

MODULE 2

NEED FOR CREATIVITY IN THE 21ST CENTURY

Our economy was dependent on agriculture in the past. Men needed only physical strength, knowledge of a trade, obedience to orders and hard work. But in the present century, the global economic conditions have gone through drastic changes and those mentioned earlier were not sufficient enough to be successful in a career. A job applicant must be result oriented, self motivated, skillful interpersonally and in many other fields.

Most of us think that creativity is only for artists and writers. But in truth, being creative means “breaking out of established patterns to look at things in a different way”.

The skills required in the 21st century can be brought under 3 different categories broadly, such as,

- 1. Learning Skills** : critical thinking, creative thinking, collaborating and communicating are included in this.
- 2. Literacy Skills** : information literacy, technology literacy and media literacy are included.
- 3. Life Skills** : flexibility, initiative, social skills, productivity and leadership come under this.

IMAGINATION, INTUITION AND EXPERIENCE

Imagination

Imagination is the ability to see the impossible or unreal. To do something in a different way, we often rely upon imagination. In creativity, we need to focus on ideas which might be possible. Imagination requires less actual knowledge and it relies rarely on facts.

Intuition

Intuition is the ability to know something without using reasoning or rational thinking. It is knowledge that we never consciously know that we had. All the experiences we receive store in our mind without our attention. It is believed that these stored experiences will help us in problematic situations. The sub conscious mind helps us connecting the stored information and provides solutions for the problems we face.

Intuition represents non linear thinking where the mind makes a jump from the known and predictable to the unknown and unpredictable. Intuition can be systematically developed and trained.

Experience

Experience is the source from which we acquire knowledge. Our brain develops databases through different experiences and knowledge is increased by our experiences. People with more experience are usually more creative. People who are more experienced are intellectually curious, comfortable with expressing and experiencing emotions and willing to try new things.

CREATIVITY

Creativity is the skill of producing something new and valuable; be it a product, an idea, a concept, a process or a solution to a problem. It involves the ability to acquire knowledge, break it down and rearrange it in a different manner to generate something new and valuable.

A creative person is able to use the existing knowledge in new ways to search for all the possible solutions to the problems he confronts with. Creative feelings cannot always be expressed in words.

According to Abraham Maslow, there are three types or levels of creativity as given below.

- 1. Primary Creativity** : It is from this level that new and fundamental ideas arise. It is most often expressed in arts and literature. It is more spontaneous and child like and is not concerned with the utility of the work. The importance here is for the self expression only.
- 2. Secondary Creativity** : Secondary creativity develops from the already existing ideas. The level and thought and planning associated with secondary creativity is higher.
- 3. Integrated Creativity** : This is the level of creativity which brings great achievement in all fields like arts, literature, science or business. It combines the elements of primary and secondary creativity.

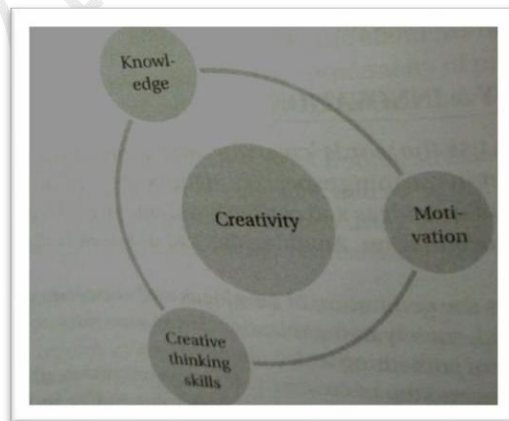
According to Margaret Boden, creativity is a fundamental feature of our intelligence and can be learned by systematic procedures and methods. **The three kinds of creativity according to Margaret Borden**, are given below.

- 1. Combinatorial Creativity** : Known ideas are combined in new, unfamiliar and different ways to form new ideas and concepts. Example: - making collage by using available pictures.
- 2. Exploratory Creativity** : New ideas are generated by exploring structured concepts which already exist. This creativity is within a certain domain. This type of creativity contributes greatly by improving and refining the existing structures. Example: - making new words by combining or coining two words like infotainment (information + entertainment).
- 3. Transformational Creativity** : This is the deepest kind of creativity where new ideas emerge by changing the structured concepts. All the conventional structures will be broken in this type of creativity.

In short, creativity is

- ✓ A basic capability of the human brain.
- ✓ A skill which can be learned and improved.
- ✓ The product of disciplined thinking.
- ✓ The result of being open to experiences and thinking about them.
- ✓ A process that involves trial and error. Creative people learn from experiences.

Sources of Creativity



Creativity is expressed in many different ways and situations. **It is widely accepted that creativity is a product of the interplay of three components – knowledge, creative thinking skills and motivation.**

1. Knowledge

We must have enough knowledge in the domain concerned to approach a problem creatively. We should have deep knowledge in our area of interest and a general awareness about other branches, so that only we can contribute something to the world by introducing innovative things. For example; an engineer who is interested in nature can concentrate in making new products by following the principle bio mimicry.

2. Creative Thinking Skills

The manner in which our intellect processes a problem, question or information and arrives at a conclusion can be called “thought process”. The more fine tuned our thinking skills are, the better our creativity becomes. **Generally, creative thinkers are,**

- ✓ Unafraid to try new things
- ✓ Accepting and giving constructive criticism
- ✓ Patient enough to persist through failures.
- ✓ Interested in synergy

There are three main aspects of intelligence which are important for creative thinking. They are, synthetic, analytical and practical.

3. Motivation

Motivation is the most important component of creativity. Motivation can be two types.

1. Intrinsic Motivation

Motivation which arises within oneself can be called intrinsic motivation. There is no external reward or fear of punishment involved. Some factors that motivate us intrinsically are acceptance

by our colleagues and friends, curiosity, independence, power, social contact and social status.

2. Extrinsic Motivation

Motivation that arises from the promise of a reward or fear of punishment is called extrinsic motivation. It arises from outside factors. Some extrinsic motivators are money, promotion, bonuses, fear of punishment, deadlines, etc.

Intrinsic motivation promotes creativity more than extrinsic motivation. People always perform better when they enjoy something rather than being forced.

LATERAL THINKING

Lateral thinking is a term coined by Edward de Bono. It represents a way of problem solving by an indirect and non sequential method using reasoning. It is a process that starts with the generation of new ideas. The logical continuity of steps to reach and solve a problem is not important here. **The two main aspects of lateral thinking are,**

1. Freeing our thought process from old ideas.
2. Stimulating the creation of new ideas.

According to Edward de Bono, 4 types of thinking tools are used for lateral thinking, and are,

1. Idea generating tools to break routine thinking patterns.
2. Focus tools to identify new focus areas or ideas.
3. Harvest tools to create more value from the ideas generated.
4. Treatment tools to consider real world constraints and opportunities.

MYTHS OF CREATIVITY

Myths are widely held but false belief or idea and are evolved as means to explain the phenomena which are difficult to understand. **According to David Burkus, the myths are,**

1. The Eureka Myth

We often think that creative ideas should come to us in a flash, which is in a Eureka moment. The creative process often takes a certain amount of time from the inception of idea to its incubation phase where the sub conscious mind links the existing knowledge.

2. The Breed Myth

The common belief that outstandingly creative persons belong to a particular personality type or have particular genetic predisposition is called the breed myth.

3. The Originality Myth

The idea that any creative work must be wholly original and depart from whatever has been done before is called the originality myth. According to this myth, an idea should be entirely unique and based on its creator's genius.

4. The Expert Myth

Most of the people believe that only experts in a particular field can be creative. Even though knowledge is important, those who understand the situation and solutions can be more creative. People are creatively the best at their younger ages.

5. The Incentive Myth

This myth says that offering more payments or incentives make people work more creatively. Incentives provide extrinsic motivation to get the things done. Actually intrinsic motivation should make people more creative.

6. The Lone Creator Myth

This myth believes that creativity is a one man show, that is, creativity is the result of a single person's efforts. Most of the inspirational stories we hear belong to this myth. In truth, everything comes as a result of teamwork.

7. The Brainstorming Myth

It is believed that the easiest and most effective way to be more creative is to come with large number of ideas and select the best from it by filtering the unwanted and unsuitable ones.

8. The Cohesive Myth

Friendly and cheerful teams can be more creative than others. This is the essence of the cohesive myth.

9. The Constraints Myth

Those who belong to the constraint myth believe that creativity flows only when there is absolute freedom. Still then, there are no evidences that constraints hamper creativity.

10. The Mousetrap Myth

The name of this myth came from the saying "*build a better mousetrap, and the world will beat a path to your door*". It implies that any good idea will be immediately accepted and popularised.

CRITICAL THINKING

Critical thinking is clear, rational and disciplined thinking where the thinker is open to recognise and raise the efficiency of thought process. It is a tool to improve one's thinking capacity. Critical thinkers analyse, unify and evaluate what is heard, seen or read by them.

CRITICAL THINKING VERSUS CREATIVE THINKING

The main differences between critical and creative thinking are given below.

Based on the Characteristics of Thought Process

CRITICAL THINKING	CREATIVE THINKING
Mostly linear	Often non linear
Selective (works by elimination)	Generative (generates new possibilities)
Converges towards single answer	Moves away from a single answer
Looks for correct answer	Looks for possibilities
Remains objective and logical	Suspends judgements

Based on Skills Used

CRITICAL THINKING	CREATIVE THINKING
Comparison, classification, sequencing, cause/effect/ patterning, analogies, deductive and inductive reasoning, forecasting, planning, hypothesising and criticising.	Flexibility, originality, fluency, elaboration, brain storming, modification, imagery, associative thinking, attribute listing, metaphorical thinking and forced relationships.

FUNCTIONS OF LEFT BRAIN AND RIGHT BRAIN

The human brain is divided into two hemispheres; the right and left hemispheres, which are connected by a band of tissue called corpus callosum. The left side of the brain controls the right side of the body and vice versa. The two hemispheres are associated with different types of cognitive functions. The left brain is associated with rational, sequential thinking and the

right brain is with intuitive and non linear thinking. In every individual, one side is more dominant. The brain functions more efficiently when both the hemispheres are equally active.

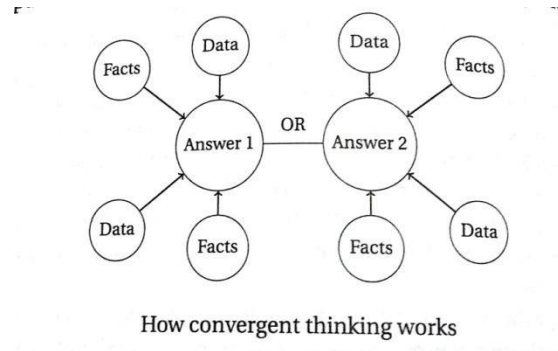
The functions of left and right hemispheres of the brain are given below.

LEFT BRAIN	RIGHT BRAIN
1. Responsible for the 3R's(Reading, wRiting and aRithmetic)	1. The sensory, spatial and synthesising part.
2. Information processed linearly. Arranges pieces of data logically before reaching to conclusions (from parts to whole).	2. Information processed holistically. Proceeds from the answer to the details (from whole to parts)
3. Controls feelings and emphasizes logic.	3. Acknowledging feelings and emotions.
4. Tasks are processed sequentially. Completes tasks in order. Responds well to schedules and lists. Comfortable with planning and structuring.	4. Tasks are processed randomly. Not systematic and changes from one task to the other.
5. Skillful in processing data represented by symbols and numbers.	5. Skillful at processing concrete concepts.
6. Logical. It sees cause and effect. Looks for logical conclusions when confronting with too many issues.	6. Intuitive. Sees correspondences and similarities.
7. Prefers validated and quantified data.	7. Prefers elusive and uncertain ideas.
8. Skillful at seeing differences and dissimilarities. Works by contrast.	8 Skillful at seeing underlying similarities.
9. Highly verbal. Responds better to verbal instructions.	9 Predominantly non verbal. Responds well to visual/graphical instructions.
10. Responsible for optimism and jolliness	10 Emotive and pessimistic.

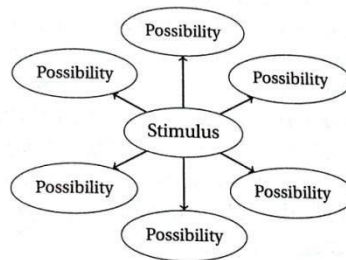
CONVERGENT AND DIVERGENT THINKING

Convergent thinking refers to the ability of a person to arrive at a single and the most appropriate and often correct answer to a question. The questions in this case do not demand much creativity. The emphasis here is on speed, accuracy, logic, etc. The answers come out of

divergent thinking can be right or wrong. It is a good problem solving tool. Critical thinking is an example for convergent thinking.



Divergent thinking is the opposite of convergent thinking. It is a thought process works by generating and exploring different alternatives for a single problem. The thought process is non linear and spontaneous. Creative thinking is an example for this. Divergent thinking is associated with personality traits such as curiosity, persistence and openness to risks.



CRITICAL READING

In simple, critical reading is reading between the lines. A critical reader approaches the reading material with an analytical outlook. The critical reader actively considers the content of the write up and tries to find out the purpose of writing, the style of the author and writing style, etc.

How to Read Critically

Critical reading is the starting point for good writing. A combination of the following approaches will help us improve reading comprehension and consequently writing skills. They are,

1. Previewing

Previewing helps defining our expectations from the reading material. It takes place before reading the text. It includes the questions we ask ourselves, like ***what am I looking for from the text? What do the title, subtitles and structure of the document tell me about the text? What do I know about the author?***

2. Annotating

Annotating means making notes at the margins of the text. This may help us for future reference.

3. Summarising

It is shortening the overall content of the text. We identify the main ideas of the given material.

4. Analysing

The total text will be analysed by the reader in this step.

5. Re reading

Critical cannot be completed in a single reading. At least three readings are necessary to find and understand the exact meaning of the text.

6. Responding

It tells about giving our own critique for the text. This can be practiced by writing a short note on what we have read.

THEORY OF MULTIPLE INTELLIGENCES

The theory of multiple intelligences was proposed by Dr Howard Gardner, in 1983. According to Gardner, there are **eight different intelligences** which individuals may have in varying degrees. They are as given below.

1. Logical Mathematical Intelligence

Prefers working with numbers, logic, patterns, mathematics and abstract thoughts.

2. Linguistic Intelligence

Comfortable with words, language and linguistics.

3. Musical Intelligence

Skillful in music, tones and rhythms.

4. Spatial Intelligence

Has aptitude for images, visualisation and understanding special relationships.

5. Bodily Kinesthetic Intelligence

Excellent body awareness, control over movements, balance, effective communication through body language.

6. Interpersonal Intelligence

Keen sense of empathy, capability for team work, mediation and inter personal communication is included in this.

7. Intrapersonal Intelligence

Highly self aware, interested in higher truths, rich inner life, etc are coming under it.

8. Naturalist Intelligence

Deals with appreciation and respect for all life forms, ability to draw inspiration from the Nature, conscious of one's relationship with Nature, etc.

PROBLEM SOLVING

Problems are obstacles thrown in front of us to hamper our progress. These problems must be solved and overcome. Problems can arise in personal, professional and social contexts. Some problems can be solved alone, some can be by collective thought and some by using computers.

Problem solving refers to any activity or group of activities that seek to resolve problems or find a solution to solve the problems, by proceeding in an orderly fashion.

Steps in Problem Solving

Problem solving requires a number of different thinking styles. Some problems require critical thinking while others need creative thinking styles. There is a problem solving cycle which has been identified by **Bransford** and **Stein** and is known as the **IDEAL model**.

The steps in IDEAL model are,

1. Identification of Problems and Opportunities

This is the first step which involves actively looking to the problems and not just responding to them. The problems must be stated clearly so that the subsequent steps are easier.

2. Definition of Goals

Defining the goals of the solution is important to decide the direction of the problem solving process. There must be clear understanding of what the

requirement is. The constraints, various interests, etc must be taken for consideration in this step.

3. Exploration of Possible Strategies

This stage needs a considerable amount of iteration. There are several methods like formal and informal for the generation of alternatives. The goals, constraints and interests must be constantly re analysed with respect to the strategy we adopt for problem solving. Every possible strategy must be tried before we take a decision.

4. Anticipation of Outcomes and Action

Every possible outcome must be analysed after deciding a strategy. The already fixed strategy may have to be modified or even discarded. Inappropriate assumptions which were made earlier can be rectified in this stage.

5. Learning through Retrospection

This is the key for all the possible and further progress. It helps to understand the mistake we made and learn from the past experiences. This helps in adopting the most suitable strategy in future.

Problem Solving through Six Thinking Hats

The Six Thinking Hats method was put forward by Edward de Bono. This method helps us analyse and structure our thought process.

According to de Bono, we are capable of different thinking styles. These styles are represented by imaginary hats, each hat with different colour. By mentally wearing and switching hats, it is easier to move from one thinking style to another. The six thinking hats are given below.

1. The White Hat

It is the hat of facts and data. When wearing a mental white hat, we must focus on analysing the available data and infer the information from them.

E.g. *There are **hundred varieties** of animals in this zoo.*

2. The Red Hat

It is the hat of feelings and emotions. When wearing a red mental hat, we are free to focus on insights, anxieties, feelings, etc.

E.g. *I **feel worried** about their safety.*

3. The Blue Hat

It is the hat of process control. When wearing the blue hat, it is about the thought process itself that we think- whether are we approaching the problem in the right way, what are all the ground rules and whether the current thinking is productive. The blue hat initiates the discussion, controls its flow and sums it up to provide the bigger picture.

E.g. ***How are we planning** to market this product?*

4. The Yellow Hat

It is the hat of optimism and positivity. We take a logically optimistic view of the problem when we wear a yellow hat. The benefits, feasibility, positive assets, etc are evaluated in this.

E.g. ***Such low product cost will raise profit.***

5. The Green Hat

It is the hat of creativity. We can think and act creatively. We are encouraged to go beyond the limits we set for ourselves. Out of the box solutions come from green hat thinking.

E.g. ***If we can pack this product as a new budget option, we can attract more customers.***

6. The Black Hat

It is the hat of caution and critical thinking. We can reflect on how an idea wouldn't work in the current context. The black hat is important for decision making, but it should be used moderately.

E.g. ***With such low price, we cannot assure quality.***

Putting on and taking off each hat, mentally helps us to switch from one type of thinking to another. All the six hats are important and they act as tools to strengthen critical thinking and the ability to solve every problem effectively. These hats help us perform well in a team towards a common goal.

Advantages of Six Thinking Hats

1. Saves time in meetings
2. Eliminates personality conflicts in meetings
3. Helps to separate each aspect of problems, i.e. emotions, facts, etc.
4. Improves performance of individuals and teams
5. Helps in preparing for changes
6. Improves clarity and conciseness in communication.
7. Parallel thought is encouraged.

MIND MAPPING

The term “mind map” was coined by Tony Buzan in 1970s. Mind mapping is a method of pictorially representing information and exploring new ideas and concepts. It represents the hierarchy/ interrelationships of new ideas and concepts in the form of a picture or network. It is a spider diagram which “maps” information.

A mind map usually has a central theme which is written prominently or drawn as an image at the centre of a blank page. Major ideas related to the central theme are placed around the central idea and are represented by words, phrases or pictures and connected to the central idea. Each major idea has smaller ideas, and those are placed in branched or hierarchical structures. Connections among these can be had with lines, arrows, etc. Use of colours, images, etc. adds effectiveness.



Uses of Mind Mapping

- ✓ Mind maps are used by many companies like IBM, Walt Disney, Microsoft, etc.
- ✓ Mind maps are used for business presentations.
- ✓ It promotes creative and critical thinking processes.
- ✓ It can be used for educational purposes like taking classes, taking down notes, etc.
- ✓ It can be used for training purposes.

Rules for Mind Mapping

- ✓ Start at the centre of a blank page and place the central idea there.
- ✓ Use a picture to represent the central idea, if possible.
- ✓ Use colours.
- ✓ Make the branches curved rather than using straight lines.
- ✓ There should be only one keyword per line.
- ✓ Images can be used.
- ✓ Develop your own style of mind mapping, if needed.

Advantages of Mind Mapping

- ✓ Both hemispheres of brain become active participants as mind maps have verbal and visual components.
- ✓ The storage and retrieval of information become easier for the brain.
- ✓ New information can be added easily into the mind map.
- ✓ Promotes creative thinking.
- ✓ Helps in concentrating on single and central idea.
- ✓ Helps in condensing large amount of information into single sheet of paper.

FORCED CONNECTIONS

Forced connections or forced association is an entertaining and radical way of generating new ideas. Forced connections help individuals and groups to breakout the thought patterns that we may get fixed with. In this method, **the group members are expected to derive or force a connection between the problem at hand and a random object or picture.** The members can connect any attribute of the object/ picture to the problem, which promotes divergent thinking.

When the brain considers two different items, it will try to find the possible connections between them. This is the basis of forced connection method.

PROBLEM SOLVING STRATEGIES

A problem solving strategy is a series of steps that a problem solver adopts to solve the problems. The steps are usually closely connected. Experts use different strategies for problem solving. **Effective strategies have 4 to 15 steps.**

Polya's 4 Step Method for Problem Solving

According to George Polya, there are 4 essential principles of problem solving which are characterised by the following questions in each step.

1. Understand the Problem

- ✓ Do you understand all the words in the problem?
- ✓ Can you re state the question in your own words?
- ✓ What do you need to find out?
- ✓ Is there a picture/ sketch you can draw?
- ✓ Is the given information sufficient for the solution?
- ✓ If not, what other information is required?

2. Devise a Plan

There may be many ways to solve a problem correctly. A plan identifies the best strategy that can be used for problem solving. Some of the strategies are,

- ✓ Look for patterns
- ✓ Draw a diagram
- ✓ Make a table
- ✓ Break into sub problems
- ✓ Do a similar and simpler problem
- ✓ Guess an answer and check

- ✓ Write down equations
- ✓ Consider special cases
- ✓ Work backwards
- ✓ Be ingenious

3. Execute the Plan

Act according to the strategy planned out in the previous stage. Make sure that there is accurate record of what you did.

4. Look Back

Reexamine the answers that you have obtained. It helps in improving our problem solving skills.

Common Problem Solving Strategies

- ✓ **Abstraction**
Modeling the system and solving at that level before moving on to actual system.
- ✓ **Analogy**
Using a solution that works for a similar problem.
- ✓ **Brainstorming**
A group activity involving suggesting a large number of solutions and refining them until an optimum solution is found.
- ✓ **Divide and Conquer**
Breaking a larger problem into simpler sub problems.
- ✓ **Hypothesis Testing**
Assuming a possible solution beforehand and trying to prove or disprove the assumption.
- ✓ **Lateral Thinking**
Approaching solutions indirectly and creatively.
- ✓ **Means Ends Analysis**
Choosing an action each step to move closer to the goal.
- ✓ **Method of Focal Objects**
Combining characteristics of different objects into something new.

✓ **Morphological Analysis**

The output and interrelationship of the entire system is considered.

✓ **Reduction**

See whether the problem can be reduced with existing solutions.

✓ **Research**

Collect existing ideas used for similar problems and use for the solution of the present problem.

✓ **Root Cause Analysis**

Identifying the basic cause of a problem.

✓ **Trial and Error**

Testing possible solutions repeatedly until the right one is found. ****

ANALYTICAL THINKING

Systematic problem solving strategies will help us solving the mathematical problems very easily. Analytical and logical thinking belong to the category of systematic problem solving. In these two, we interconnect the facts given in a problem and the required outcome.

QUANTITATIVE REASONING – STRATEGIES

Problem solving strategies can be used based on the type of problem we confront with, information given, accuracy of the expected result, etc. They involve translating the representation of mathematical problem, making educated guesses, pattern searches, using simplifications and so on. Some of the strategies are given below.

Translate from Verbal to Numeric Form.

This strategy can be used effectively for word problems. The information given in word form is written in the form of an expression. The problem is understood in the language of mathematics to model it mathematically.

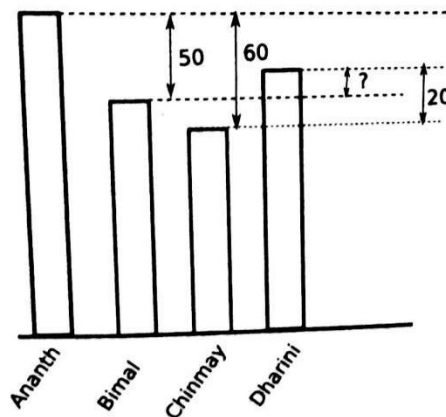
***Example:** the minimum charge for an autorikshaw is Rupees 20 for the first two kilometers. Every additional kilometer costs Rupees 4. If I paid Rupees 32 to come to college, how far away is my home?*

If the distance is d, $20+4(d-2) = 32$

Translate from Verbal to Graphical Form.

In this strategy, Information given in the problem is represented in the form of a picture. This can be either a sketch like, conceptual or schematic diagram. Maximum care should be there to draw the diagram. Drawing makes it easier to analyse the data and to identify the solution method.

Example: in a quiz, Ananth has 50 points more than Bimal, Chinmay has 60 points less than Ananth and Dharini is 20 points ahead of Chinmay. What is the difference in points between Bimal and Dharini?



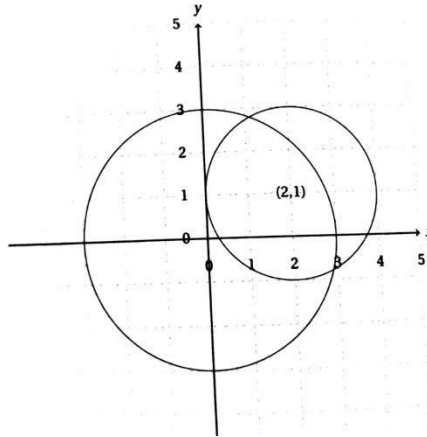
The figure is based on the data given in the question and the answer is $20 - (60 - 50) = 10$.

Translate from Numeric/Algebraic to Graphical Form

The problems that are stated in numeric or algebraic form can be understood and solved better if converted to graphical form. This is especially useful when the problems involve coordinates.

Example: which are the points of intersection of the two circles $x^2 + y^2 = 9$ and $(x-2)^2 + (y-1)^2 = 4$?

- (A) (1.1, 2.8), (2.9, -0.8) (B) (-1.1, 2.8), (-2.9, 0.8) (C) (3.6, 1.3), (0.8, 2.9)
 (D) (-3.6, 1.3), (-0.8, -2.9)

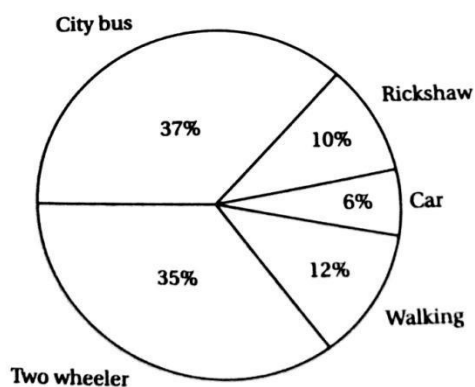


The figure is based on the data given in the question. Referring to the figure closely we can reach the conclusion that the answer is option (A) $(1.1, 2.8)$, $(2.9, -0.8)$

Translate from Graphic to Numeric/Algebraic to Form

If the question is given in the form of a picture, it can sometimes be translated into numeric/algebraic form that can be handled more easily. This strategy is widely used in reading and interpreting problems involving charts and graphs where data are represented graphically.

Example: Our college authority thinks about starting a new college bus route. A survey has been conducted among students living along the proposed route. From the pie chart given below, determine the percentage of students likely to use the college bus to travel.



Form the given data, we can assume that those who use their own vehicles will continue to do so and those who walk to the college live near to the college. Therefore the percentage of students likely to use the college bus is, %possible to travel by college bus = % bus + % rickshaw = $37+10=47$