook the obvious, easy solution.

Langer (1989) saw that Einstellung effects are one type of mindlessness that characterises human behaviour, particularly in our dealings with other people. All too often we act from a single perspective or rule that has worked in the past. Instead of exploring our environment carefully to seek out alternative courses of action, we sample just enough features to recognise that our set approach seems to be on track.

Einstellung also constrains how we represent problems as well as how we search them.

Self Assessment Questions

1) Define problem solving.

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2) Describe effective problem solving. What is required for effective problem solving.

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3) What are the various other methods of problem solving?

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4) What is Einstellung? Explain

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4.3.2 Understanding the Problem

1) **Interpretation**

Develop a relatively clearer understanding of the problem before attempting to solve it.

Devote more time and effort to the initial formulation of ill structured problems.

Look at the immediate problem in its relation to the broader mission and problems of the organisation.

2) **Goals**

Adopt a broader range of goals for problem solving

When solving problems in groups, have less personal stake in any preconceived solution. Because their aim is to arrive at the best solution the group can produce.

4.4 OVERCOMING THE CONSTRAINTS

The problem solver must adequately anticipate many of the constraints likely to arise during problem solving.

They must show a greater tendency to plan, in advance, for how to address anticipated constraints.

They must respond more adaptively and flexibly to constraints that arise unexpectedly.

They should not view the constraints as major impediments to problem solving.

4.4.1 Typical Processes in Solving a Problem

- Think through their solution processes in considerable detail
- Develop an explicit plan for solving the problem, which often includes many steps.
- Collect comprehensive amounts of relevant information from reliable sources as part of developing and implementing their solution plan.
- Monitor progress with the plan and refine it when outcomes are not satisfactory.
- Consult, often extensively, with others in developing their solution plan.
- Plan for follow-up.

4.5 IMPEDIMENTS IN PROBLEM SOLVING

Solving problems is a complex process and each of us is better at the skills required at some stages than others.

A problem exists when an obstacle prevents the person from reaching an objective.

In order to achieve effective problem solving , this problem solving itself can be divided into stages, which must be followed methodically.

Solving problems effectively requires a controlled mixture of analytical and creative thinking.

The following are the list of some of the reasons why people fail to find effective solutions include:

- Not being methodical
- Lack of commitment to solving the problem
- Misinterpreting the problem
- Lack of knowledge of the techniques and processes involved in problem solving
- Inability to use the techniques effectively.
- Using a method inappropriate to the particular problem
- Insufficient or inaccurate information
- Inability to combine analytical and creative thinking
- Failure to ensure effective implementation.

Self Assessment Questions

1) What are the two important aspects involved in problem solving?

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2) What are the ways in which the constraints in regard to problem solving could be overcome?

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3) What are the various impediments in problem solving?

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4) Why do people fail to find effective solutions to problems?

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4.6 PRODUCTIVE PROBLEM SOLVING AND IMPEDIMENTS THEREOF

Let us first consider what is required for productive problem solving. The following provides the requirements

A clear description of the problem.

A description of the limiting (or negative) factors involved in the problem.

A description of the constructive (or positive) factors involved in the problem.

A clear delineation of the "ownership'' of the problem. Whose problem is it: mine, yours, the other guy's, my boss', my spouse's, my child's, my parents', my teacher's?

A clear description of the scope of the problem: How extensive a problem is it? How long has this problem existed? How many people are affected? What else is affected by this problem?

A clear description of the consequences if the problem were not solved: What is the possible impact on my family, job, marriage, school performance, life in this community, etc., if this problem isn't solved? What is the worst possible thing that could happen if this problem isn't solved?

A list of brainstormed solutions to the problem, with each alternative analysed as to its reality, its benefits and the consequences for following each one.

A system of ranking each solution to finalise the decision-making process. A rating system for analysing each solution is developed, e.g., 100 percent chance of success, 75 percent chance of success, 50 percent chance of success.

It is always ideal to brainstorm the problem and to do this one should follow the rules given below:

1) Express all ideas.
2) Deem no idea too wild to be considered.
3) Quantity is important; every idea that comes to mind should be included.
4) Getting together with others to brainstorm is desirable.
5) Criticism or negative evaluation regarding any idea is forbidden until brainstorming is completed.

Some of the questions one should ask of oneself in order to achieve effective problem solving are:

- Am I procrastinating?
- Am I avoiding the problem?
- Am I in denial?
- Am I shutting down or blocking my creativity on this problem?
- Am I ignoring it, hoping it will go away?
- Am I using magical and/or fantasy thinking in addressing the problem?

4.6.1 Impediments to Productive Problem Solving

- A "Yes, but'' attitude.
- Intellectual defensiveness closed to new ideas.
- Fear of being perceived as being incompetent.
- Fear of one's ideas being unaccepted.
- Inability to be objective about the problem.
- Fear of being wrong.
- Inability to be creative, imaginative or "off the wall'' in developing alternative solutions.

- Being inflexible or too serious to have fun while problem solving.
- Not tuning into one's "inner child''.
- Being so chronically immersed or emotionally "stuck'' in problems that no feelings or emotions can be elicited.
- Believing that one's emotions and feelings about a problem are "wrong'' and should be discounted in problem solving.
- Resentment about having to solve the problem and blaming others for causing the Problem.
- No desire to own up to the problem yourself.
- Believing that problems are the concerns of others, why waste time in trying to solving them.
- Mental and/or physical fatigue from trying to cope with problems and finding no fruitful solutions.
- Burnout, feeling so stressed, anxious or tense in the face of a problem that your body systems shut down.
- Getting so angry about the problem that all energy and attention is drawn to the anger rather than to the problem.
- Feeling sorry for oneself so much that the "self-pity'' overwhelms and obstructs all creative thinking on the matter.
- Getting so down or depressed about the problem that it is impossible to come up long enough to deal with the problem.
- Denial that the problem exists.
- Bargaining in dealing with the problem; e.g., agreeing to perform certain steps only as long as the solution to the problem benefits you.

Self Assessment Questions

1) What is meant by Productive problem solving?

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2) What are the essential pre requisites for productive problem solving?

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3) What are the impediments to productive problem solving?

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4) How can you overcome these impediments to productive problem solving?

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4.7 PROBLEM SOLVING IN TEAMS AND SMALL GROUPS

There are many things that make a group or team fail to solve a problem. Some of the barriers in this regard include the following:

1) Lack of structure.

When there is no structure group members lose focus and direction.

2) Poor communication.

This is a barrier that can wreak havoc for every group member that is involved. Poor communication can lead to misunderstanding of the problem. Further poor communication itself can be caused by inattentiveness and dominance that can be made by one or more group members. Ineffective communication will definitely be a negative against any discussion or meeting.

3) No communication

This would be a problem solving killer.

4) Negative attitude

This is a barrier to problem solving in small groups. If members are not flexible and open minded during a discussion or meeting, then a balanced opinion can not be produced.

5) No goal or agenda

When having a team or small group meet for problem solving, it is very important to have a goal or agenda. This in turn will help to avoid most barriers and keep the group focused and organised.

6) Lack of participation

It is important in a small group or team every member should participate in the problem solving process. They must all have clear idea as to what the

group is trying to achieve and give all members time to participate and give their views and feelings. This path, in the end, will help to keep focus, structure, and communication open for all members.

In addition to the above other problems that may affect the problem solving processes are:

- Emotions
- Learning styles
- Gender
- Cognitive barriers
- The lack of transfer of structure between problems.

4.8 CRITICAL THINKING IN PROBLEM SOLVING AND IMPEDIMENTS

Critical thinking consists of three steps:

1) Becoming aware that assumptions exist
2) Making assumptions explicit
3) Assessing their accuracy

Misconceptions about Critical Thinking

- It is a wholly negative process – it tears down ideas and puts nothing in their place
- It will lead to relativistic freeze – the inability to make commitments to people, ideas, and structures.
- It seems to involve traumative change – one is expected to abandon old assumptions continually.

Other fallacies in regard to problem solving are :

- Irrelevant reason.
- The person's character attached to discredit arguer rather than argument
- Generalisation – one event which follows was cause by first
- Slippery slope with an either or approach which leads to non resolving a problem.
- Appeal to emotion – emotional appeals rather than logical reasons to persuade.

Self Assessment Questions

1) How do problems get resolved in teams and groups?

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2) What makes solution to the problem a failure in teams and groups?

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3) What is meant by critical thinking in problem solving?

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4) What are the impediments to problems solving through critical thinking?

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4.9 OTHER BARRIERS TO PROBLEM SOLVING

These are Perceptual blocks, Emotional blocks, Intellectual blocks, Environmental blocks, Culture blocks.

4..9.1 Perceptual Blocks

Perceptual blocks exist when we are unable to clearly perceive a problem or the information needed to solve it effectively .

They include:

a) Seeing *only what you* expect to see

Obscures the "true nature of a problem, either because we exclude relevant information or include information simply because we assume it is there.

b) *Stereotyping*

Often we don't look beyond the obvious and tend to label. For example, if someone isn't working as hard as we would like and we apply the label 'lazy' to that person, we might overlook the possibility that boredom with monotonous work is the problem, and not laziness

c) *Not recognising problems*

Problems go unnoticed until the effects have become severe and emergency action is required.

d) *Not seeing the problem in perspective*

This results from taking too narrow a view of the situation, so that we recognise only part of the problem or the information required to solve it. Sometimes people fail to recognise how different parts of the problem are related, rather they look at the problem more superficially and hence the solution alsom becomes inadequate.

e) *Mistaking cause and effect*

If cause and effect are confused then we are unlikely to find an effective solution. For example, if goods do not arrive and we assume that the supplier is late in despatching them when in fact our ordering department has failed to send out the order, then our search for solutions will be misdirected. In this situation the late despatch of the goods is an effect of the problem and not a cause.

4.9.2 Emotional Blocks

Emotional blocks exist when we perceive a threat to our emotional needs. These needs differ in type and strength from person to person but include needs for achievement, recognition, order, belonging and self-esteem. The emotional blocks include:

a) *Fear* of *making mistakes* or *looking foolish*

This is the most significant emotional block because it affects most of us and is difficult to overcome. As a result of traditional schooling, the expected reaction when we make a mistake or suggest radically different ideas is laughter and ridicule. No one likes being laughed at and as a result we learn to fear making mistakes and to avoid suggesting ideas which are different. This block becomes more severe in the presence of colleagues of a different rank to our own. With those who are more senior we imagine that we will be thought inexperienced or immature. With those more junior we want to protect our image as being knowledgeable and experienced.

b) *Impatience*

Being impatient to solve a problem may be due either to a desire to succeed quickly or to end the discomfort or loss caused by the problem. This has two major consequences. We tend to grab the first solution which comes along, without adequate analysis of the problem, and we evaluate ideas. too fast, almost instinctively rejecting unusual ideas. Either way, our solution is unlikely to be the most effective available.

c) *Avoiding anxiety*

This is another common block. Some of- us are more susceptible to anxiety and also find it more unpleasant than others. Many factors can cause anxiety, including high risk, disorder and ambiguity, long-term stress, and fear for our security. The effects on problem solving include avoiding risks, indecision in situations which are not ‘black and white’, excessive reliance on others’ judgement, and avoiding challenging the status quo. .

d) *Fear of taking risks*

This leads to the avoidance of situations where the outcome is uncertain or could be unpleasant. A major cause is our desire for security. The consequences include setting objectives within easy reach, so that there is no risk of failure, and accepting known solutions in preference to the unusual because their value is certain. A liking for taking risks and over-confidence in being able to avoid unpleasant, consequences are more dangerous blocks.

e) *Need for order*

This is related to avoiding anxiety. It can lead to an inability to cope with the frustration of situations which are not clear cut or where ambiguities exist.

f) *Lack* of *challenge*

This may arise when the problem is routine or the benefits/losses are not significant to us. The result is that either we don't tackle the problem or we take the easiest, quickest route to solution.

4.9.3 Intellectual Blocks

Intellectual blocks exist when we don't have the necessary thinking skills to find a successful solution, or are unable to use them effectively. They include:

a) *Lack of knowledge or skill in the problem solving process*

This is one of the most common blocks. It includes: inadequate skills in analytical and creative thinking; an inflexible strategy, using one approach for every type of problem; the inability to use the various problem solving techniques. They can all lead to ineffective solutions.

b) *Lack of creative thinking*

This is always caused by an inability to use the skills rather than their absence, resulting from the dominance of analytical thinking in our day-to-day lives and a lack of practice.

c) *Inflexible thinking*

This is a difficulty in switching from one type of thinking skill to another, such as from analysis to idea generation or from verbal to visual thinking.

d) *Not being methodical*

This is perhaps the most common block. A step-by-step approach is essential to solving problems effectively.

e) *Lack of knowledge or skill in using the 'Language' of the problem*

If a problem involves a language that we cannot understand or cannot use, such as specialist jargon or statistical analysis, we will not be able to tackle the problem effectively. Similarly, we may use an inappropriate language, such as trying to find an error in accounts by describing the situation verbally rather than analysing it mathematically.

f) *Using inadequate information*

This happens when we do not make sufficient effort to collect the relevant information, or do not understand what information is relevant, where to find it,

or how it relates to the problem. Similarly, using inaccurate information can lead us to the wrong conclusions.

4.9.4 Expressive Blocks

Expressive blocks arise when we are unable to communicate in the way required to produce an effective solution, e.g. not being able to express our ideas effectively to those who have to implement the solution. .

Expressive blocks exist when we do not have the knowledge or skills necessary to communicate or record ideas in the ways required. They are caused by an inability to use 'languages' effectively, such as words, drawings, mathematics, scientific symbols, and so on. They include:

a) *Using the wrong language*

Some problems are more effectively solved or communicated using one language rather than another. For example, we are unlikely to get very far if we record data only verbally when the problem requires quantitative analysis. Similarly, people may find it hard to grasp our meaning if we try to explain our feelings about a situation using mathematics instead of words.

b) *Unfamiliarity with* a *particular application* of a *language*

The most obvious example is the difficulty many people have making a speech, even though they can write their ideas effectively on paper.

Inadequate explanations

These can result from a real lack of information about what you are trying to convey, or from assuming that your audience already has some of the information when, they don't.

c) *A passive management style*

A situation where we are reluctant to or find it difficult to exert influence may prevent us communicating our ideas effectively. This is particularly important when people need to be convinced of the validity of ideas.

d) *A dominant management style*

This is when we exert oppressive control, either deliberately or unconsciously, and can make those we are communicating with automatically reluctant to accept what we say or hostile to our ideas.

4.9.5 Environmental Blocks

Environmental blocks are caused by external obstacles in the social or physical environment, which prevent us from solving a problem effectively, e.g. distractions from the task.

Environmental blocks, which exist when the social or physical environment hinders our problem solving, include:

i) *Management style*

The way in which we are managed can influence both our attitude to problem solving and the freedom we have to create and implement ideas. For example, if

our ideas are dismissed constantly with comments such as 'No, it wouldn't work because ...', or 'No, we've tried it before and it didn't work', we soon give up trying.

ii) *Distractions*

Due to excessive noise and interruptions, these affect some people more than others, but in general they have a detrimental effect on problem solving.

iii) *Physical discomfort*

This can create a distraction as well as resulting in stress or lethargy depending on the circumstances. For example, poorly designed chairs may create a distraction by giving us backache which, in turn, can make us irritable and less interested in any type of work.

iv) *Lack* of *support*

This comes in many forms. For example, we may need specialist information, advice, skills or other resources, or authority to take action. A more pervasive aspect of this block is a lack of encouragement and the necessary organisational structure to support and exploit people's ideas.

v) *Stress*

Stress due to pressure of work and deadlines, affects people differently. For those who are susceptible to stress it can be a powerful block, hindering creative thinking in particular.

vi) *Lack* of *communication*

This has a number of effects, including inability to get the information you require and a lack of encouragement.

vii) *Monotonous work*

This can dull enthusiasm for solving problems and put us onto 'automatic pilot', making us blind to problems when they occur.

viii) *Expectations* of *others*

These can influence both our general performance in problem solving and the objectives we set ourselves. For example, if our peers and superiors are happy with a regular solution to a problem we may feel that it's a waste of time looking for a new; more effective solution. On the other hand, if we are expected to find an innovative solution we are likely to make a greater effort.

4.9.6 Cultural Blocks

Cultural blocks result from our conditioning to accept what is expected or 'normal' in a given situation, e.g. when the work ethic says that we must be serious-minded, but finding an effective solution requires some playful fantasy.

Cultural blocks exist when our problem solving is hindrance by accepting that some things are good or right and are done, while others are bad or wrong and are not done, So that we become bound by custom. They include:

a) *Unquestioning acceptance* of *the status quo*

There is a tendency to conform to established ideas an methods of working and not to question them or express ideas which depart from them. If something is not normal done we tend to look for the reasons why it can't be done or why it wouldn't work, rather that looking for 'the reasons why it should be done or why it could work'.

b) *Dislike* of *change*

The attitude that tradition is preferable to change can arise, from the need for security. If a situation is acceptable as it is, any change, which must involve some uncertainty, is felt to be threatening by some people. However, as we become more and more accustomed to change this block is becoming less common, but there must be reasons for change. Change for change's sake can be dangerous.

c) *Fantasy and humour are not productive*

There is still a widespread belief that fantasy and humour have no place in the serious business of problem solving. Subjective reports from innovators suggest otherwise. Fantasy and humour are connected by one common feature – the unlikely combination of ideas (think about it' next time you hear a good joke – the punch line is always unexpected). Innovative solutions to problems arise in the same way – by making a link between apparently unrelated ideas.

d) *Feelings, intuition and subjective judgements are unreliable'*

There is a strong bias towards reason, logic and quantitative judgements because they can be measured and communicated in accurate terms. Feelings, intuition and subjective judgements, which cannot be measured or communicated as effectively, are seen as unrealiable and are mistrusted.

Even in mathematics, one of the most logical of sciences, intuition is often reported as playing a key role in, problem solving. A good problem solver needs to be able to use both objective, logical methods and subjective, intuitive methods in the search for solutions.

e) *Over-emphasis on competition* or *cooperation*

A strongly competitive environment (for recognition, promotion, and so on) can make people unwilling to listen to the ideas of those with whom they are competing. Similarly, in a strongly cooperative environment we may avoid expressing new ideas because we don't want to stand out from the crowd.

f) *Taboos*

Some actions and ideas are excluded from problem solving because they are regarded as distasteful, or are harmful, or contravene accepted moral codes. For example, in a test of creativity a group of students were given a problem to solve using calculus. They had to follow certain rules and the objective was to see who produced the largest number of different routes to the correct solution. A few students produced a lot more than the others because they chose to break the rules they were told to follow.

Although eventually we may not decide to break a taboo, there is no harm in breaking them in thought. This can often lead to new perspectives on a problem.

We can overcome most of our own blocks permanently by re-learning, and overcome other people's blocks which hinder us by learning ways to sidestep them.

Self Assessment Questions

1) What are the various other barriers to problem solving?

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2) What is meant by perceptual blocks to problem solving?

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3) Discuss the emotional and Intellectural blocks in problem solving

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4) Discuss the expressive and environmental blocks in problem solving

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5) What are the cultural blocks that affect problems solving?

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Other barriers

Learning styles: Other barriers to problem solving include Learning styles or how persons learn to solve problems. Some people learn primarily visually, others aurally; some learn step-by-step, others employ an all-or-nothing process; some cogitate on a problem introspectively, while others find they work problems best when they can discuss them.

There is also evidence that some thinking styles that affect the ability to solve problems are gender-linked. For instance it has been found that females organise and relate data more efficiently than males.

Cognitive barriers: to mastering problem-solving is another important factor. The primary difficulty is the inability to identify and use concepts and procedures in analogous but novel situations.

The lack of transfer of structure: between problems is a significant cognitive difficulty, not only for inexperienced problem-solvers but also for experts. Successful transfer rests on the ability to recognise analogies, but even when given an analogy, students often fail to see how to employ it.

A lack of transfer skills: is frequently marked by functional fixedness, the perception that a particular object or concept has only one use. Another problem is superficial transference, where persons identify and link words or variables between problems instead of linking deeper, more meaningful structures.

4.10 TEACHING AND LEARNING STRATEGIES THAT ENHANCE PROBLEM-SOLVING SKILLS

There are two types of strategies that can overcome difficulties in problem-solving:

Pedagogical strategies, which are teacher-centered methods, and Methodological strategies, which tend to be learner-centered.

4.10.1 Pedagogical Strategies

Some pedagogical strategies allow the teacher to address the emotional, psychological, and cognitive barriers to problem-solving simultaneously. For example, on the first day of class, the teacher could have open discussion about the nature of the course material, etc., and encourage students to voice their fears and concerns about it. This approach helps create a comfortable learning environment. Class discussion also reinforces success and transfer of learned skills.

One effective strategy is that active involvement is critical in developing problem-solving skills, and thus student learning groups can be used to promote active experimentation with problems.

Other effective strategies include accepting multiple attempts of solutions for an assignment. The persons should be asked to record how the problem was solved etc., and then discuss if there are other methods that could be used to solve the problem.

Different learning styles as well as gender-specific differences in thinking can be addressed by employing a variety of activities and approaches in teaching.

The traditional instructional mode of lecturing and explaining is effective for only one learning style.

One might use graphics to illustrate concepts, provide opportunities for practice in class, ask for the persons interpretations of data, etc. could also be used to address the other learning styles.

The five steps usually contained in many solution strategies is IDEAL.

1) Identify the problem.
2) Define and represent the problem.
3) Explore possible solution strategies.
4) Act on the strategies.
5) Look back and evaluate.

This scheme is beneficial in a large number of disciplines.

4.10.2 Promoting Transfer

Other strategies assist persons in transferring problem solving techniques from one problem to very similar or analogous problems.

For successful transfer to occur, it is essential for persons to identify the central theme that is common to a set of problems so they can readily recognise and apply it in more abstract settings.

Through the conscious use of analogy, persons can explore situations which are similar, transferring structure to the problem at hand.

4.10.3 Dialogue

This can also be useful in promoting transfer by highlighting the differences between the problem-solving techniques used by experts and novices. In order to solve a problem, both experts and novices do follow the same pattern, that is, they read and analyse, plan a strategy, act on that strategy to produce a solution, and then try to verify it.

Encouraging people to talk through the differences between problems that have similar superficial structures but different deep structures decreases the risk of incorrect transfer.

Having students work on numerous problems individually and in groups also facilitates transfer.

Choosing problems which evolve from simple and well-defined to complex and ill-defined will help people to develop transfer skills.

To develop better problem-solvers, persons should be helped to overcome both emotional and cognitive barriers to learning effective problem-solving skills.

By first creating a comfortable environment and helping people to overcome their fears and anxieties related to problem-solving, one lays the necessary foundation for successful learning.

Then using an array of pedagogical and methodological strategies, one can promote in the person the ability to reflect on the problem-solving process itself and provide critical tools for and practice in productive problem-solving.

Self Assessment Questions

1) Discuss the other barriers related to the person that affect the problem solving adversely.

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2) What is IDEAL. Elaborate. How do these help in problem solving?

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3) Discuss the pedagogical strategiesin problem solving.

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4) Explain how promoting transfer and dialogue help in problem solving?

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4.11 FUNCTIONAL FIXEDNESS

Functional fixedness discovered by Duncker (1935) refers to the tendency to see objects as having only a single, typical use. A hammer is for pounding nails and other things for instance. We categorise objects based on their functional features as well as their features. Generally the prototypical function dominates the way we think.

Duncker in his experiment led an individual into a room with a table holding several small objects. They included three cardboard boxes filled with candles, tacks and matches, respectively and an ashtray, paper, paper clips, string, pencils, and tinfoil. The individual was instructed to mount the candles at eye level on the wall, ostensibly to prepare the room for a vision experiment. Can you think of a way to put the candles on the wall using these materials?

Duncker found that only 43% of his participants could develop a solution to the problem. He hypothesised that they fixated on the common function of a box, namely, to serve as a container.

To help break their functional fixedness, he repeated the experiment but this time emptied the candles, tacks, and matches on the table, leaving the boxes empty. Under these circumstances, all participants solved the problem by first mounting the boxes on the wall using the tacks, which then served as platforms for the candles.

Here is another example of functional fixedness, called the *coin problem* (Simmel, 1953). Suppose you have eight coins and a balance. One of the coins is a counterfeit coin and therefore lighter than the others. The problem is to find the counterfeit coin by using the balance only twice?

Most people initially think of dividing the coins into two groups of four coins each. One of the groups of four will be lighter and so must contain the counterfeit coin. Then you can take the four coins from that group, and weigh them two against two. Of course, one of the groups of two will be lighter. However, you cannot determine which of the two remaining coins is counterfeit, because you have already used the balance twice.

Before we consider how to approach this problem correctly, let us analyse the previous solution attempt. Why do we initially divide the coins into two groups of four? One reason is that we know that eight things can be evenly divided into two groups of four. One of the functions of the number eight is that it can be so divided.

The fact that 4 + 4 = 8 is a highly available bit of knowledge for us. Because this property of the number eight is so available, it is the first thing we think of. In fact, when people try to solve this problem, they often keep coming back to the four versus four divisions. When the obvious way of using things keeps us from seeing the correct way of using them, then we are functionally fixed.

In Simmel's coin problem, the solution is often very difficult to see. You need to divide the coins in a way that is far from obvious at first. Suppose you divide them into three groups of three, three and two coins. Then weigh three versus three. If they balance, then the counterfeit coin must be in 'the group of two coins. Your second weighing, then, is to take the group of two coins, and weigh one versus one. Alternatively, suppose on your first weighing one group of three coins is lighter: Then on your second weighing, take any two of the three coins and weigh one against the other. If they balance, then the third (unweighed) coin must be the counterfeit one. If they do not balance, then lighter one is counterfeit. This procedure is guaranteed to find the solution. However, it is much more complex and unfamiliar than the wrong procedure.

Thus, finding solutions to problems may require you to overcome functional fixedness. It may only be after you have realised that the obvious ways of tackling a problem do not work that you will be open to a reorganisation of the problem that will allow you to see the solution.

4.12 USING INCOMPLETE OR INCORRECT REPRESENTATIONS

A related difficulty in problem solving has to do with initial interpretation of the problem. If the information is misunderstood, or if the wrong information is provided/ focused upon, the solver is at a disadvantage. This can be illustrated by a problem from Perkins (1981):

"There is a man at home. That man is wearing a mask. There is a man coming a home. What's happening?"

Most of the people start to go wrong in making assumptions about the home in situation. Many equate home with house, although the answer is baseball game. Perkins (1981) argue that assumptions people make in interpreting the problem are a kind of mental set and that this mental set hinders problem solving.

In terms of representation, representing the problem in terms of a person sitting in a house would lead you down the wrong path. It would be a case of using an incorrect representation, that is one that included information not presented in the problem and not correct.

The choice of representation can often make a great difference. Schwartz (1971), studying problems such as this one found that people who constructed charts and flow charts were successful in solving the problems than people who merely wrote down available facts.

Here's another example of a case where representation can make a problem either very easy or very hard. It is called the numbers game and the objective of each player is to choose from the set of digits enough to make an exact total of fifteen from three digits.

Two players are given a sheet of numbers, 1 2 3 4 5 6 7 8 9.

They take turns crossing one of the digits off the list and adding it to their own list.

The first player to have three digits totaling 15 (for example 4, 5, 6; or 1, 6, 8) wins.

If you were to play this game, what would your problem solving strategy be? What if you played first, which digits would you choose? What if you played second and your opponent had first chosen a five?

The first time or two if you play this game, you might find it surprisingly challenging. Now look at the figure below and notice how this problem can be represented alternatively:

6	7	2
1	5	9
8	3	4

Notice that, depicted this way, the difficult numbers game is actually the game of tic tac toe in disguise. Represented this way the game is easy but without this representation the problem is much harder to solve.

Self Assessment Questions

1) What is Functional Fixedness? Explain mental set in problem solving.

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2) Present Duncker's experiment.

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3) How does coin problem demionstrate functional fixedness?

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4) What is meant by incomplete or incorrect represtnations? How do these affect problem solving? Give suitable examples

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4.13 LACK OF PROBLEM SPECIFIC KNOWLEDGE OR EXPERTISE

Until now we have been discussing general problem solving abilities with problems that have a puzzle like character. The assumption is that most of these problems are about equally unfamiliar to everyone and that people basically go about solving them in the same way. Other kinds of problems – for example,

those in chess or others killed games; textbook problems in physics, geometry, or electronic; computer programming and problems in diagnoses and management of health problems – seem to be different kind from the puzzles we have been talking about. In particular, experts and novices approach most such problems differently (Chi, Glaser & Farr, 1988).

Familiarity with a domain of knowledge seems to change the way one solves problems within a frame of reference. A good example is to compare the ability to of undergraduate psychology students from their professors in designing experiments.

A classic study of expert novice differences was carried out by de Groot (1965). He examined the thinking process of both chess masters and weaker players considered about the same number of possibilities but somehow chose the best move more easily. Chase and Simon (1973), in a replication study, found that the more expertise a chess player had, the more information he extracted even from brief exposures to chess boards set up to reflect ongoing chess games. That is, when a chess master and chess beginner are both shown a chess board for five seconds, the chess master will remember more about where the pieces were placed, but only if the pieces are configured to depict a chess game.

In problem solving, experts see and represent a problem in their domain at a deeper and more principled level than do novices, who tend to represent information superficially (Chi, Feltovich, & Glaser 1981). For example, when solving physics problems experts tend to organise the problems in terms of physics principles like Newton's first law of motion; novices instead tend to focus on the objects mentioned in the problem, such as an inclined plane or a frictionless surface. Experts tend to spend proportionately more time qualitatively analysing the problem, trying to grasp or understand it; relative to novices who are more likely to plunge in and start looking at solutions. Finally, throughout the process of problem solving, experts are more likely to check for errors in their thinking.

Expertise by itself is not always enough for problem solving other factors like medical status, mental status and other related aspects can also affect problem solving abilities (Goel & Grafman, 2000).

4.14 LET US SUM UP

As discussed in earlier chapters problem solving involves both domain specific and general strategies that people may use and may be attained through various techniques. However, most of us often come across many situations when our attempts at problem solving fail. This is largely because there are numerous factors that are influential impediments to problem solving. Einstellung (or set or mental set) and functional fixedness are classic obstacles to both proper representation and search identified by the gestalt psychologists. Einstellung is the tendency to set the mind into a routine approach to problem solving. Functional fixedness refers to the tendency to see objects as having only a single, typical use. Researchers have also talked about the novice versus expert differences in problem solving.

4.15 UNIT END QUESTIONS

1) What is a mental set? Think of the few problem situations where you think your mental set hampered effective problem solving.
2) Describe some novice expert differences in problem solving.
3) Critically evaluate the concept of functional fixedness.
4) Compare and contrast with the help of examples the concept of Einstellung with the concept of functional fixedness.
5) How does lack of problem specific knowledge or experience affect problem solving?

4.16 SUGGESTED READINGS

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