PROBLEM SOLVING, JUDGEMENT AND DECISION-MAKING

Problem solving is the act of defining a problem; determining the cause of the problem; identifying, prioritizing, and selecting alternatives for a solution; and implementing a solution. People face problems every day—usually, multiple problems throughout the day. Sometimes these problems are straightforward: To double a recipe for pizza dough, for example, all that is required is that each ingredient in the recipe be doubled. Sometimes, however, the problems we encounter are more complex.

In order to effectively manage and run a successful organization, leadership must guide their employees and develop problem-solving techniques. Finding a suitable solution for issues can be accomplished by following the basic four-step problem-solving process and methodology outlined below.

1. Define the problem

Diagnose the situation so that your focus is on the problem, not just its symptoms. Helpful problem-solving techniques include using flowcharts to identify the expected steps of a process and cause-and-effect diagrams to define and analyze root causes.

The sections below help explain key problem-solving steps. These steps support the involvement of interested parties, the use of factual information, comparison of expectations to reality, and a focus on root causes of a problem. You should begin by:

- Reviewing and documenting how processes currently work (i.e., who does what, with what information, using what tools, communicating with what organizations and individuals, in what time frame, using what format).
- Evaluating the possible impact of new tools and revised policies in the development of your "what should be" model.

2. Generate alternative solutions

Postpone the selection of one solution until several problem-solving alternatives have been proposed. Considering multiple alternatives can significantly enhance the value of your ideal solution. Once you have decided on the "what should be" model, this target standard becomes the basis for developing a road map for investigating alternatives. Brainstorming and team problem-solving techniques are both useful tools in this stage of problem solving.

Many alternative solutions to the problem should be generated before final evaluation. A common mistake in problem solving is that alternatives are evaluated as they are proposed, so the first acceptable solution is chosen, even if it’s not the best fit. If we focus on trying to get the results we want, we miss the potential for learning something new that will allow for real improvement in the problem-solving process.

3. Evaluate and select an alternative

Skilled problem solvers use a series of considerations when selecting the best alternative. They consider the extent to which:

- A particular alternative will solve the problem without causing other unanticipated problems.
- All the individuals involved will accept the alternative.
- Implementation of the alternative is likely.
- The alternative fits within the organizational constraints.

4. Implement and follow up on the solution

Leaders may be called upon to direct others to implement the solution, "sell" the solution, or facilitate the implementation with the help of others. Involving others in the implementation is an effective way to gain buy-in and support and minimize resistance to subsequent changes.

Regardless of how the solution is rolled out, feedback channels should be built into the implementation. This allows for continuous monitoring and testing of actual events against expectations. Problem solving, and the techniques used to gain clarity, are most effective if the solution remains in place and is updated to respond to future changes.

APPROACHES TO THE STUDY OF PROBLEM SOLVING

A problem-solving strategy is a plan of action used to find a solution. Different strategies have different action plans associated with them. For example, a well-known strategy is trial and error. The old adage, “If at first you don’t succeed, try, try again” describes trial and error. In terms of your broken printer, you could try checking the ink levels, and if that doesn’t work, you could check to make sure the paper tray isn’t jammed. Or maybe the printer isn’t actually connected to your laptop. When using trial and error, you would continue to try different solutions until you solved your problem. Although trial and error is not typically one of the most time-efficient strategies, it is a commonly used one.

Another type of strategy is an algorithm. An algorithm is a problem-solving formula that provides you with step-by-step instructions used to achieve a desired outcome (Kahneman, 2011). You can think of an algorithm as a recipe with highly detailed instructions that produce the same result every time they are performed. Algorithms are used frequently in our everyday lives, especially in computer science. When you run a search on the Internet, search engines like Google use algorithms to decide which entries will appear first in your list of results. Facebook also uses algorithms to decide which posts to display on your newsfeed. Can you identify other situations in which algorithms are used?

A heuristic is another type of problem solving strategy. While an algorithm must be followed exactly to produce a correct result, a heuristic is a general problem-solving framework (Tversky & Kahneman, 1974). You can think of these as mental shortcuts that are used to solve problems. A "rule of thumb" is an example of a heuristic. Such a rule saves the person time and energy when making a decision, but despite its time-saving characteristics, it is not always the best method for making a rational decision. Different types of heuristics are used in different types of situations, but the impulse to use a heuristic occurs when one of five conditions is met (Pratkanis, 1989):

- When one is faced with too much information
- When the time to make a decision is limited
- When the decision to be made is unimportant
- When there is access to very little information to use in making the decision
- When an appropriate heuristic happens to come to mind in the same moment

Working backwards is a useful heuristic in which you begin solving the problem by focusing on the end result. Consider this example: You live in Washington, D.C. and have been invited to a wedding at 4 PM on Saturday in Philadelphia. Knowing that Interstate 95 tends to back up any day of the week, you need to plan your route and time your departure accordingly. If you want to be at the wedding service by 3:30 PM, and it takes 2.5 hours to get to Philadelphia without traffic, what time should you leave your house? You use the working backwards heuristic to plan the events of your day on a regular basis, probably without even thinking about it.

Another useful heuristic is the practice of accomplishing a large goal or task by breaking it into a series of smaller steps. Students often use this common method to complete a large research project or long essay for school. For example, students typically brainstorm, develop a thesis or main topic, research the chosen topic, organize their information into an outline, write a rough draft, revise and edit the rough draft, develop a final draft, organize the references list, and proofread their work before turning in the project. The large task becomes less overwhelming when it is broken down into a series of small steps.

Other Strategies

There are many other ways of solving a problem. The most effective depends on the type of problem and the resources at hand.

- Abstraction: solving the problem in a model of the system before applying it to the real system.
- Analogy: using a solution for a similar problem.

- Brainstorming: suggesting a large number of solutions and developing them until the best is found.
- Divide and conquer: breaking down a large, complex problem into smaller, solvable problems.
- Hypothesis testing: assuming a possible explanation to the problem and trying to prove (or, in some contexts, disprove) the assumption.
- Lateral thinking: approaching solutions indirectly and creatively.
- Means-ends analysis: choosing an action at each step to move closer to the goal.
- Morphological analysis: assessing the output and interactions of an entire system.
- Proof: try to prove that the problem cannot be solved. The point where the proof fails will be the starting point for solving it.
- Reduction: transforming the problem into another problem for which solutions exist.
- Root-cause analysis: identifying the cause of a problem.
- Trial and error: testing possible solutions until the right one is found.

PROBLEM REPRESENTATION AND PROBLME SOLUTION

According to the cognitive psychologist Mayer (1992) the process of solving problems has two steps, problem representation and problem solution. For problem representation, a learner needs to transform a problem's description to his or her internal mental representation in two stages: problem translation and integration. Problem translation extracts concepts from the textual description of the problem by using linguistic and semantic knowledge. Linguistic knowledge is used to comprehend the words' meanings in the textual description, while semantic knowledge means factual knowledge in the world. Problem integration requires a learner to connect sentences in a problems' description and produce a coherent representation. At this stage, schematic knowledge of problem classification is needed to integrate the pieces of information provided by the problem. Moreover, schematic knowledge allows a learner to determine the category of a problem. After the problem's description is translated into the learner's internal mental representation (mental model), it means that the learner has already comprehended the problem.

Bodner and Domin (2000) suggest that an essential component of an individual's problem solving behaviour is the construction of a mental representation (mental model) of the problem that can contain elements of more than one representation system. The first representation establishes a context for understanding the statement of the problem. In some cases, this representation contains enough information to both provide a context for the

problem and to generate a solution to the problem. In other cases, additional representations may be needed. According to Slotta, Chi, and Joram (1995), problem solvers set up some initial representation based on key words in the problem statement. The information is often closely tied to real, familiar objects which in the case of the chemistry problems are images of laboratory apparatus or procedures. This representation is not linguistic but based on the individual's experience with, and knowledge about, the world. Bodner and Domin (2000) also found that successful problem solvers construct significantly more representations while solving a problem than those who are not successful. Unsuccessful problem solvers seem to construct initial representations that active an inappropriate schema (also referred to as frames or scripts, relate to one's knowledge about science) for the problem.

One of the most influential theories to be formulated in cognitive psychology in recent years is Johnson-Laird's (1983; 2000) theory of mental models. The theory seeks to provide a general explanation of human thought; at its core is the assertion that humans represent the world they are interacting with through mental models. In order to understand a real-world phenomenon a person has to hold, what Johnson-Laird describes as, a working model of the phenomenon in his or her mind. Johnson-Laird has formulated his mental model definition in his attempt to explain the reasoning processes in tasks of syllogisms and language comprehension. The author proposes that reasoning about a problem is facilitated if a person utilises a mental model that represents the relevant information in an appropriate fashion for the problem to be solved.

This theory is based on three main assumptions (Johnson-Laird, 2000).

• Each mental model represents a possibility. Models can represent relationships among three-dimensional entities or abstract entities; they can be static or kinematic. They underlie visual images, though many components of models are not visualizable.

• A mental model is iconic, that is, its parts correspond to the parts of what represents, and its structure corresponds to the structure of the possibility. The iconic nature of the model yields a conclusion over and above the propositions used in constructing the model.

• Mental models represents what is true according to the premises, but by default not what is false.

Ferguson-Hessler and de Jong (1990) distinguished four major types of knowledge for the content of an adequate knowledge base with regard to its importance for problem solving.

- Situational knowledge is knowledge about situations as they typically appear in a particular domain. Knowledge of problem situations enables the solver to sift relevant features out of the problem statement.

- Declarative knowledge, also called conceptual knowledge, is static knowledge about facts and principles that apply within a certain domain.
- Procedural knowledge is a type of knowledge that contains actions or manipulations that are valid within a domain. Procedural knowledge exists alongside declarative knowledge in the memory of problem solvers.
- Strategic knowledge helps the student to organize the problem-solving process by showing the student which stages he should go through in order to reach a solution.

External representations to facilitate problem solving

- Using external representations through symbols and objects to illustrate a learner's knowledge and the structure of that knowledge can facilitate complex cognitive processing during problem-solving (Vekiri, 2002). Such external representations can help a learner elaborate the problem statement, transform its ambiguous status to an explicit condition, constrain unnecessary cognitive work, and create possible solutions (Scaife & Rogers, 1996). Larkin (1989) argued that an external representation supports human problem-solving by reducing the complexity of problem and its associated mental workload. Moreover, Bauer and Johnson-Laird (1993) showed that diagrams helped learners solve a problem more effectively and efficiently.
- Learners have a limited working memory, and instructional representations should be designed with the goal of reducing unnecessary cognitive load. However, prior knowledge can determine the ease with which learners can perceive and interpret visual representations in working memory (Cook, 2006). Three issues developed from using multiple representations in problem solving: how students use multiple representations when solving problems, how different representational formats affect student performance in problem solving, and how the utilization of representational learning strategies can lead to substantial improvements in problem-solving.

INSIGHT AND CREATIVITY

Insight, often referred to as an "aha moment," has been defined as a sudden, conscious change in a person's representation of a stimulus, situation, event, or problem. Insight is not a sudden flash that comes from nowhere, but in fact is the result of the unconscious mind piecing together loosely connected bits of information stemming from prior knowledge and experiences and forming novel associations among them. Insight has been defined as any sudden comprehension, realization, or problem solution that involves a reorganization of the elements of a person's mental representation of a stimulus, situation,

or event to yield a nonobvious or nondominant interpretation. Insights may appear suddenly, but are preceded by incremental unconscious processing.

Insight, commonly referred to as an “aha moment,” has been defined as a sudden, conscious change in a person’s representation of a stimulus, situation, event, or problem [1]. It should be noted that insights, while they do suddenly merge into one’s stream of consciousness, are proceeded by unconscious processing to arrive at the insight. This is in contrast to analytical problem solving which involves the use of a systematic process or simply logical reasoning to arrive at a solution to a problem. It is deliberate and conscious, and often involves the use of some type of strategy which allow the individual to progress incrementally toward a solution. Because this type of methodology involves storing and manipulating information in the prefrontal cortex utilizing the individuals working memory capacity, individuals can typically fully explain the steps taken to arrive at the solution [2], whereas with insight, individuals cannot readily reconstruct the procedure followed to reach the solution.

Creativity, however, involves many cognitive processes, occurring in many regions of the brain and thus cannot be laterally localized as insight can. Thus, creativity is not considered synonymous with insight; however, insight can certainly result in creative solutions during creative problem solving.

One of the most enduring theories of creativity is the Wallas model of creativity. It begins with a preparation stage where the individual properly identifies and defines the problem, and then proceeds to gather information necessary to solve the problem. Next comes incubation which involves taking some time away from a problem to allow the unconscious mind to process the information to produce a solution. This is the state where information is assimilated, and remote associations are thought to be formed.

The third stage in the Wallas model is illumination, or more commonly referred to as insight because it results in the familiar Aha! experience. During this stage, a solution suddenly emerges into consciousness, light a lightbulb being turned on.

The final stage was verification. At that point, the individual tests the idea or applies the solution. Although the four stages of the creative process included in the Wallas model are generally accepted to be accurate.

RELATIONSHIP BETWEEN INSIGHT AND CREATIVITY

Whether insight is a component of creativity (or a component of the creative process), simply a form of problem solving that may or may not produce a creative solution to a given problem or something else entirely is as yet unanswered. Sternberg and Davidson

conceptualized creativity as the ability to change existing thinking patterns, producing something that is useful, novel and generative. One cannot help but notice similarities between this conception of creativity and the generally accepted definition of insight, namely "a reorganization of the elements of a person's mental representation of a stimulus, situation or event to yield a nonobvious or nondominant interpretation".

We know from experience that insight is not always involved in creative problem solving and therefore must not be a necessary component of it. Creative solutions can also arise through a conscious, deliberate analysis of the problem.

For each problem, the solution is a single word that can form a compound word or phrase for each of the words (e.g., "mind" or "piece" could both work with game, but neither works for all 3; the actual solution is at the bottom of this page). Sometimes people solve these with insight (Aha!) and sometimes through straightforward solving methods.

COMPLEX THINKING:

Complex thinking refers to the ability to interconnect different dimensions of reality. Complex thinking processes often involve content that is abstract or complex.

A separate set of mental processes facilitates your ability to do complex, sophisticated thinking, such as understanding concepts, generating original ideas, and using logical approaches to address complicated problems. Complex thinking includes many key abilities that are important to success in today's world.

People with strengths in complex thinking may be good at deeply understanding ideas and concepts, seeing connections among information from different sources, demonstrating imagination, constructing and defending arguments based on facts or evidence, taking risks with new ideas, and/or drawing inferences from limited information.

REASONING:

Reason is the capacity of consciously making sense of things, applying logic, and adapting or justifying practices, institutions, and beliefs based on new or existing information. Reasoning is associated with the acts of thinking and cognition, and involves using one's intellect. Reasoning may be subdivided into forms of logical reasoning, such as: deductive reasoning, inductive reasoning, and abductive reasoning.

Types of Reasoning: The two major types of reasoning, deductive and inductive, refer to the process by which someone creates a conclusion as well as how they believe their conclusion to be true.

Deductive reasoning requires one to start with a few general ideas, called premises, and apply them to a specific situation. Recognized rules, laws, theories, and other widely accepted truths

are used to prove that a conclusion is right. The concept of deductive reasoning is often expressed visually using a funnel that narrows a general idea into a specific conclusion. In practice, the most basic form of deductive reasoning is the syllogism, where two premises that share some idea support a conclusion. It may be easier to think of syllogisms as the following theorem: If A=B and C=A, then B=C. Deductive reasoning is meant to demonstrate that the conclusion is absolutely true based on the logic of the premises.

Inductive reasoning uses a set of specific observations to reach an overarching conclusion; it is the opposite of deductive reasoning. So, a few particular premises create a pattern which gives way to a broad idea that is likely true. This is commonly shown using an inverted funnel (or a pyramid) that starts at the narrow premises and expands into a wider conclusion. There is no equivalent to a syllogism in inductive reasoning, meaning there is no basic standard format. All forms of inductive reasoning, though, are based on finding a conclusion that is most likely to fit the premises and is used when making predictions, creating generalizations, and analyzing cause and effect. Just as deductive arguments are meant to prove a conclusion, inductive arguments are meant to predict a conclusion. They do not create a definite answer for their premises, but they try to show that the conclusion is the most probable one given the premises.

JUDGEMENT:

Judgment is formed by analysis of the intuitive whole. A judgment or decision making (JDM) task is characterized either by uncertainty of information or outcome, or by a concern for a person's preferences, or both. Unlike other tasks, there may exist no criterion for determining whether a single choice or judgment is correct, since the response is based in part on personal opinions or preferences. It is possible, however, to impose a mathematical or logical structure on the task that defines the consistency of a set of responses.

HEURISTICS:

A heuristic is a mental shortcut that allows an individual to make a decision, pass judgment, or solve a problem quickly and with minimal mental effort. While heuristics can reduce the burden of decision-making and free up limited cognitive resources, they can also be costly when they lead individuals to miss critical information or act on unjust biases. A heuristic is a mental shortcut that allows people to solve problems and make judgments quickly and efficiently. These rule-of-thumb strategies shorten decision-making time and allow people to function without constantly stopping to think about their next course of action. Heuristics are helpful in many situations, but they can also lead to cognitive biases.

Heuristics play important roles in both problem-solving and decision-making. When we are trying to solve a problem or make a decision, we often turn to these mental shortcuts when we need a quick solution.

Types of Heuristics

Some common heuristics include the availability heuristic and the representativeness heuristic.

Availability

The availability heuristic involves making decisions based upon how easy it is to bring something to mind. When you are trying to make a decision, you might quickly remember a number of relevant examples. Since these are more readily available in your memory, you will likely judge these outcomes as being more common or frequently-occurring.

For example, if you are thinking of flying and suddenly think of a number of recent airline accidents, you might feel like air travel is too dangerous and decide to travel by car instead. Because those examples of air disasters came to mind so easily, the availability heuristic leads you to think that plane crashes are more common than they really are. The availability heuristic describes the mental shortcut in which someone estimates whether something is likely to occur based on how readily examples come to mind.

Representative

People who make use of the representativeness heuristic categorize objects (or other people) based on how similar they are to known entities—assuming someone described as "quiet" is more likely to be a librarian than a politician, for instance. The representativeness heuristic involves making a decision by comparing the present situation to the most representative mental prototype. When you are trying to decide if someone is trustworthy, you might compare aspects of the individual to other mental examples you hold. A sweet older woman might remind you of your grandmother, so you might immediately assume that she is kind, gentle and trustworthy.

If you meet someone who is into yoga, spiritual healing and aromatherapy you might immediately assume that she works as a holistic healer rather than something like a school teacher or nurse. Because her traits match up to your mental prototype of a holistic healer, the representativeness heuristic causes you to classify her as more likely to work in that profession.

Affect

The affect heuristic involves making choices that are influenced by the emotions that an individual is experiencing at that moment. For example, research has shown that people are more likely to see decisions as having benefits and lower risks when they are in a positive

mood. Negative emotions, on the other hand, lead people to focus on the potential downsides of a decision rather than the possible benefits.

ANCHORING AND ADJUSTMENT HEURISTICS

The anchoring heuristic, or anchoring bias, occurs when someone relies more heavily on the first piece of information learned when making a choice, even if it's not the most relevant. The anchoring and adjustment heuristic allows people to estimate a number by starting at an initial value (the "anchor") and adjusting that value up or down.

DECISION MAKING

Decision-making is regarded as the cognitive process resulting in the selection of a belief or a course of action among several possible alternative options, it could be either rational or irrational. Decision-making process is a reasoning process based on assumptions of values, preferences and beliefs of the decision-maker. Decision-making can be regarded as a problem-solving activity yielding a solution deemed to be optimal, or at least satisfactory. It is therefore a process which can be more or less rational or irrational and can be based on explicit or tacit knowledge and beliefs.

A major part of decision-making involves the analysis of a finite set of alternatives described in terms of evaluative criteria. Then the task might be to rank these alternatives in terms of how attractive they are to the decision-maker(s) when all the criteria are considered simultaneously. Another task might be to find the best alternative or to determine the relative total priority of each alternative (for instance, if alternatives represent projects competing for funds) when all the criteria are considered simultaneously.

Characteristics of decision-making

- Objectives must first be established
- Objectives must be classified and placed in order of importance
- Alternative actions must be developed
- The alternatives must be evaluated against all the objectives
- The alternative that is able to achieve all the objectives is the tentative decision
- The tentative decision is evaluated for more possible consequences
- The decisive actions are taken, and additional actions are taken to prevent any adverse consequences from becoming problems and starting both systems (problem analysis and decision-making) all over again
- There are steps that are generally followed that result in a decision model that can be used to determine an optimal production plan

Stages in Decision Making:

1. Deliberation:

The first stage of decision making process starts from the point at which deliberation begins. In this stage different aspects of the problem and the pros and cons of the possible alternatives are examined in proper prospective.

2. Act of making a choice:

While making a choice between different alternative, certain alternatives which do not have much relevance may be omitted from the list of possible alternatives, so that it becomes easy to take a decision from a few alternative.

3. Final choice:

After examining all aspects, finally a decision is arrived at, which is considered right, helpful, practicable and profitable in the present situation.

4. Post decision period:

The post decision period includes the psychological consequences of making a choice, the relationship between decision making and the major sources of conflict and modes of conflict resolution at each stage of the decision sequence.

NORMATIVE AND DESCRIPTIVE APPROACHES TO DECISION-MAKING

The two branches of decision theory typify the unending juxtaposition of the rational versus the irrational. *Normative* decision theory models the most ideal decision for a given situation. In normative theory, an actor is assumed to be fully *rational*. Normative decisions always try to find the highest expected value outcome. A fully rational actor is capable of arriving at the highest expected value with perfect accuracy. This is an ideal not often found in the real world. Practical application of normative theory is thus aimed more at creating methodologies and software. Normative decision theory is concerned with identification of optimal decisions where optimality is often determined by considering an ideal decision maker who is able to calculate with perfect accuracy and is in some sense fully rational. The practical application of this prescriptive approach (how people *ought to* make decisions) is called decision analysis and is aimed at finding tools, methodologies, and software (decision support systems) to help people make better decisions. Normative decision theory is much more formalized than descriptive theory.

In contrast, positive or descriptive decision theory is concerned with describing observed behaviors often under the assumption that the decision-making agents are behaving under some consistent rules. These rules may, for instance, have a procedural framework. D*escriptive* decision theory is more about what *will* occur in a situation, not what should. Descriptive decision theory takes into consideration outside factors that influence an

actor's decisions toward less optimal, less rational ends. Descriptive decision theory is concerned with characterising and explaining regularities in the choices that people are disposed to make. It is standardly distinguished from a parallel enterprise, normative decision theory, which seeks to provide an account of the choices that people *ought* to be disposed to make. Descriptive decision theory purports to describe how people actually make decisions in a variety of situations.

A simple way of distinguishing between these modes of decision making is: Descriptive: What people actually do, or have done. Prescriptive: What people should and can do. Normative: What people should do (in theory).