

# Scientific Thinking



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# Chapter 1

## Introduction to Scientific Thinking

- Man is distinguished from the other living things by his ability to think this ability enabled him to build various and many of civilizations over the time helped him to meet a lot of his needs consisting with the surrounding environment.
- In addition, this ability helped him to change his life according to exigent condition. So we can say that thinking is an important human feature and is necessary to every citizen in our modern world.

### Definition of Science:-

- Science is an intellectual activity during which occur observation, description, experimentation, and explanation of natural phenomena.

### Types of Thinking:-

There are division of types of thinking as following :

- 1) Unscientific Thinking
- 2) Scientific Thinking

## Unscientific Thinking

1. Superstitious Thinking
2. Fictional
3. Thinking with other minds
4. Thinking with trial and error
5. Thinking depending on individual experience .

## Scientific Thinking

- 1) Reflective Thinking
- 2) Reasoning Thinking
- 3) Rational Thinking
- 4) Critical Thinking
- 5) Metaphysic Thinking
- 6) Mathematical Thinking
- 7) Creative Thinking
- 8) Visual Thinking Network
- 9) Systemic Thinking
- 10) Lateral Thinking

### Scientific Thinking:-

We will explain some of scientific thinking such as :- •

Mathematical Thinking- Creative Thinking

Some ways and models to develop thinking and the most important of the person practicing scientific affective and intellectual features thinking.

### Definition of the Scientific Thinking:-

“Scientific Thinking is an unlimited or simple intellectual activity which express about intellectual process but it is a complicated intellectual activity in it’s form and it has specific characteristic and feature” .

- So some scientists define it as “ A mental activity used by person when faces a certain problem.”

So this person behaves positively using a specific approach depending on a group of successive steps to solve this problem.

This means that Scientific thinking is the mental activity process depending on mind and proof to understand and explain phenomena to solve problems and this process depends on observation, induction and inference.

## **Characteristic of the Scientific Thinking :-**

- Scientific Thinking has some characteristic which distinguish it from other types of thinking Scientific Thinking is :-

### **1) A human process**

this kind of thinking is a human one and affects the human curiosity and it tends to search for material reasons of the universal phenomena in persuasive ways .

### **2) An Objective Process:**

Scientific Thinking aims to solve problems which face man and also it tends to study and understand the different phenomena to know its theories and laws

### **3) An Organized Process:**

This thinking is an organized activity occurred according to specific steps where every step completes the other irrespective of the matter thinking .

### **4) An integrated Process**

This thinking takes the situation as whole to its elements and aspects and study all possibilities and conditions that may affect the situation , this thinking is characterized with accuracy and knowledge comprehension

### **5) A flexible Process**

This means that this thinking is not limited to one way of thinking , because it's result can be revised and modified.

### **6) A creative Process:**

Because it is occurred without a serial of steps “hierarchy steps” but this process has a creative feature which plays an important role in this process.

## **The Aim of scientific Thinking**

1. Description
2. Interpretation
3. Prediction
4. Control
5. Getting a new Knowledge
6. Applying scientific Laws

### **1- Description**

- This means that we record what we observe as facts , things, and phenomena and relations among each other .
- Description depends on mainly on sensory realization, notice or observation and experiment more than depends on the highly thinking process as analysis , synthesis and evaluation

### **2- Interpretation :-**

We try to know the reasons of accidents and phenomena , so interpretation depends on highly thinking processes as analysis and synthesis and evaluation.

### **3- Prediction:-**

is to expect what will happen in the future in the light of the last information that we reached and called it as scientific theories.

### **4- Control:-**

Means knowing the conditions and circumstances of a certain phenomena it may “preventing phenomena from being occurred by preventing its conditions , it may mean control the natural forces to serve man.

### **5- Getting a new Knowledge**

### **6- Applying scientific Laws:-**

Laws and theories to get useful tools and equipment.

## **Basic Scientific Thinking Processes**

### **Definition :-**

These processes are intellectual ones performed by man to discover the universe, so we can do experiments and explain data as well as formulating theories and laws objectively .

This means that the basic processes of the scientific thinking are methods and techniques which one uses to solve his scientific problem and access to information .

These process are summarized as following :-

- 1- Observation
- 2- Experimenting
- 3- Classification
- 4- Measuring
- 5- Analysis
- 6- Synthesis
- 7- interpreting data
- 8- Formulating hypothesis
- 9- using Numbers
- 10- using space and time



11- inference

12- prediction

### **1) Observation**

Individual uses all his senses and tools to check things or incidents or phenomena and record them accurately.

#### **What are skills of observing?**

- 1) Recognizing the features of phenomenon or thing by using senses.
- 2) Formulating notices in a quantitatively way.
- 3) Differentiating between observing and inference.
- 4) Knowing the difference among similar things.

### **2) Experimenting**

Means testing a certain phenomenon or some phenomena to be observed accurately or test a specific result or a specific hypothesis

#### **Scientific Hypothesis:-**

- A suggested solution for a specific problem through examining or testing many alternatives.
- **Conditions to form a scientific hypothesis:-**
  1. It should be built on observations and experiments.
  2. It should be accurate and clear
  3. It should not be in consistent (opposite) with any natural law.
  4. It should be able to explain all phenomena to whom it was supposed.
  5. These hypothesis should be limited in number.

### **3) Classification**

It is a process in which we classify things or incidents into groups according to specific features.

#### 4) Measuring

A process in which we use measuring tools to estimate a certain characteristics in a quantitative way as measure area , volumes, temperature or speed

#### 5) Analysis

It is a process in which we move from complex to simple or from result to reasons. This analysis may be physical or intellectual .

- Physical Analysis :-

Is decomposing the complex to it's simple elements. For example :- the chemist analyzes water into oxygen and hydrogen.

- Intellectual Analysis:-

Is used in math's so mathematician analyzes quantity

$(x^4 - 16)$  into  $(x^2 + 4)(x^2 - 4)$  and analyzes the quantity  
 $(x^2 - 4)$  into  $(x-2)(x+2)$

#### 6) Synthesis

Is the opposite of analysis and it is moving from simple to complex or from reasons to results

Synthesis may be physical or intellectual .

The chemistry scientist may recompose water by exposing oxygen and hydrogen to fire , this is the physical synthesis.

#### 7) Interpreting Data

Where we reach and get some data which explain a certain problem .

#### 8) Formulating hypothesis

#### 9) Using Numbers

It's process where we use mathematical equation to solve scientific problems.

**10) Using space and time relations:**

It is a process which develops the skills of description of space relations and how change with time.as define the volocity of something moving-make chart to tridimensional figures.

**11) Inference**

Formulating some result from given information and data

**12)Prediction**

It's expecting what will happen in the future in the light of the previous information that we perceived and expressed them as scientific theories.

## Chapter 2

# Mathematical Thinking

Math is an abstract science made by human mind , and this science depends on written equations in a symbolic delicate language. These equations may be converted to each according to specific rules.

### Definition of Mathematical Thinking :-

Mathematical Thinking is an intellectual activity performed in an organized and flexible way to solve the mathematical problems.

### Components of Mathematical Thinking :-

#### 1- Induction

A process of thought that uses known facts to produce general rule(result, theory, law) and reach a mutual characteristic

#### Example:-

Producing a divisible number by 2,5,10 by knowing the unit numbers in “16, 24,38,20,12” or analyzing quantity( $X^m-1$ ) by analyzing some familiar quantities such as  $(X^4-1)$ ,  $(X^3-1)$ ,  $(X^2-1)$ .

Induction includes the following skills :-

1. Concluding a general rule from conditions.
2. Producing results from the given information.
3. Getting the right inferences
4. Discovering the relations among the general rule and special circumstances.
5. Discovering the existing relations among the parts of problem.
6. Discovering relations among the given information.

Example:-

Use induction to prove that  $1 + 2 + 3 + \dots + n = \frac{n(n+1)}{2}$   
where  $n$  is any natural number.

**Solution:**

Considering  $n = 1$ , we get the statement  $1 = 1$ , which is true.

Assuming  $n = k$ , the statement can be written as  $1 + 2 + 3 + \dots + k = \frac{k(k+1)}{2}$  is true.

Now, considering  $n = k + 1$ , we get

$$\begin{aligned} & 1 + 2 + 3 + \dots + (k + 1) \\ &= 1 + 2 + 3 + \dots + k + (k + 1) \\ &= \frac{k(k+1)}{2} + (k + 1) \\ &= \frac{k(k+1) + 2(k+1)}{2} \\ &= \frac{(k+1)(k+2)}{2} \\ &= \frac{(k+1)[(k+1) + 1]}{2}, \text{ which proves that the given statement is} \\ & \text{true for } n = k + 1 \end{aligned}$$

Thus,  $1 + 2 + 3 + \dots + n = \frac{n(n+1)}{2}$ , where  $n$  is any natural number.

Example :-

**Prove that  $(xy)^n = x^n y^n$  is true for every natural number  $n$  using mathematical induction.**

**Solution:**

Considering  $n = 1$ , we get the given statement  $(xy)^1 = xy = x^1y^1$ , true

Assuming  $n = k$ , the statement  $(xy)^k = x^ky^k$  is true.

Now, considering  $n = k + 1$ , we get

$$\begin{aligned} (xy)^{k+1} &= (xy)(xy)^k \\ &= (xy)(x^ky^k) \\ &= (x^kx)(y^ky) \\ &= x^{k+1}y^{k+1}, \text{ which proves that the given statement is true for } n = k + \end{aligned}$$

1

Thus,  $(xy)^n = x^ny^n$  is true for every natural number 'n.'

Example :

**Using Mathematical Induction, prove the given statement: For any natural number  $n$ ,  $2^{2n} - 1$  is divisible by 3.**

**Solution:**

Considering  $n = 1$ , we get,

$$2^{2(1)} - 1 = 2^2 - 1 = 4 - 1 = 3, \text{ divisible by 3}$$

Thus, the given statement is true for  $n = 1$ .

Assuming  $n = k$ , the statement  $2^{2k} - 1$  is divisible by 3

It means  $2^{2k} - 1 = 3p$ , where  $p$  is a natural number.

Now, considering  $n = k + 1$ , we get

$$\begin{aligned} 2^{2(k+1)} - 1 &= 2^{2k+2} - 1 \\ &= (2^{2k} \times 2^2) - 1 \\ &= 4(2^{2k}) - 1 \\ &= (2^{2k} - 1) + 3(2^{2k}) \\ &= 3p + 3(2^{2k}) \\ &= 3(p + 2^{2k}), \text{ divisible by 3, which proves that the given statement is} \end{aligned}$$

true for  $n = k + 1$

Thus,  $2^{2n} - 1$  is divisible by 3 for any natural number 'n.'

**2- Deduction**

Means producing a special results depending on a general principle.

Deduction process includes the following skills :-

- 1- Applying the general rule on special conditions
- 2- Using relations properly and applying them on new ideas.
- 3- Applying or carrying out the principles and theories in new situations.
- 4- Define the relation among general rules and specific circumstances.
- 5- Distinguishing between correct information and false or wrong one.
- 6- Explaining the general rules

Example :-

### 3- Generalization:

Means formulating a mathematical sentence to determine relation between two concepts in math's

**Example :-**

Student generalize that when we multiple two negative numbers result will be positive numbers  $-4 \times -7 = 28$  [ $-5 \times -9 = 45$ ]

The only difference between generalizing and induction is that we formulate results in generalizing , while in induction we suffice to find a result which may ne a number or quantity.....etc

### 4- Reflection :-

An intellectual process depends on individual's perception to the problem and then analyzing it to some elements and relations and drawing plans to understand it, so he will reach all possible solutions.

**Reflection process includes the following skills:**

1. Ability to define problem
2. Ability to analyze problem into elements.

3. Ability to realize the relations among the elements and problem.
4. Ability to remembering and applying the general rules
5. Ability to remember the ideas and information related to problem
6. Ability to suppose definite hypotheses to solve problems and check every hypothesis.
7. Ability to organize results in a useful way to reach problem solving.

### **5- Discovering Relations:-**

Means realizing inferential relations between reasons and result and providing amendments and proofs to get solutions.

**This process has some skills :**

- 1- Ability to realize relations among shapes.
- 2- Ability to realize similarity and difference between the given information.
- 3- Ability to discover relations among the results
- 4- Ability to discover relations among reasons and results .
- 5- Ability to discover relations between relations and shapes
- 6- Ability to discover relations among information and shapes.

### **6- Mathematical translation:-**

Means expressing about mathematical ideas and information or changing the language into another shape without changing meaning.

Example :-

Pupil proves that “ the total of the two square number is less or equal the square of the total number of two numbers as following

$$(X^2+Y^2) \leq (X + Y)^2 .$$

**This process includes some skills as following :-**

1. Changing equation into words.
2. Changing charts into words.



3. Changing tables into words.
4. Changing words into equation.
5. Changing table into equation.
6. Changing equation into tables.
7. Changing words into tables.
8. Changing charts into tables.
9. Changing words into charts.
10. Changing tables into charts.
11. Changing equation into charts.

### **7- The formal logic**

Means studying the sentence according to it's form, where we represent or provide the sentences and connections into symbols , and applying the final result to all sentences. The logical thinking is occurred when we reach a result from reasons or facts which include result.

#### **The formal logic includes some skills:-**

- 1- Discovery the rule which connect between information or the shapes.
- 2- Discovery the relation among the given shapes.
- 3- Deducting results from the reasons or facts.
- 4- Realizing the difference and similarity among information and shapes.

### **8- Mathematical Proof**

Means a symbolic processing by getting sentences through a recognized evidence(such as theories) and inducting these sentences by logic techniques.

#### **Mathematical Proof has some skills :-**

1. Ability to define facts “reasons” and question . In mathematical relation.
2. Ability to determine facts and questions in charts.

3. Ability to infer good and correct result and give the reason.
4. Ability to connect between results to get solution.
5. Ability to write solutions in a logic way.
6. Ability to prove rules and theories.

## Chapter 3

# Creative Thinking

Creative thinking is one of the most advanced human thinking , because we live in technology world so one does not think traditional but needs creative thinking . Any scientific progress achieved only through human creative abilities .

### **Definition of creativity :-**

Creativity is an intellectual activity leads to a continuous valuable and serious ideas for society.

### **Definition of creative thinking in mathematics:-**

Creative thinking is :

- A way of looking at problems or situations from a fresh perspective that suggests unorthodox solution ( which may look unsettling at first). Creative thinking can be stimulated both by an unstructured process such as brain storming, and by a structures process such as lateral thinking
- Creative thinking is the creativity , it is ability to produce unusual solutions to the engineering problems
- Creative thinking is " The ability to connect things or ideas in a new way".
- Creative thinking is ability to solve a certain engineering problem by among ways and notice the similarities and difference according to previous experience".
- Creative thinking defines it as "individual's ability to produce various solution (alternatives) to engineering problems need new types or it producing new results among ideas or designing some new geometric figures or solving unusual engineering problems.

Creative thinking involves students learning to generate and apply new ideas in specific contexts, seeing existing situations in a new way, identifying alternative explanations, and seeing or making new links that generate a positive outcome. This includes combining parts to form something original, sifting and refining ideas to discover possibilities, constructing theories and objects, and acting on intuition. The products of creative endeavour can involve complex representations and images, investigations and performances, digital and computer-generated output, or occur as virtual reality.

### **Creative components :-**

Creative has (4) abilities as following :-

- (1) Fluency
- (2) Flexibility
- (3) Originality
- (4) Elaboration

### **Fluency :-**

Refers to individual's ability to produce all possible solution to certain problem in a specific period (limited time). Fluency divides into some abilities :-

#### **(A) Ideational Fluency**

Refers to individual's ability to generate a large number of ideas in response to a certain situation in a specific or limited time irrespective of quality.

Example : Asking student about the various benefits or how we use internet in different ways.

#### **(B) Associational Fluency**

Refers to individual's ability to produce a large number of relations synonyms in idea.

Example :- write a large number of synonyms of some words.

#### **(C) Expressing Fluency**

Ability of individual to formulate useful statements quickly within limited time.

### Exercise on Fluency :-

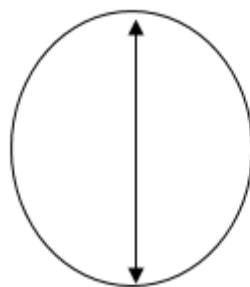
Examine the following dots use your numbered ruler and reach points each other to get



- Acute angle
- Obtuse Angle
- Right Angle
- Straight Angle

2) Draw about sail has different kinds of angles(acute, obtuse, right)

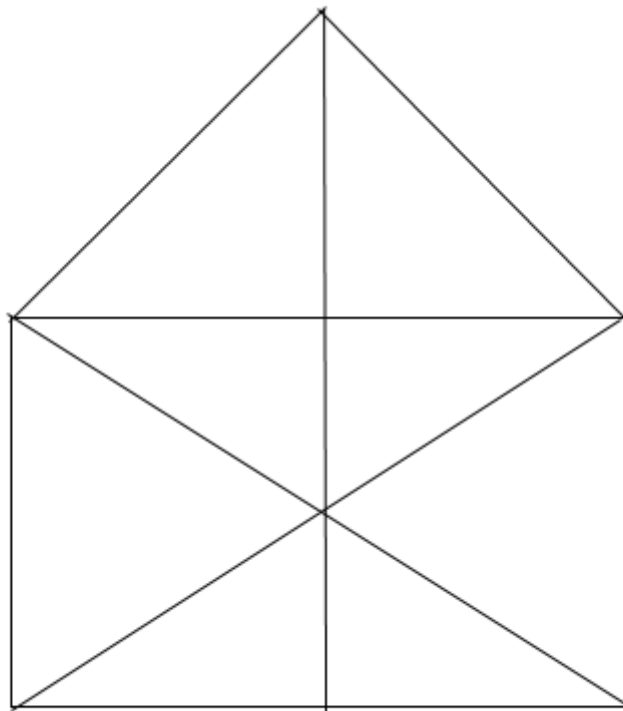
3) Look at the clock , move the hands to get some angles (acute-obtuse)



### 2) Flexibility :-

Individual's ability to generate various ideas and moving from one thinking to another kind

Example : look at the following figure and answer the questions :

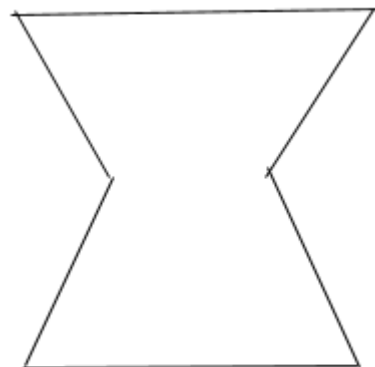
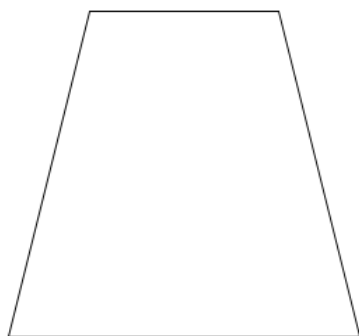


How many squares and rectangle are there?

How many triangles are there ?

How do you see this figure?

2) look at this figures and get or find small triangle with same shapes?

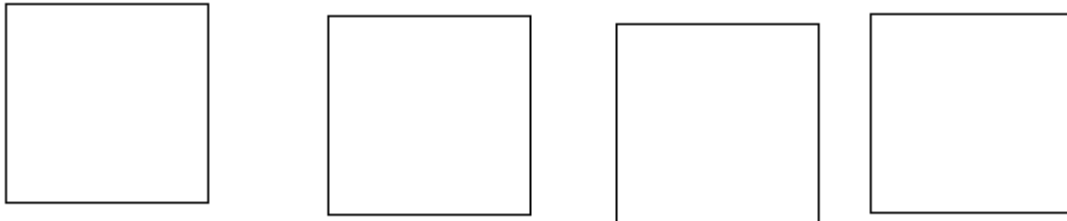


**3) Originality :-**

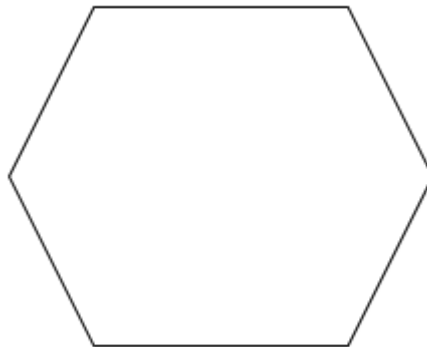
Individual's ability to generate new ideas which are unusual to solve a problem .

**Example:-**

1) If I give you (4) rectangle bars of chocolate (as in figure) and you are asked to divide every bar into similar shapes but different in size



2) the following figure is a table cloth use tools to get what you can from engineering shapes or figure.

**4) Elaboration**

Individual ability to generate a lot of information on a certain topic to improve and develop.

Example:-

Talk about the traffic problems in Egypt.

Techniques to develop creative thinking generating a large number of new ideas to solve a problem.

Example:- Write the description of the following figure

## Solving

- 1) A square without two upper angles
- 2) A triangle on a rectangle
- 3) A house side
- 4) Two halves of rectangle side by side

Example: Write a description of the following figures

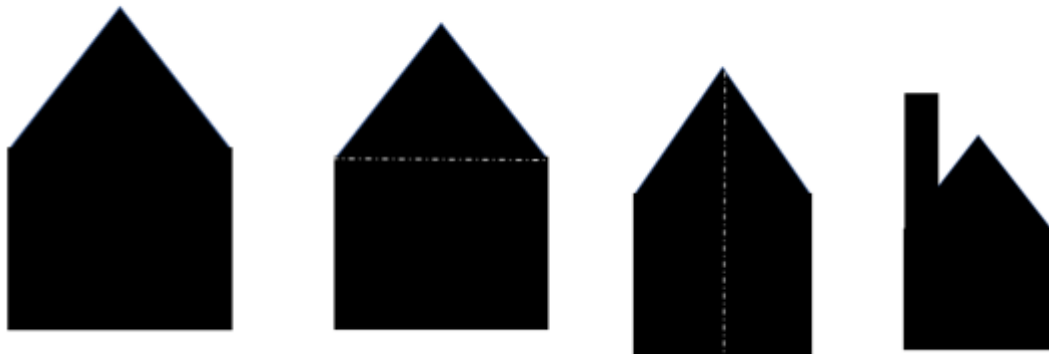
## Techniques to develop creative thinking:-

- 1- Generating new ideas
- 2- Morphological analysis
- 3- creative problem solving
- 4- Brain storming

## Generating new ideas:-

Generating a large number of new ideas to solve a problem.

- Example:- Write the description of the following figures



## Solving ideas:-

- 1) a square without two upper angles
- 2) A triangle on rectangle
- 3) A house side
- 4) two halves of rectangle side by side.



- Example (2) write the description of the following figures

Solving ideas :-



- 1) L-figure
- 2) carpenter angle
- 3) A half- frame
- 4) chair without legs

Example(3) how can you divide a square into four equal parts

### **Morphological analysis**

- Means analyzing any problem according to its important dimensions:-
  - (1) Analyze every dimension to variables which are independent elements.
  - (2) Producing some relations to connect among variable or elements.
  - (3) Estimating how a solution is good and useful to be practically applied.

### **Creative problem solving**

- This technique includes three successive processes as following :-

- 1) Understanding problem : by collecting enough data and define it accurately.
- 2) Generating ideas: by producing or generating a large number of different ideas
- 3) Planning for action to reach the ideal solution to the problem .

### **Brain storming**

- This approach established by “Osborn “ which is a meeting or session consist of (12-15) persons to produce ideas related to solve certain problem .

#### **Stages of Brain storming:-**

##### **This process has three stages:-**

- 1) Explain problem and analyze it to elements, then classify these elements.
- 2) Leader or manager of the meeting explain how to work and behave.
- 3) Evaluating and testing ideas to reach new ideas.

#### **Brain storming meeting or session conditions :-**

- 1) A voiding any criticism or correcting to ideas provided by participants.
- 2) Accepting any idea no matter what is imaginative.
- 3) Providing or expressing about a large number of ideas
- 4) Following and understanding the other ideas.

#### **Session time:-**

The meeting of brain storming ranges from (15-60) minutes (medium 30).

How can we use brain storming?

- 1) We use this process when we solve a problem with a large number solutions, we don't use this process with problems needing an instant decision.
- 2) This process deals with problems of technology , engineering , trade and advertisement.....etc.

## **Mind Mapping**

**Mind mapping is a graphical way to represent ideas and concepts, and their interrelationships, centering around a core subject.**

Imagine it as a tree with many branches. The central idea questions the trunk, and the branches are the primary sub-ideas, following branches being the subdivisions, and so on.

Mind mapping's visual approach helps to organize complex information, enabling efficient solution formations and decision making. It's a powerful tool for note-taking, memory enhancement, and creative idea generation.

However, bear in mind, clarity and conciseness are key attitudes while crafting mind maps. Over-complication can muddle the simplicity of this creative thinking tool.

**Mind Mapping Example:** An entrepreneur may use a mind map to break down a business plan, visually representing areas like marketing, product development, and financial planning.

## **Analogical Thinking**

**Analogical thinking is the process of identifying a common similarity between two or more distinct objects or situations and using it to solve a problem at hand. Literally, you're *creating an analogy*.**

This method is like solving a puzzle piece by piece. The process involves matching different parts based on their similarities.

Analogical thinking allows people to apply familiar experiences to new, unfamiliar situations, which stimulates new ideas and insights.

However, a word of caution: overextending analogies can lead to incorrect conclusions, faulty heuristics, and fallacies. Make sure to keep the similarities and differences in perspective.

**Analogical Thinking Example:** A business facing budget allocation issues could use analogical thinking and look at how a household manages finances, utilizing that as a model for distributing the company's resources.

### **Five Whys**

The Five Whys technique is a problem-solving strategy that involves asking 'Why' five times, or as many times as needed, to identify and understand the underlying issue.

Envision peeling an onion. Each 'Why' removes a layer, exposing a deeper level of the problem.

This is a straightforward but effective method for coming up with new insights. It helps to avoid focusing on surface-level features and instead gets you down to the underlying root causes.

**Five Whys Example:** If a business is experiencing low revenues, asking "why" might reveal problems with marketing, which might lead to a lack of resources, and so on.

### **Three Ifs**

The Three Ifs technique is about stimulating creativity through hypothetical 'If' scenarios.

Imagine what could happen if certain variables in the current scenario were altered. Postulate three 'If' statements, and explore possible outcomes, thereby developing fresh perspectives.

This technique fosters innovation and flexibility. It challenges people to break away from current limitations and imagine a different reality.

However, remember: not all solutions envisioned in hypothetical scenarios can be implemented in real life. Maintain a sense of realism.

**Three Ifs Example:** A product designer could use ‘If’ scenarios like ‘What if the product was half its size?’, ‘What if it doubled in functionality?’ or ‘What if it could be used in a totally different manner?’ to create innovative designs.

## **Blue Skies Thinking**

**Blue Skies Thinking is the act of thinking without any preconceived limits and boundaries.**

It’s akin to daydreaming; there are no wrong answers. The sky’s the limit when it comes to ideation.

This technique facilitates out-of-the-box thinking and fosters radical innovation. With all constraints removed, truly transformative ideas can surface.

However, it’s critical to bear in mind: while this process provides great ideas, the real world’s feasibility and constraints need to be considered before implementation.

**Blue Skies Thinking Example:** In a startup brainstorming session for a new product design, Blue Skies Thinking would encourage participants to envision the most effective, cutting-edge product imaginable, without worrying about feasibility constraints like production cost or technology limitations initially.

## **Lateral Thinking**

**Lateral Thinking encourages unconventional approaches to problem-solving, often leading to innovative solutions.**

Picture a maze; instead of going through it, lateral thinking will have you climb over it or bash through the walls.

By breaking free from traditional thinking patterns, lateral thinking facilitates the generation of creative solutions. It encourages you to look at problems from different perspectives.

Despite this, bear in mind: some lateral thinking ideas might seem ludicrous. It is essential to filter out the unrealistic ones while preserving the innovative spirit.

Lateral Thinking Example : An ad company facing difficulties catching consumer attention might use lateral thinking to come up with a unique, unexpected advertising strategy, straying from the typical marketing conventions to better engage viewers.

## SCAMPER Technique

**SCAMPER is a mnemonic that stands for Substitute, Combine, Adapt, Modify, Put to another use, Eliminate, and Reverse. It is a strategic method used to spark creativity in exploring potential improvements for existing products or processes.**

Imagine a clay model; you mold, shape, and carve it to improve or adapt it to your interests.

The SCAMPER technique stimulates a broad array of ideas for product or process innovation. It gives you a structured way to think about potential improvements.

Although this tool is highly efficient, ensure it doesn't confine your creativity. Blend it with other thinking styles for best results.

**SCAMPER Technique Example:** If a technology company wanted to innovate their popular device, they could use the SCAMPER technique. They might Substitute certain features, Combine it with another device, Adapt it for new users, Modify the design, and so on.

## Role Playing

**Role-playing is a method wherein individuals take on different personas to gain a fresh perspective on a situation or problem.**

Imagine wearing somebody else's shoes. By temporarily adopting another person's role, you can gain fresh insights and viewpoints.

Role-playing can lead to empathetic understanding, improved communication, and innovative thinking. It helps examine situations through an additional lens.

But remember, it's crucial to remain respectful and sensitive when engaging in role-playing. Misrepresentation and stereotyping need to be avoided.

**Role-Playing Example:** A team could employ role-playing to better understand customer needs and perspectives, with different team members taking on roles such as the customer, salesperson, and customer service representative.

## Reverse Thinking

**Reverse thinking, also known as backward thinking, is a problem-solving technique that involves thinking in a counter-intuitive or opposite way.**

Consider the process of reverse engineering. This methodology pursues a backward trail from a known solution, venturing to identify the question related to it.

Reverse thinking offers a fresh perspective, encouraging you to step away from conventional logic. But, remember to keep realistic limitations in mind.

**Reverse Thinking Example:** If a company is struggling to increase its customer base, it could use reverse thinking and ask, “How could we lose all our customers?” By addressing the issues that would push customers away, the company can work on preventing these scenarios, therefore retaining and acquiring more customers.

## Counterfactual Reasoning

**Counterfactual reasoning entails considering alternative versions of events that have already occurred in order to plan for the future or understand the past in a new way.**

Imagine looking at history through a lens of “what could have been.” By altering the facts of a past situation in your mind and exploring outcomes, you can gain insightful perspectives.

This helps in honing decision-making skills and planning for future contingencies. However, avoid dwelling excessively on the past, which can prevent forward movement.

Example of **Counterfactual reasoning:** A project manager could practice counterfactual reasoning by imagining how a project might have unfolded if they had made different leadership decisions, helping them to learn lessons for future projects.

## Six Thinking Hats

**The Six Thinking Hats method, devised by Edward de Bono, involves examining situations from six distinct perspectives represented by six colored hats.**

It’s like watching a play from various seats to get the complete picture. Each hat symbolizes a unique mindset – Red for feelings, White for facts, Green for

creativity, Yellow for benefits, Black for drawbacks, and Blue for process control.

This technique facilitates holistic thinking, unearths blind spots, and promotes comprehensive understanding. Yet, make sure you are fully attentive to each perspective to reap maximum benefits.

**Six Thinking Hats Example:** In a meeting, a team might don the “Yellow Hat” to focus exclusively on the potential benefits of a new project, before switching to the “Black Hat” to consider potential problems or risks.

## Storyboarding

**Storyboarding is a technique that visually narrates your ideas, breaking them down into sequences.**

Picture it as creating a comic strip. Each box is a scene, illustrating a part of the narrative. Through writing your storyboard, you can be creative and playful in your story-making process.

Storyboarding can showcase a concept’s flow and feasibility, pointing out any structural gaps. They’re typically employed in video production, website design, business strategy planning, and more. Always remember, clarity is the key quality in this tool.

**Storyboarding Example:** In developing a new software user interface, a design team might create a storyboard showing how a user would navigate through each feature, allowing them to better visualize and enhance the user experience.

## Morphological Analysis

**Morphological Analysis is a creative problem-solving technique that involves breaking down complex problems into simpler parts and exploring various combinations to generate a wide range of possible solutions.**

Consider it as solving a puzzle, where each piece represents a different element of the problem. By examining each piece and reassembling them in novel configurations, you create a wealth of potential solutions.

This promotes a deep understanding of the involved elements, their interactions, and potential impacts. Remember to ensure each solution is realistic and feasible.

**Morphological Analysis Example:** A manufacturer could use this technique when designing a new bike, breaking down the bike into different parts (frame,



tires, gears, etc.) and evaluating alternative options for each, aiming to create the optimal combination.

## Daydreaming

**Daydreaming is the process of letting your mind wander freely and imaginatively, which may lead to innovative ideas.**

Imagine yourself lounging on a cotton cloud. Your mind roams, exploring novel ideas and possibilities. Far from being non-productive, daydreaming can provide a departure from habitual ways of thinking and foster creativity.

Though this technique nurtures creativity by exploring alternative realities, it's imperative to balance it with action-oriented activities for practical implementation of these ideas.

**Daydreaming Example:** An author experiencing writer's block may resort to daydreaming, allowing their mind to roam freely through different scenarios and characters, eventually unearthing a breakthrough thought for their narrative

## Doodling and Sketching

**Doodling and sketching involve spontaneously creating drawings or diagrams, often while brainstorming or contemplating ideas.**

Imagine your thoughts flowing onto paper through the strokes of a pen. These spontaneous drawings can capture complex ideas and concepts in simple, visual forms.

These methods can provide a creative outlet, facilitating the synthesis and assimilation of new information. Nonetheless, do ensure the essence of ideas is not lost in the excitement of the doodling process.

**Doodling and Sketching Example:** A teacher might doodle while brainstorming lesson plans, using sketches to visually organize concepts and highlight connections between different topics.

Employing creative thinking can lead to novel insights, innovative solutions, and improved decision-making. Sourcing from a wide range of disciplines, creative thinking methodologies encourage multifaceted perspectives, leading to enhanced effectiveness in addressing complex problems.

In an increasingly competitive world, the ability to think creatively is more critical than ever. It enables individuals to navigate the complexities of modern life and businesses to stay relevant in an evolving marketplace.

## **Chapter 4**

# **Critical Thinking**

### **Definition of Critical Thinking :-**

Critical Thinking is the ability to think clearly and rationally about what to do or what to believe. It includes the ability to engage in reflective and independent thinking .

**Critical thinking is the ability to analyze information and make reasoned decisions. It involves suspended judgment, open-mindedness, and clarity of thought.**

It involves considering different viewpoints and weighing evidence carefully. It is essential for solving complex problems and making good decisions.

People who think critically are able to see the world in a more nuanced way and understand the interconnectedness of things. They are also better able to adapt to change and handle uncertainty.

**Someone with Critical Thinking skills is able to do the following :**

- (1) Understand the logical connections between ideas.
- (2) Identify, construct and evaluate arguments.
- (3) Detect inconsistencies and common mistakes in reasoning
- (4) Solve problems systematically.
- (5) Identify the relevance and importance of ideas.
- (6) Reflect on the justification of one's own beliefs and values.

**What is critical thinking ?**



Critical Thinking is not a matter of accumulating information . A person with a good memory and who know a lot of facts is not necessarily good at a critical thinking. A critical thinker is able to deduce consequences from what he knows, and he knows how to make use of information to solve problems, and to seek relevant source of information to inform himself.

Critical Thinking should not be confused with being argumentative or being critical of other people. Although Critical Thinking skills can be used in exposing fallacies and bad reasoning, Critical Thinking can also play an important role in cooperative reasoning and constructive tasks. Critical Thinking can help us acquire knowledge , improve our theories and strengthen arguments. We can use Critical Thinking to enhance work processes and improve social institutions.

Some people believe that Critical Thinking hinders creativity because it requires following the rules of logic and rationality, but creativity might require breaking rules. This is a misconception. Critical Thinking is quite compatible with thinking “out-of-the-box”, challenging consensus and pursuing less popular approaches.

### **The importance of Critical Thinking:-**

- Critical Thinking is a domain-general thinking skill. The ability to think clearly and rationally is important whatever we choose to do. If you work in education , research, finance, management or the legal profession, then Critical Thinking is obviously important. But Critical Thinking skills are not restricted to a particular subject area. Being able to think well and solve problems systematically is an asset for any career.
- Critical Thinking is very important in the new knowledge economy. The global knowledge economy is driven by information and technology . one has to be able to deal with changes quickly and effectively. The new economy places increasing demands on flexible intellectual skills, and the ability to analyse information and integrate diverse sources of

knowledge in problem solving problems. Good Critical Thinking promotes such thinking skills and is very important in the fast-changing workplace.

- Critical Thinking enhances language and presentation skills . thinking clearly and systematically can improve the way we express our ideas. In learning how to analyse the logical structure of texts , Critical Thinking also improves comprehension abilities.
  
- Critical Thinking promotes creativity . to come up with a creative solution to a problem involves not just having new ideas. It must also be the case that the new ideas being generated are useful and relevant to the task at hand . Critical Thinking plays a crucial role in evaluating new ideas, selecting the best ones and modifying them if necessary.
  
- Critical Thinking is crucial for self-reflection. In order to live a meaningful life and to structure our lives accordingly, we need to justify and reflect on our values and decisions. Critical Thinking provides the tools for this process of self-evaluation.
- Good Critical Thinking is the foundation of science and democracy . Science requires the Critical use of reason in experimentation and theory confirmation.
- The proper functioning of a liberal democracy requires citizens who can think critically about social issues to inform their judgments about proper governance and to overcome biases and prejudice.

### **Components of Critical Thinking:-**

- 1- Perception
- 2- Assumption
- 3- Emotion
- 4- Language
- 5- Argument

- 6- Fallacy
- 7- Logic
- 8- Problem solving through logic
- 9- Valuing truth above self-interest
- 10- Accepting change
- 11- Empathizing
- 12- Welcoming divergent views
- 13- Tolerating ambiguity.
- 14- Recognizing personal biases
- 15- Thinking independently
- 16- Analyzing data for value and content
- 17- Employing a variety of thinking processes in problem solving

### **1 – Perception**

Perception is considered to be the manner in which individuals receive, interpret and translate experiences. How individuals perceive things works to define how they think. Perception tends to provide individuals a significant filtering system.

### **2 – Assumption**

Assumptions are central to critical thinking . they tend to be implied, where individuals are not always conscious of them. Assumptions are not always bad and often rest on the notion that some ideas are obvious. They tend to make individuals comfortable with their present beliefs, shutting out any alternatives.

### **3 – Emotion**

Trying to leave emotion out of almost anything is impossible as it is part of everything people do and think, Emotions are the number one cause of creating and putting into place and operating barriers, which are continually used as a defense mechanism. Critical thinker do not ignore or deny emotion but learn to accept and manage them.

### **4 – Language**

Thinking can't be separated from language since both tend to have three primary purposes : to inform, persuade and explain . Language denotes(designates meanings) and connotes(implies or suggests something), and relies heavily on the metaphors. Metaphors are powerful language tools, which are able to influence how individuals think and problem solve. These figures of speech give phrases, stories, or even poetic renditions and is a verbal message that listeners can easily interpret and visualize.

### **5 – Argument**

An argument is a claim, which is used to persuade that something is or is not) true, or should (or should not) be done. An argument contains three basic elements: an issue, one or more reasons or premises, and one or more conclusions. An argument can be either valid or invalid based on its structure and only premises & conclusions are reached , which are either true or false.

The goal of critical thinking is to implement a sound argument, which has both a valid or proper structure and contains true premises. This is where using logic makes all the difference.

### **6 – Fallacy**

Reasoning that doesn't meet the criteria for being a sound argument is considered erroneous, or fallacious. A fallacy comes from incorrect patterns of reasoning. However, it does not always mean that the conclusion is false, but it does underscore the fact that the reasoning used to support it is not: valid, based on true premises , or complete and does not include all necessary relevant information.

### **7 – Logic**

Logic incorporates two methods or types of reasoning: deductive and inductive. Deductive reasoning relies on facts, certainty, syllogisms, validity, truth of premises sound arguments and supported conclusions. Inductive reasoning relies on diverse facts, probability, generalizations, hypotheses, analogies and inductive strength.

### **8 - Problem solving through logic**

A logic problem is like any problem. It requires :-

- Understanding the problem. In other words, listen, read & take heed.
- Identifying all of the “unknowns” as well as the “known”
- Interpreting relationships between them (visual aids can help).
- Generating a strategy from steps two and three.
- Applying the strategy and solving the problem.

### **9 - Valuing truth above self-interest**

Critical thinkers hold themselves and those they agree with to the same intellectual standards to which they hold their opponents.

### **10 – Accepting Change**

Critical thinkers remain open to the need for adjustment and adaptation throughout the life cycle. Because critical thinkers fully trust the processes of reasoned inquiry, they are willing to use these skills to examine even their most deeply held values and beliefs, and to modify these beliefs when evidence and experience contradict them

### **11 – Empathizing**

Critical thinkers appreciate and try to understand others’ thoughts, feelings, and behaviors. Noncritical thinkers view everything and everyone in relation to the self.

### **12 – Welcoming Divergent Views**

Critical thinkers value examining issues from every angle and know that it is especially important to explore and understand positions with which they disagree.

### **13 – Tolerating Ambiguity**

Although formal education often trains us to look for a single “right” answer, critical thinkers recognize that many issues are complex and subtle, and that complex issues may not have a “right” answer. They



recognize and value qualifiers such as “probably, highly, and not very likely”.

### **14 – Recognizing Personal Biases**

Critical thinkers use their highest intellectual skills to detect personal biases and self-deceptive reasoning so they can design realistic plans for self-correction. COGNITIVE Components- the thought processes actually involved in critical thinking.

### **15 – Thinking Independently**

Critical thinking is independent thinking. Critical thinkers do not passively accept the beliefs of others and are not easily manipulated.

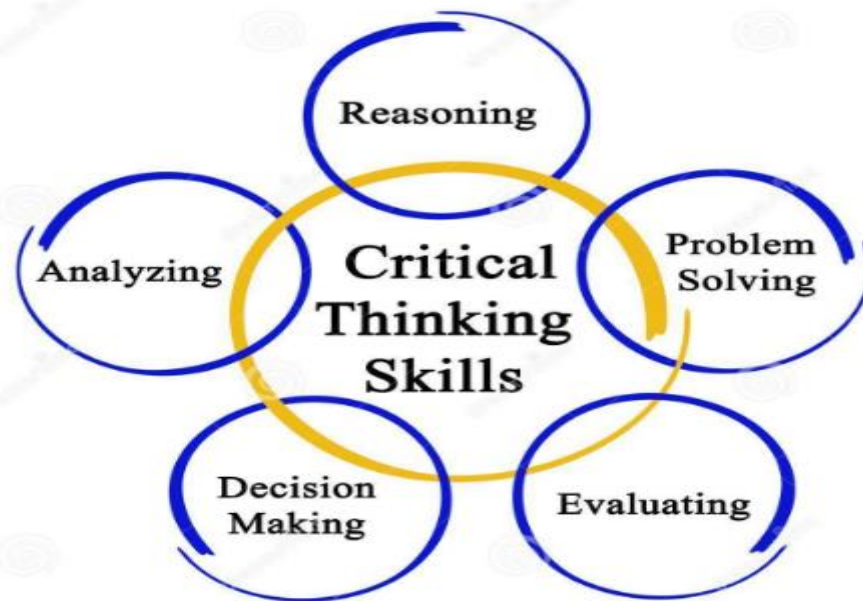
### **16 – Analyzing Data for Value and Content**

Be carefully evaluating the nature of evidence and the credibility of the source, critical thinkers recognize illegitimate appeals to emotion, unsupported assumptions, and faulty logic. This enables them to discount sources of information that lack a record of honesty, contradict themselves on key questions or have a vested interest in selling a product or idea.

### **17 – Employing a Variety of thinking Processes in solving problem**

Among these thinking processes are inductive logic-reasoning that moves the specific to the general ; deductive logic-reasoning that moves from the general to the specific; dialogical thinking-thinking that involves an extended verbal exchange between differing points of view or frames of reference; and dialectical thinking- thinking that tests the strengths and weaknesses of opposing points of view.

### **Skills of Critical Thinking:-**



### 1- Analytical

Part of Critical Thinking is the ability to carefully examine something, whether it is a problem , a set of data , or a text . People with analytical skills can examine information, and then understand what it means, and what it represent

#### **Skills**

- Asking thoughtful questions
- Data analysis
- Information seeking
- Interpretation
- Judgment
- Questioning evidence
- Recognizing differences and similarities
- Skepticism

### 2- Communication

Often, you will need to share your conclusions with your employers or with a group of colleagues. You need to be able to communicate with others to share your ideas effectively. You might also need to engage in critical thinking with a group. In this case, you will need to work with others and communicate effectively to figure out solutions to complex problems.

## Skills

- Asking important questions
- Assessment
- Collaboration
- Explanation
- Expressing opinions and ideas
- Interpersonal
- Presentation
- Teamwork
- Verbal communication
- Written Communication

### 3- Creativity

critical thinking often involves some level of creativity, you might need to spot patterns in the information you are looking at or come up with a solution that no one else has thought of before. All of this involves a creative eye.

#### Skills

- Cognitive flexibility
- Conceptualization
- Curiosity
- Imagination
- Making abstract connections
- Making inferences

### 4- Open-Minded

To think critically, you need to be able to put aside any assumptions or judgments and merely analyze the information you receive. You need to be objective, evaluating ideas without bias

#### Skills

- Embracing different cultural perspectives
- Fair
- Humble

- Inclusive
- Objective
- Observation
- Reflection

### 5- Problem Solving

Problem solving is another crucial critical thinking skill that involves analyzing a problem , generating and implementing a solution and assessing the success of the plan. After all, employers don't simply want employees who can think about information critically. They also need to be able come up with practical solutions.

#### Skills

- Applying standards
- Attention to detail
- Clarification
- Collaboration
- **Decision making**
- Evaluation
- Grounded
- Identifying patterns

#### Example on how to use Skills:

If critical thinking is a key phrase in the job listings you are applying for, be sure to emphasize your critical thinking skills throughout your job search.

**Firstly** , you can use critical thinking keywords(analytical, problem solving, creativity, etc)in your resume. In the description of your work history , you can include any of the below skill that accurately describe you. You can also include them in your resume summary, if you have one. For example

your summary might read, “Marketing Associate with five years of experience in project management.

**Secondly**, you can include these critical thinking skills in your cover letter. In the body of your letter, you can mention one or two of these skills, and give a specific example of a time when you demonstrated those skills at work. Think about times when you had to analyze or evaluate materials to solve a problem.

**Finally**, you can use these skill words in an interview. Discuss a time when you were faced with a particular problem or challenge at work and explain how you applied critical thinking to solve it.

Some interviewers will even give you a hypothetical scenario or problem, and ask you to use critical thinking skills to solve it. In this case, explain your thought process thoroughly to the interviewer. He or she is typically more focused on how you arrive at your solution rather than the solution itself. The interviewer wants to see you use analysis and evaluation (key parts of critical thinking).

Of course, each job will require different skills and experiences, so make sure you read the job description carefully and focus on the skills listed by the employer.

### **Methods and Techniques on using critical thinking:-**

#### **7 ways to think more critically:-**

- 1- Ask Basic Questions
- 2- Question Basic Assumptions
- 3- Be Aware of Your Mental Processes
- 4- Try Reversing Things
- 5- Evaluate the Existing Evidence
- 6- Remember to Think for Yourself

7- Understand That No One Thinks Critically 100% of the time

### **Ask Basic Questions**

“the world is complicated. But does every problem require a complicated solution”

- Stephen J. Dubner

Sometimes an explanation becomes so complex that the original questions get lost. To avoid this, continually go back to the basic questions you asked when you set out to solve the problem.

Here are a few key basic questions you can ask when approaching any problem:-

- ✓ What do you already know?
- ✓ How do you know that?
- ✓ What are you trying to prove. Disprove, demonstrated, critique, etc.?
- ✓ What are you overlooking?

Some of the most breath taking solutions to problems are astounding not because of their complexity, but because of their elegant simplicity. Seek the simple solution first.

### **Question Basic Assumptions**

“when you assume, you make an ass out of you and me”

The above saying holds true when you're thinking through a problem. It's quite easy to make an ass of yourself simply by failing to question your basic assumptions.

Some of the greatest innovators in human history were those who simply looked up for a moment and wondered if one of everyone's general assumptions was wrong. From Newton to Einstein to Yitang Zhang, questioning assumptions is where innovation happens.

You don't even have to be an aspiring Einstein to benefit from questioning your assumptions. That trip you've wanted to take? That hobby you've wanted to try? That internship you've wanted to get?

That attractive person in your world Civilizations class you 've wanted to talk to ?

All these things can be a reality if you just question your assumptions and critically evaluate your beliefs about what's prudent, appropriate , or possible.

If you're looking for some help with this process , then check out Oblique strategies. It's a tool that musician Brian Eno and artist Peter Schmidt created to aid creative problem solving. Some of the "cards" are specific to music, but most work for any time you're stuck on a problem.

### **Be Aware of Your Mental Processes**

Human thought is amazing, but the speed and automation with which it happens can be a disadvantage when we're trying to think critically. Our brain naturally use heuristics(mental shortcuts) to explain what's happening around us.

This was beneficial to humans when we were hunting large game and fighting off wild animals, but it can be disastrous when we 're trying to decide who to vote for.

A critical thinker is aware of their cognitive biases and personal prejudices and how they influence seemingly "objective" decision and solutions.

All of us have biases in our thinking. Becoming aware of them is what makes critical thinking possible.

### **Try Reversing Things**

A great way to get "unstruck" on a hard problem is to try reversing things. It may seem obvious that X causes y , but what if Y caused X?

The "chicken and egg problem" a classic example of this. At first, it seems obvious that the chicken had to come first. The chicken lays the egg, after all. But then quickly realize that the chicken had

to come from somewhere, and since chickens come from eggs, the egg must have come first. Or did it?

Even if it turns out that the reverse isn't true, considering it can set you on the path to finding a solution.

### **Evaluate the Existing Evidence**

“if I have seen further it is by standing on ye shoulders of Giants”

- Isaac Newton

When you're trying to solve a problem, it's always helpful to look at other work that has been done in the same area. There 's no reason to start solving a problem from scratch when someone has already laid the groundwork.

It's important, however to evaluate this information critically or else you can easily reach the wrong conclusion. Ask the following questions of any evidence you encounter:-

- ✓ Who gathered this evidence?
- ✓ How did they gather it?
- ✓ Why?

Take for example: a study showing the health benefits of a sugary cereal. On paper, the study sounds pretty convincing . that is until you learn that a sugary cereal company funded it.

You can't automatically assume that this invalidates the study's results, but you should certainly question them when a conflict of interest is so apparent.

### **Remember to Think for Yourself**

Don't get so bogged down in research and reading that you forget to think for yourself sometimes this can be your most powerful tool.

Writing about Einstein's paper “on the Electrodynamics of Moving Bodies”(the paper that contained the famous equation  $E=mc^2$ ), C.P Snow observed that “it was as if Einstein “had reached the



conclusions by pure thought, unaided, without listening to the opinions of others. To a surprisingly large extent, that is precisely what he had done”

Don't overconfident, but recognize that thinking for yourself is essential to answering tough questions. I find this to be true when writing essays-it's so easy to get lost in other people's work that I forget to have my own thoughts. Don't make this mistake.

### **Understand That No One Thinks Critically 100% of the time**

“critical thinking of any kind is never universal in any individual; everyone is subject to episodes of undisciplined or irrational thought.”

Michael Scriven and Richard Paul

You can't think critically all the time and that's okay. Critical thinking is a tool that you should deploy when you need to make important decisions or solve difficult problems, but you don't need to think critically about everything.

Even in important matters, you will experience lapses in your reasoning. What matters is that you recognize these lapses and try to avoid them in the future.

### **What are examples of Critical Thinking?**

The circumstances demanding critical thinking vary from industry to industry .

Some examples includes:

- A triage nurse analyses the cases at hand and decides the order by which the patients should be treated.
- A plumber evaluates the materials that best would suit a particular job.
- An attorney reviews evidence and devices a strategy to win a case or to decide whether to settle out of court.

- A manager analyses customer feedback forms and uses this information to develop a customer service training session for employees.



## How to Develop critical thinking Skills

### 1- Become a self-critic

The very first and most important step developing critical thinking skills is becoming a critic of your own thoughts and actions. Without self-reflection, there can't be growth. You can break down your own thoughts by asking yourself why you believe something. When you do this, you need to clarify your thoughts by assessing this information objectively and finding a solid logic to what you believe rather than just a muddled idea. Another aspect of becoming a self-critic is acknowledging your strengths, weaknesses, personal preferences and biases. When you know this information, you can understand why you approach certain situations from a specific perspective, and then

You can step around that viewpoint because you are aware of its presence.

## **2- Active Listening**

Thinking listening are nearly impossible to do at the same time. To become a critical thinker, you need to be able to listen to others' ideas, arguments and criticisms without thinking of your response or reaction while they are speaking. You can't properly absorb the information someone is trying to convey to you don't take the time to truly listen. Listening allows us to feel empathy. We hear someone else's story, struggles, ideas, successes and passions, and how they reached them. When we hear their perspective, we can take that information and analyse it. When we use active listening skills, we can fully understand what someone is trying to tell us because that conversation continues until all parties can reiterate what the other is trying to say.

## **3- Analyzing Information**

Analyzing Information is paramount for critical thinking . No one thinks critically at all times. Sometimes our joy, sadness or other emotions are too great, and other times we struggle to focus on the central issue at hand. To reach success , we need to analyse the information before us, whether it is information in our mind or being shared by others. We can break it down by assessing what is being said, and ensuring that we clearly understand what it is that needs to happen. Then we can dissect and appraise all arguments, including our own, and think about how the decisions would impact others, as well as the bottom line. When we can step back and analyze an argument, it allow us to approach it from an objective viewpoint.

## **4- Nonviolent communication**

Critical thinking isn't much help if you can't communicate in a nonviolent, productive way. When listening and analysing different arguments, you first need the ability to recognize valid logic. Then you need to be able to communicate with other people in a productive way. The basis of nonviolent communication is compassion, observation and collaboration. When we approach

any scenario with compassion, we are already in a peaceful mindset, rather than a defensive one. When we observe, we can observe our arguments and others without judgment and evaluation. We can detach our emotions from an idea. He doesn't like my idea, so he must not like me. And collaboration naturally happens when everyone comes into the process with a compassionate, open mind, with the focus on solving the objective at hand rather than protecting anyone's ego.

### **5- Developing foresight**

The ability to predict the future impact of a decision is foresight. Foresight is a critical component for success in all aspects of your life. When you move somewhere, you plan ahead to see what the job outlook is and the safety of a neighbourhood. If you are moving a business, it is wise to examine the impact of that decision. Will it be too far for some of your talented employees to drive? Will you lose business because of the change? What will you gain? Every decision should be weighted carefully, with consideration of how the choice affects your bottom line, but also for the people who are working toward success alongside you.

Critical thinking requires the ability to reflect on one's beliefs as well as someone else's ideas, and then see the connections between those things. It requires the ability to actively listen to others, to assess, dissect and appraise arguments, and to separate intense emotion from the topic at hand.

Learning to think critically is a lifelong journey and there's always more to learn.

## Chapter 5

# Systematic Thinking

Systemic thinking is a powerful problem-solving approach that includes a variety of tools and methods. Generally used as a way to diagnose complex and cross-functional issues in business operations and technical workflows, systemic thinking focuses on the 'system' as a whole. Applying the lessons of systemic thinking in your professional and personal life can help solve recurring and pervasive challenges. In this article, we define systemic thinking and discuss its benefits, explain how to use it in the workplace and learn about some elements and tools of this theory.

### **What is systemic thinking?**

Systemic thinking, or systems thinking, is a comprehensive analytical approach to understanding how different elements interact within a system or structure. Commonly used for research and development purposes in business, scientific, human resources, medical, economic and environmental studies, systemic thinking is a holistic approach that helps contextualise information. In contrast to regular analysis methods that usually isolate different components of a system to find solutions, systems thinking involves studying all components and their influence on each other together.

Businesses and large organisations usually deploy systems thinking tools and methods to find a resolution to long-standing complex problems. This approach is useful in solving challenges that remain unsolved despite efforts to identify the cause-and-effect patterns. According to this interdisciplinary approach, all systems comprise interdependent parts that change with their environments, time, space and other factors. The purpose of the systemic approach is to identify the synergies between these parts and prescribe the right behaviour of these different elements.

## Advantages of systemic thinking:-

**Systemic thinking offers many advantages over traditional forms of research and analysis. Systemic thinking:**

- **Helps identify interconnectedness:** Rather than exclusively studying the elements individually, systems thinking also studies how these elements interact with one another and to what result.
- **Doesn't limit to one hypothesis:** Most research and analytical processes begin with a base assumption and try to identify the cause and effects of problems. Systems thinking isn't limited to such conditions and recognises that a simple solution or reason is not always the answer.
- **Improves the entire system:** Instead of improving the performance or efficiency of one part of the system and leaving the rest of the structures untouched, systems thinking helps improve and upgrade the system in its entirety. This is possible because systems thinking studies the interrelation of elements and not their behaviour in isolation.
- **Provides more freedom for testing:** Research methodologies and processes usually have rigid step-by-step structures that provide little to no room for improvisation. Systems thinking has multiple entry points and interventions that may not use conventional research methods and therefore offers greater flexibility.

## How to implement systems thinking?

There's no universal guide or rulebook on how to implement systemic thinking into your daily life and work, but you can learn the fundamental aspects of the approach to start applying it. Here are some steps to help you:

### 1. Start by observing

Observe, learn and understand the system, its different elements and stakeholders in the beginning. If you're aiming to improve specific processes, look at different tools, software and hardware systems, users and data points. Try to create a map of how these elements

operate in unison and establish the connections between different subsystems. You can also verify historical data to check if the diagram and observations of your system reflect past behaviour.

## **2. Identify and analyse the problem**

Determine the core issue that's causing the problem. These issues are usually systemic and can be difficult to locate instantly. An easier approach can be to identify smaller and manageable problems first and add more details. Since the solution or source of the problem isn't likely to be a single person or element, you can apply new perspectives. Create new flowcharts and diagrams that follow the flow or command of information and increase their complexity as you identify and understand the problem.

## **3. Shortlist interventions**

Devise a list of possible interventions that change the interconnectedness of different elements or change the speed of their interaction. For example, consider changing hardware parts of a system that's prone to lagging. Similarly, you can decide that hiring a new person to reduce the team's workload is the best way to improve efficiency. Depending on the nature of the problem, create a list of changes that are easy to implement and measure.

## **4. Apply solutions**

Start by applying the most obvious and likely solutions. Make sure you don't make significant changes simultaneously that make it challenging to locate the source of the solution. Additionally, keep in mind the disruptions and outages caused in the system while you're changing the elements or reallocating their purpose

## **5. Gather feedback and evaluate results**

Collect feedback about the impact of the change from multiple sources and stakeholders. Conduct team meetings to understand what changes have taken place on the ground level. Be open to making changes and accepting suggestions, or even failure.

## 6. Continue the improvement process

Once the changes are in place, audit the entire system periodically to ensure that the elements continue to function as expected. Remember, space and time can also hamper the efficacy of systems elements and how they interact. Apply solutions that consider future needs and don't hesitate to optimise and improve the existing solution.

### Elements of the systems thinking approach

There are many different elements of a systemic thinking approach, and they usually vary as per the industry or subject. Some common elements and tools of the approach are:

- **Interconnectedness:** Systems thinking recognises and identifies that different subsystems and parts of a large system don't always connect linearly but that there's a web of interactions that influences their behaviour. For this reason, the approach considers all elements equally, rather than focusing on just the bigger or more important aspects of a system.
- **Synthesis:** When two or more parts of a system combine or work together, they synthesise a new result. It's crucial for systems thinking to understand this process of synthesis and analyse its complex and dynamic nature.
- **Emergence:** What emerges from the process of synthesis is of equal importance as the outcome influences the entire system. For example, in biology, this may study the emergence of various life forms from different biological elements and evolutionary backgrounds.
- **Feedback loops:** Feedback loops help examine and learn about the flow of information between different parts of a system. Broadly, two main types of feedback loops, namely reinforcing and balancing, are prevalent.
- **Causality:** This involves understanding how one part of the system is influencing the other. This helps understand the connection, feedback and individuality of elements in greater detail.



- **Mapping:** Systemic thinkers use systems mapping to divide complex processes into simpler and easier to understand visuals that help visualise the entire system and its interconnectedness all at once. Different types of graphs, charts and flow diagrams can create these maps.

Other concepts like boundaries, adaptation, homeostasis, microsystem, equifinality, systems architecture and others may be useful depending on the subject and study.

# Chapter 6

## Techniques to develop Scientific Thinking

### Problem Solving and Decision Making :-

#### Definition :-

Problem is a situation in which you don't know how to be have toward two conditions one is known , while the other is not.

Man in primary status .....> Man in the final status

#### Problem Elements :-

Most of scientists agree that problem is a situation determined by three elements :-

- (1)Facts: the present or current status when we try to solve the problem
- (2)Objectives: The situation or status we seek to solve the problem
- (3)Obstacles: Refer to the difficulties which prevent from achieving or reaching solutions at the same time we don't have steps to overcome these difficulties.

We can represent the element of the problems as the following

#### Facts :-

- Three bases arranged according to size on the first right column
- The smallest one is above “on top” , then bigger and bigger.
- We can move one base only every time.
- We can not put a bigger base on the smaller.
- You should use a few number of movements.

**Obstacles:-**

- These are not a clear strategy when we look at the problem .

**Required:-**

Move the bases in the same arrangement from column (1) to column (3).

**Problem Solving :-**

It's techniques and approaches which used to solve a problem or bridge the gap between the primary and final status.

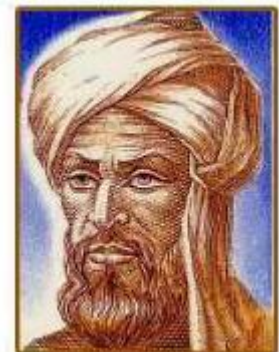
**Algorithm :-**

A group of sequential steps to reach the right solving of the problem.

**Mohamed Ibn Moussa Al Khowarezmy:-**

He is a muslim Iraqi scientist . His major contributions are in mathematician, astronomer, astrologer geographer and a scholar in the House of Wisdom in Baghdad. He was born in Persia of that time around 780. Al-Khwarizmi was one of the learned men who worked in the House of Wisdom.He invented the concept of Algorithm in math's

He also introduced the concept of zero..



**Steps of problem solving :-**

- (1) Feeling with problem
- (2) Defining the problem
- (3) Collecting information related to problem .
- (4) Supposing hypotheses and choosing the most likely ones testing , the hypotheses.
- (5) Reaching the solving of problem.
- (6) Generalizing the results.
- (7) Using these results in interpretation .

**Types of Problems :-**

Number of researchers classify problems by different criteria and define problems in different ways. one of these classifications is Reitman(2014) who classify problems into five kinds according to the clear facts:-

- 1- Problem have clear and definite facts and objectives are clear such as

You have three glass containers “A, B, C” and it’s capacity 8,5,3 respectively. If the ”A” container is full of water while the others are empty (B, C) how can we spill water from A to B ,C equally( 4 cups of water) if there aren’t any limit in spilling water from one jug to another?

- 2- Facts of problem are clear and definite while objectives are not as :

- How to design “Mercedes” 200 to save or rationalize petrol?
- One of the problems faces the modern world is “energy saving”, think in different ways to design a roof of house saving energy this roof will turn into black one in winter to absorb heat.
- Imaging that you are responsible for ads office and you were assigned to write a culture advertisement to a magazine, suggest magazines name and write the

advertisement and how to organize a comprehensive campaign?

3- Facts of problem are not clear or definite while objective are clear.

4- Facts and objectives of problem are not clear.

5- Insightful problem: these problems have a clear answer but the steps to move from the present or current situations to final one are not clear and we need a great effort to reformulate the problem and solution can be described as sudden and invisible flash such as :-

- How can you arrange (10) coins in 5 column , where every column has 4 coins?
- One has four chains and everyone of them has three rings, this man wants to tie these chains to form one closed chain .

Suppose that the opening ring costs 2 piasters and closed costs three piasters. This man connected and tied these chains by 15 piastres , how did he do that ?

And there is another classifying to problems by (Greeno and Simon 2016) this classification includes four kinds :-

- 1- Transformation Problems
- 2- Arrangement (Organizing )Problem
- 3- Inductive Problems
- 4- Deductive Problems

### **Reasons of mistake in Problem Solving :-**

Whimbey and Lochhead (2015) mentioned a list of reasons which lead to mistake in problem solving , as following :-

- 1) Reading in an inaccurate way
  - Reading the subject or matter without understanding its meaning.
  - Reading quickly without a complete understand.
  - Passing an idea or ideas or facts because of giving attention during reading.
  - Not reading the difficult parts or understand them completely.

**2) Thinking in an inaccurate way**

- Student does not check or revised the equation he used.
- Student does not check or revised the answers or conclusions.
- Working quickly leads to commit mistakes.
- Inconsistency in explaining words or the processes.

**3) Weakness and atrophy in analysis the problem**

- Student doesn't decompose or undo the complicated problem he does not begin with the easy part of problem to move to difficult one.
- Passing the odd words or strange sentences and not understand them correctly.
- Student doesn't use dictionary even when he needs it.
- Student doesn't write the ideas in the text nor put them in his mind.
- Student doesn't explain the strange words in his own language.
- Student doesn't put his explanation or solution in the light of his previous studying to the problem.

**4) Student needs hard working "diligence"**

- Student doesn't work hard nor exert enough effort to solve the problem because he doesn't trust in his ability to solve this problem.
- Student thinks superficially and guesses the answer .
- He solves problem simultaneously without proper thinking.
- He think quickly and jumping to answer.

**5) Student fails to think in a loud voice**

- Student doesn't think in a loud voice during solving the problem.

**Secondly : Scientific Inquiry**

A group of behaviors performed by individual to get a reasonable explanation to a certain phenomenon, or provide solutions to scientific problems, or gain new knowledge and skills.

**Scientific Inquiry steps:-**

- 1) Present the problem in a question or as hypothesis.
- 2) Collecting information and data related to the problem.

- 3) Testing the information and data.
- 4) Organizing information in tables or recording it in cards or transferring it into charts.
- 5) Providing evidence and conclusions : in this stage all previous steps are revised and checked to reach a solution and explaining it.
- 6) Generalization : we apply results and decisions in new situations.

### **Thirdly : The difference reduction methods**

It is difference reduction between the primary and final conditions, this method is used when the problem is queer.

### **Fourthly : Means-ends analysis**

### **Fifthly: Problem Solving by analogy**

We use this method to solve problems by using the solutions used in previous similar problems and usually we use this method to solve the mathematical problems in which students estimate their teacher in solving

### **Sixthly : General Strategy to solve the Problem**

- 1) Read the problem through: Take notice of the main words and terms, realizing the context of problem , define the missing reformulate problems.
- 2) Solution plans: draw a figure or model , make table, search for a type.
- 3) Choose a strategy : search for a simply problem , guess, suppose a temporary hypothesis, suppose a solution.
- 4) Apply solution
- 5) Revise and check the solution through : revising the answer , how to improve the solution.

### **Seventh :Attribute Listing**

**This technique seek to find ideas or suggestions to improve or modify something so , individual will:**

- (1) Define the distinguishing characteristics of the modified thing.**
- (2) Individual should consider every element as if it can be modified or improved in many ways.**
- (3) Providing a large number of ideas or suggestions of a certain characteristics**

## **Decision-making Process**

### **Definition :-**

It is a complex thinking process seek to choose the best alternative or available solving to a certain situation to “achieve the hopeful goal.

### **Decision taking process has many stages:-**

- 1) Defining aims or goals clearly.**
- 2) Defining all possible alternatives or solutions.**
- 3) Analyzing alternative after collecting all related information.**
- 4) Arranging alternatives and possible results In a priority list according to it's benefit.**
- 5) Estimating the best two or three alternatives in the light of it's hazards and the possible results other the first stage of analysis.**
- 6) Choosing the best alternative from the best three alternatives and get ready to apply.**

### **Decision Classification :**

Scientists classified decisions as following :-

- 1) Decision are taken confidently, when every option has a definite result.**
- 2) Decision are taken with hazard when every option leads to possible results.**
- 3) Decision are taken with doubts when every option leads to possible results but unknown probabilities.**
- 4) Decision are taken with doubt and hazard “risks” when individual are not sure from the possibility of results, but at the same time he has data which enable him to estimate the success of every option.**



## **The relation between decision-making and problem solving**

**There are many similarity between decisions making and problem solving. Both of them include a series of steps beginning with a problem and ends with solution. Both of them include estimating the various alternatives and solutions in the light of selected criteria to reach a final decision. But the main difference is perceiving solving. In problem solving , one has not a clear answer and tries reaching a practical and accepted solving to the problem, while in decision making individual may start with a probable solutions but he wants to reach the best ones to achieve his goals.**

**There are another differences:-**

- 1) Social customs and traditions play an important role in decisions making.**
- 2) In decision making , alternatives are being estimated at one time and not step by step as in problem solving.**
- 3) In decision making we use qualitative and quantitative criteria know how proper will be the alternative.**
- 4) In decision making there is no one right alternative objectively, but there may be more than one acceptable solution.**

## Chapter 7

### Characteristic of the Scientific Thinker

In this part there are explanations of :-

- 1- Affective Characteristic of scientific thinker
- 2- Intellectual Characteristic of scientific thinker

#### Firstly : Affective Characteristic of scientific thinker:-

##### 1- Communication :-

Individual's ability to communicate with others by many ways.

#### Individual pointers:-

- Listen well to other ideas and respond with them
- Expresses about his ideas and feelings in a simple and delicate language
- Choose proper ways suitable for reader provides words explaining his ideas.
- Summarize his ideas
- Asking explanation to ideas which are not clear
- Uses words and concepts accurately.

##### 2- Sympathy

Interacting with other's views accurately and objectively.

#### Individual pointers:-

- Respects other's feeling and views
- Imagines as if he were one of them
- Listen to other's views
- Changes his behaviour when other people are affected.
- Understands and estimates other's situations even if he objects it
- Works for achieving the group of goals.

- Provides effective skills in interacting with other
- Perform various role effectively in the group "community"
- Provides ideas helping in objective goals.
- 

### **3- Cooperates with team work**

Individual's ability to participate others in different works to achieve specific goals.

#### **Individual pointers:-**

- Experts efforts to achieve the team goals
- Stands corrected and accepts better ideas.
- Contributes and sticks to community union
- Provide new amendments to develop product

### **4- Self knowledge**

Individual's right to express about him self without prejudice to other.

#### **Individual pointers:-**

- Objects in a nice way to other views
- Persists on his view and supports it without prejudice to other
- Don't angry when he listens to
- Others views
- Choose delicate words to explain his point of view.

### **5- Curiosity**

Individual wants to ask and inquire to collect more information

#### **Individual pointers:-**

- Ask many questions to himself and to others
- Inquire the ambiguous things
- Expert efforts and time to overcome difficulties.
- Wants to know everything new in the interested field.
- Read more and more and search for more information
- Does not pay attention to complicated matters
- Refers to various and new sources.

**6- Calculated Risk**

Individual's awareness to face prevailing thoughts or belief

**Individual pointers:-**

- Express about his opinion bravely
- Provides evidence to his opinion
- Stands corrected
- Discuss the different ideas objectively and by different views and aspects .

**Secondly Intellectual Characteristic of scientific thinker:-****(1) Perseverance**

Individual's ability to preserve in paying attention for along time to a certain goal although or in spite of difficulties.

**Individual pointers:-**

- looks for facts and information
- determines the difficulties in the problem.
- Concentrates attention for along time on one thing
- Tries reaching new information
- Seeks to discover new relations
- Always revises his work
- Tries achieving a high quality standards.

**(2) Induction :-**

Discovering unknown principles as notices and observation

**Individual pointers:-**

- Concentrates on specific parts of situation
- Looks for relation between there parts
- Explain the relation he has noticed.
- Looks for new observations to support his generalizing.
- Determine what he wants in the light of analysis.

**(3) Deduction :-**

Discovering unknown results through known principles.

**Individual pointers:-**

- Determine the general rules used in the situation
- Determine conditions to apply these rules.
- Determine what he wants in the light of rules and general principles.

**(4) Inference**

Forming a result in the light of certain facts.

**Individual pointers:-**

- Examines the relation between premises and results.
- estimate how parts are true in the light of information.
- Uses inference in predicting.
- Understand information deeply.

**(5) Originality:-**

Individual's ability to give new ideas which measured through scarcity of skills , quality and providing new ideas.

**Individual pointers:-**

- Provides new ideas to the problem.
- Interested in the new ideas to develop.
- Looks for new explanation to events.
- Provides untraditional or unusual use of things.
- Test his originality compare to others.

**(6) Adding details:-**

Individual's looking for more details to help him in understanding something well.

**Individual pointers:-**

- Looks for details of the matter subject.
- Studies situations form all its aspects
- Interested in enriching subject with more details.

**(7) Mistakes analysis :-**

Determining the mistakes in the information or processes.

**Individual pointers:-**

- Wander if the information enough
- Check and examine how information proper to certain idea.
- Wanders how information are a greed or consistent with his notices.
- Looks for more details if there is a contradiction among information.
- Criticizes all available information
- Find out mistakes and provides evidence.
- Correct the mistakes.
- Compare between right and mistake.

**(8) Perspective Analysis**

Defining the individual views on a certain subject.

**Individual pointers:-**

- Seeks to pinpoint writer's view about subject.
- Analyses why writer adopted this view
- Make sure that the different views have been discussed.
- Expresses about the different views by his personal experience to discover any bias towards any idea.
- Expresses about his vision support by proof
- Explain why he agreed or not agreed with the writer.

**(9) Changing Phenomena into quantities**

Individual's ability to use the proper tools to measure something.

**Individual pointers:-**

- Uses suitable tools and ways of measuring
- Knows the proper time of measuring
- Uses measuring tools accurately and properly.
- Knows the measuring units he uses.
- Wants to check measuring.

**(10) Planning**

Individual's ability to design a project, search or solution of a problem which includes data a collecting and producing results.

**Individual pointers:-**

- Makes plans to achieve goals and an alternative one in case of not achieving goal.
- If he does not achieve goals , he revises plans and why it does not work.
- Revise what is achieved by every plan.
- Determine the variables needing adjust.
- Determines the independent and dependent variables.
- Arranges the steps of experiment logically.
- Arranges steps successively
- Follows a personal way to record results.
- Has an alternative plan
- Has near , intermediate and for goals.

**(11) Inquiry**

Individual's ability to ask questions to explain things.

**Individual pointers:-**

- Explain the available related information
- Determines the ambiguous points in the information.
- Determines the gabs between information and conclusions.
- Asks questions to explain ambiguous points.
- Seeks to generate new questions during work.
- Adds goals to the main one.

**(12) Classifying**

Collecting things in categories with specific characteristics.

**Individual pointers:-**

- Defines thing he wants to classify
- Specifies one of them and determines the similar events.

- Analyses the characteristics of the chosen unit and uses it as a rule to classifying
- Determine the common rule.
- Reclassifies on a new base by the following the previous steps.

### **(13) Learning from past Experience**

Individual's ability to learn from the past experiences to help in new situation.

#### **Individual pointers:-**

- Ask himself if he faced the same problem before.
- Inquires how he can benefit from past situation
- Ask himself what he had done to succeed in the previous situation.
- Asks himself what he had done in the past and if he could repeat it in the current situation.
- Asks himself about the most important information which may be benefit him in this situation.

### **(14) Explanation-on**

Producing resulting and conclusion and giving reasons.

#### **Individual pointers:-**

- Infers solution from observations and measuring
- Explains tables and charts.
- Discovers the relation between reasons and result.
- Predicts the results according to specific reasons.
- Differentiates between causative relation and relative on.

### **(15) Estimating**

Governing how something is valuable and its degree in the light of standards and how to amend it.

#### **Individual pointers:-**

- Ask about the final standards of the subject under measuring.



- Decides the standards according to the previous step.
- Arrange standards according to its propriety and importance.
- Know how standard exists in what he estimates.
- Changes performance when it doesn't consistent with standard.
- Seeks to achieve the final goal or hear it.
- Develop his performance continuously according to the new information.
- Listens to others estimating to his work.
- Discuss the deficits in his work with experts.
- Amends his performance according to feed back.

### **(16) Differentiating between views and fact**

Individual's ability to determine beliefs and ideas that can be accepted in the light of available information.

#### **Individual pointers:-**

- Provides evidence to information he accepts
- Changes his beliefs when he finds new information.
- Determines the axioms in the light of accepted standards.
- Provides probable explanations under axioms.

### **(17) Sensibility toward problems:-**

Individual's ability to see how many problems in one situation, so he knows mistakes and deficits.

#### **Individual pointers:-**

- Ask himself about the meaning of the situation
- Notice accurately the deficits
- Ask himself how to change the situation to the better.
- Puts another postulation of the situation if another new information added.
- Determines the goals.
- Differentiates between useful information and unuseful one.

### **(18) Fluency**

Producing a large number of ideas and solutions.

**Individual pointers:-**

- Provides a large number of ideas and views
- Uses one thing in different ways.
- Provides various views to explain events.
- Ask many questions about one subject.

**(19) Flexibility**

Individual's ability to amend and develop his views and ideas or change them and study subjects from all its aspects

**Individual pointers:-**

- Looks at any subject from different sides.
- Amends his behaviour according to new information.
- Uses various ways or techniques to achieve a goal.
- Varies ways of his explanations to results .
- Studies subject from all its aspects.
- Recognizes his plans and goals according to the new information or situation.

**(20) Comparison**

Defining the similarities and difference.

**Individual pointers:-**

- Analyses the situation to choose the important elements.
- Choose the most important elements on which comparison based.
- Explains how the points of comparison are similar or different according to the chosen characteristics.
- Determines what he benefits from comparison to understand or discover new relation.

**(21) Observation**

An accurate study to what we hear and collect by using the different senses.

**Individual pointers:-**

- Determines goals through observing
- Decides or determines sides that should be notices
- Differentiates between the important and unimportant elements.
- Reviews the method and result of a previous situation.
- Arranges what he observes according to its important.
- Seeks to discover or find out the relation between the parts he observed.
- Tries to get the meaning .

**(22) Putting forward hypotheses**

Finding out solutions to a problem or predicting solution.

**Individual pointers:-**

- Collects data and makes observations to the problem.
- Collects data and results of observations.
- Determines the relations between facts “premises “ and results.

**(23) Benefit from knowledge**

Benefit from the cognitive experiences which gained in another new situation.

**Individual pointers:-**

- Connects the educational experiences to each other.
- Connects the educational situation to another one.
- Uses the educational experiences in a real situations of life.

## *Chapter 8*

### *Basic Presentation Skills*

- 1- Coping with nerves
- 2- Relaxation
- 3- Breathing
- 4- Posture
- 5- Body Language
- 6- Voice Production
- 7- Structuring an presentation
- 8- Opening your presentation
- 9- Main body of the presentation
- 10- Ending the presentation
- 11- Visual Aids
- 12- Handling the question

#### **1- Coping with nerves**

When giving a presentation , most people usually suffer from nerves, it is important to realize that nerves are a necessary part of giving a presentation as they give the speaker energy which heshe needs in order to give a good performance.

Face up to your fears and try analyze why you feel nervous.

Speakers are normally afraid for some or all of the following reasons:-

- (a) Fear of the unknown
- (b) Fear of oneself
- (c) Fear of the audience
- (d) Fear of failure

In order to come to terms with our fears try and remember the following points:-

- (a) Preparation , planning and practice will help overcome nerves.
- (b) Face up to your fears acknowledge they are there.
- (c) Turn negative fear into positive power.
- (d) Remember that even the most experienced of speakers feels afraid.

## **2- Relaxation**

- The ability to relax is a very good way to help you control nerves. When you are speaking to an audience . It is possible to learn to relax and to use your powers of relaxation when in stressful situation such as speaking to an audience.

If you do not appear relaxed , your audience will also find it difficult to relax and give you their full attention .So try and put your listeners at ease.

- Practice your breathing so that you develop control. Good breathing is important for two reasons:-
  - Relaxation
  - Voice Production

### **A. Breathing**

The ribs move up and out and the diaphragm flattens. Air is drawn into the lungs through the nose and the lungs expand until the whole chest space is filled. The chest should expand in all direction.

#### **Breathing out :**

The chest wall and diaphragm return to their normal position and air is forced out of the lungs, the muscles in between the ribs control how quickly the ribs and lungs expand .

Remember :

- Practice :Breathing and breath control is improved with practice!
- Tension:- Beware of tension creeping into the throat and shoulders as you concentrate on deep breathing
- Relaxation : Good breathing is the key to relaxation and effective voice production

### **B.Posture**

Remember that posture is an important part of the language and you .

### **C.Body Language**

- A whole science has grown up around the study of body language accounts for approximately 65 % of human interaction- with words accounting for the rest.
- 90% of the impression that we make when we first appear before an audience is formulated with the first 60 seconds. It is therefore vital to get not only the words right but also the gestures and body language.
- Body language can also cancel or reinforce what we are saying verbally and it is essentially that the two sets of messages agree.

### **Eye Contact :-**

- Eye contact is one of the most important aspects of body language. Eyes are the 'window to the soul' and they will inform the speaker whether their message is being truly received and understood.
- It is important to maintain firm and assertive eye contact with your audience. There is nothing more disturbing than a speaker

who steadfastly refuses to look at his audience or who insists on looking permanently at a point over their head. The opposite is equally frustrating- a speaker who selects a member of the audience giving them a long hard stare and refuses to avert his eyes. A happy medium is what we need to strive for where we look at all our audience for approximately 2 seconds each.

- When you audience is practice making 'W or M' movements with your eyes so that all areas of the audience receive eye contact.

### **Hands and Gesturing :-**

- Avoid any unnecessary hand movements such as putting your hair, scratching , biting your nails, or fiddling with a pen. These are all examples of displacement activities. Which we tend to resort to when we are under stress and which show that we are anxious or uncomfortable.
- Keep hands at your side if you are tempted to fidget. Try to only use your hands or arms to emphasize a verbal point with a well-timed gesture this can be very powerful.
- On general the body should remain open with the avoidance of positions such as : folded arms , clamped together hands and lifted shoulders. These closed positions give the impression of a barrier between yourself and your audience.
- Avoid any physical barriers such as flip charts, overhead projectors, lecterns, tables and chairs. Maintain maximum exposure to your audience own the space in which you are presenting . it is your territory.

### **Reading Body Language :-**

A research was held at the university of Pennsylvania to determine to what extent a person's body language can affected the impression people make of him her. The shocking result was that people build their impressions of you based on :-

- 55 percent body form , postures and movements.
- 38 percent on the tone of your voice (tempo and frequency).
- Only 7 percent on what you say .

That makes a total of 93 percent for body language (which comprises Bodily gestures and voice tones) and only 7 percent for speech. This means that 93 percent of what you want to say is not uttered in words but emitted from your body language and postures.

### **How to Interpret Body Language:-**

- Researchers have succeeded in identifying a lexicon of feelings and their corresponding postures.
- Anyone with enough information can effectively read people's feelings through their body language. Learning interpret body language is not a hard task; you just need to know the familiar postures in body language and their associated emotional states, then link them together.

### **The Use of Body Language:-**

- Body language can help you read people in such a way that you can understand their current feelings with an accuracy that is close to 100%.
- Body language doesn't only allow you to read people but it can also help you give the impression you want to people.
- Body language is now widely used in politics, investigations of all kinds where the suspect's body language is analysed), sales, negotiations and other situations where communication between people is involved.

### **Body Language Pitfalls:-**

- Cultural differences: there are some slight difference between cultures. For example, Italians may keep small private distance while English people may keep a big distance in both cases,



without taking the cultural differences into consideration, may result in getting inaccurate readings.

- Body language is perspective dependent if someone takes the negative evaluation posture as soon as he see , doesn't like seeing you, he may have been thin king of something bad right before seeing you for example.
- Body language detects states of feelings and not personality : if you see someone taking the confidence posture then this does not mean that he is a confident at the moment. However, you can still know his personality by watching for the repetition of the same postures over , if that person always takes the confidence posture then he is confident by nature.
- People have habits : some people have the habit of folding their arms or putting their hands in their pockets make sure you filter out the habits.
- Use your mind : some people may take the defensive posture because the weather is cold, others may scratch their nose because they just want to scratch it, to avoid wrong results , use your mind in addition to the use knowledge.

### **1) State of Confidence**

The state of confidence is one of the easiest states to recognize . the following postures signal a confident person:-

- When you see someone standing with hands behind his back , as shown in the picture, then know that he probably is feeling confident because he is a confident person or because he believe he's on top of matters in a current situation.



Maybe the people he's talking with are talking about a topic he's well familiar with. They could be talking about unemployment for example when he's already got a well- paid job.

There are another posture that identifies a confident person , which is the clasping of the hands in front of the stomach. This one is more popular and is usually seen on television when the president of a country is standing ( you will never see a president or a minister crossing his arms on television).

A third gesture that shows confidence is when finger tips touch each other (see picture below) A person may take this posture when confident about what he has to say or when he's talking about what



has to say or when he 's talking about something he deeply believes in

The third picture shows the superiority position, the person takes this posture when he feels superior or overconfident. You can call this the state of over confidence or superiority.

For example, when someone finishes a hard task or completes an exam you may find his taking the superiority posture. The superiority posture may not be a polit form to take in a public meeting or when in the company of strangers.

### **D.Voice Production**

- The quality of a speaker's voice an important factor in how successful presentation will be : if the sound of the speaker's voice is dull and uninteresting the audience Nill switch of and will be very difficult to get them to switch back on again.
- Do not worry if you have an accent – accent can add a great deal of natural color and vitality to a voice and it is also part of your personality. However , it is important to make sure that your voice is clear and that you can be understand if you have a pronounced accent.
- When you are speaking always bear in mind the three 'p' s:-
- Pitch :- this simply means the note at which you speak. Just as a musical instrument would be very dull if it was played using two or three notes so the voice if a speaker has a restricted
- Pace
- Pause

### **E.Structuring a Presentation**

Preparation and planning are vital ingredients in structuring a presentation. You will need to consider the following points before you can start to structure your presentation :-

- Establish your objective for speaking.
- Your overall objective may be quite general for example to inform , to persuade, to train, to convince etc. this general objective needs to be followed by some more specific objectives.

- Ascertain who your audience will be .
- Analyzing your audience is vital because it will help you to make your presentation relevant to that particular group.

Ask yourself the following questions about the audience:-

- ✓ What is their objective for listening ?
- ✓ What will they expect to be told?
- ✓ What do they need to know?
- ✓ How much do they already know about the topic?
- ✓ How much do they think they know?
- ✓ How many will be present ?
- ✓ Will there be 'Decision Makers' in the group?

### **8- opening your Presentation :-**

the opening of the presentation is vital as it will set the tone or the rest of the presentation . Try to have an attention grabbing opening which will really make the audience sit up and listen and say “Wow” this speaker is worth listening to

-powerful speakers start powerfully

-adopt the following pattern when opening your presentation:-

- a. Get the attention of your audience
- b. Explain to the audience what is in it for them or the benefits of listening.
- c. Tell the audience who you are why you are speaking to them.
- d. Tell the audience the direction you are going to take.

### **9- Main Body of the Presentation**

- Be aware of trying to fit too much information and key points into the main body of the presentation. It is far better to cover fewer points and really make sure that your audience have understood than to cover too many points and leave the audience confused.
- 4 or 5 key points during a 20 minute presentation would be about right
- Each key point should be like a mini-presentation of its own with a beginning , a middle and an end.

- Avoid the main body of your presentation being just a long list of facts.
- Remember to constantly summarize during the main body of the presentation especially at the end of each key point.

### **10- Ending the Presentation**

- The end of the presentation is rather like the opening because this is usually where you will have maximum concentration from the audience.
- Your audience should expect the end so do sign post the conclusion so that you have maximum attention.
- Remember the last few words said by the speaker are what tends to stay with the audience so make them memorable.
- Use some of the suggested way for opening your presentation when you close your talk as well as anecdote, quotation, etc.
- Another good way to end a presentation is by posing a question to the audience which they will want to consider after the presentation has finished.
- Do come to a definite close so that the audience knows you have finished speaking

### **Visual Aids:**

#### **Advantages:-**

- 1- Illustrate instantly and vividly things that are impossible to convey verbally.**
- 2- Save time**
- 3- Create interest**
- 4- Bring variety**
- 5- Add impact**
- 6- Remain in memory longer than words**

#### **Disadvantages:-**

- 1- Reduce flexibility**

**2- Expensive**

**3- Can direct attention from what is being said**

**4- Confusion and humiliation if they go wrong**

**11- Producing the Visual Aids**

- Use color whenever possible. Color is pleasing to the eye. It adds emphasis and helps to differentiate from one point to another.
- Avoid using too much color as this can lead to confusion.
- Be aware of producing visuals which only contain black and white. They are very dreary and the content of the visual will lose impact.
- Use diagram wherever possible information is easier to assimilate and retain in diagrammatic form than by simply using words.
- Avoid clutter in the layout achieve consistency in the production of visual so that they appear to be linked together.

**12- Handling Question:-**

always try to anticipate questions if you possibly can put yourself in the position of some of the key members of the audience and try to establish what sort of question they will be likely to ask.

- This will enable you to plan your answers which will help you to feel for more in control and appear more professional during question time.
- Treat all questions with the same importance and never make a questioner feel embarrassed.
- If you do not know the answer to a question admits that you do not know but commit yourself to answering the question by a given time.
- Use the following techniques for handling questions:-
  - ✓ Listen to the question
  - ✓ Pause- give yourself valuable thinking time

- ✓ Show understanding : seek for agreement initially.
- ✓ Control your audience with eye contact.
- ✓ Brevity keep your answer short and succinct.

## Chapter 9

# Models to Develop Skills of the Scientific Thinking

In this part there are explanation of

1. Polya Model
2. Carkfuff Model
3. Frank Lester Model
4. Lee Model

### Polya Model

George Polya in his book “ How to solve it ?”

Presented a model consisted of 4 stages

#### **A. Understanding problem**

- What vis the unknown ? what are facts?
- What are conditions?

#### **B. Devising Plan**

- Did you face this problem before? Or in a different picture?
- Do you know a related problem? Or a useful theory?

- Consider the unknown and try thinking in the similar problem and has the same unknown will you benefit from this result?
- Can you reformulate problem in a different way?
- If you can't solve the problem, try solving a related problem.

### **C. Carry out your**

When you carry out your plan , your plan , you should check every step, can you know that this step is right, and can you prove that?

### **D. Looking back**

- Can you test result ? can you check amendments?
- Can you use the technique to solve some problems?

## **Carkuff Model**

This model consist of 4 stages :-

### **F. Developing the problem**

Asking some questions properly to help individuals in explaining problem well.

### **B. Breaking down the problem**

### **C. Considering causes of action:**

This means taking all alternatives that may lead to goal or objective .

### **G. Choosing courses of action and implementing.**

## **Frank lester Model**

H. lester provided a model to solve problems and consists of 6 stages

### **A. problem awareness first stage**

### **I. Problem comprehension “ second stage”**

This stage includes some questions that individual must answers:-

- What is information related to problem?



- Are there clear relations among given information?

#### J. Goal Analysis “third stage”

Means reformulate problem or put it in another figure to be more suitable to be solved.

#### K. Plan development “Fourth stage”

This does not mean defining strategies to solve problem but also containing some questions such as :

- Are there ways to solve problem?
- Is there an ideal one?
- Does this plan lead to solve problem?

#### E. Plan implementation

#### F. Procedures and solution evaluation “sixth stage”

### **Lee Model :-**

This model consists of (4) stages ?

#### **L. Understanding the problem**

This stage includes the following questions :-

- What contents of the problem ?
- What are the relations among the problem elements ?

#### **B. Making plan**

This step includes :-

- Can you draw a picture or figure to help ?
- Can you make a map or table ?
- Did you solve a similar problem before?

#### **C. Carrying out the plan**

#### **D. Looking back**

- Is your answer logic ?
- Try to find another solving ?

## Scientific Term

Scientific Thinking	التفكير العلمى
Creative Thinking	التفكير ابداعى
Critical Thinking	التفكير الناقد
Scientific Knowledge	معرفة علمية
Data	بيانات
Application	تطبيق
Hypothesis	فرض
Problem	مشكلة
Hypotheses	فروض
Logical Errors	أخطا منطقية

<b>Theory</b>	النظرية
<b>Results</b>	نتائج
<b>Inference</b>	استدلال
<b>Personal</b>	شخصية
<b>Development</b>	تطوير
<b>Planning</b>	تخطيط
<b>Reasoning</b>	استنتاج
<b>Induction</b>	استقراء
<b>Deduction</b>	استنتاج

**Reference:**

[1] <http://www.criticalthinking.orgpages/defining-critical-thinking/766>.

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[3] The thinking student guide to college by Andrew Roberts.

[4] Schoenfeld, H (2012) : Mathematical thinking and problem solving.