

# **PEDAGOGY OF** **MATHEMATICS**



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## UNIT - 1

# MEANING, NATURE AND SCOPE OF MATHEMATICS

1. **Define Mathematics. Explain the nature and scope of mathematics?**

**Ans :** The term mathematics is derived from two greek words "Manthanein" and "Techne". Etimological meaning of Manthanein is learning and "Techne" is an art or technique. Therefore the Meaning of mathematics is art of learning related to disciplines or faculties.

### Definitions:

**Mathematics is the study of quantity - Aristotle**

**Mathematics is a science of order and measure  
- Descartes**

### Nature of Mathematics:

Mathematics is also called the science of logical reasoning. According to Locke "Mathematics is a way to settle in mind a habit of reasoning. Reasoning in Mathematics is of two types

a) **Inductive reasoning:** Mathematics in the making is experimental and Inductive. It leads from concrete to abstract, particular to general and from examples to general rule.

b) **Deductive Reasoning:** This type of reasoning is based on self - evident - truths, postulates, axioms etc.

### Pure and Applied Mathematics:

**Pure Mathematics:** In pure Mathematics we start from rules of Inference. It treats only theories and principles without regard to their application to concrete things thus pure Mathematics Involves systematic and deductive reasoning.

**Applied Mathematics:** Applied Mathematics considers those parts of mathematical theories that have certain direct or practical application to objects or actions in the material world.

**Scope of Mathematics:** The scope of Mathematics is unlimited It occupies all walks of life. Mathematics plays its role in the following ways

✦ In developing technology ✦ In learning any subject ✦ In developing various skills ✦ In developing intellectual powers ✦ In becoming self dependent.

2. **Write about History of Mathematics with special emphasis on teaching of mathematics?**

**Ans :** Mathematics Holds the Mirror up to civilisation mathematics has been a progressive science.

### Value of History:

**It values can be explained as follows:**

1. Mathematics will be presented as a dynamic and progressive subject, full of human Interest. 2. It warns the learner against hasty conclusions. 3. It revelas that, at every stage, major or significant development of mathematics was conditioned by human needs. 4. It shows that mathematics is a man - made science 5. Most of the terms, concepts and conventions can be properly understood only by Reference to their historical back ground.

### The Ancient civilisations and Mathematics:

**The Baby Lonians:** The study of Baby lonian Mathematics begins with the notation of numbers. A vertical wedge stood for 1. While the characters signified 10 and 100 respectively. Babylonians possessed the knowledge of multiplication and division tables, tables of squares and square root, of geometric progression, a few computations and the rules for finding the areas of squares, triangles and right triangles.

**The EGYPTians:** Aristotle says that mathematics had its birth in Egypt because there the priestly class had leisure need full for its study. Geometry is said to have originated in Egypt. The Egyptians were Familiar with well - known property of the right angled triangle. The period of Ahmes was a flowering time for Egyptian Mathematics.

**The Greeks:** The Greeks made wonderful contributions

in the mathematical field. They divided the field of Mathematics into arithmetic and geometry and considered both to have originated in practical activities.

**The school of Pythagoreans:** The word Mathematics was probably first used by Pythagorus. Their Geometry is much concerned with areas. Pythagorus called the sphere the most beautiful of all solids, and the circle the most beautiful of all plane figures.

**The sophist school:** Sophist taught Geometry, astronomy philosophy and language.

**The Hindus:** The Indians discovered zero itself. The Indians were the first to recognise the existence of absolutely negative quantities.

3. Write a short note on contribution of the following Indian Mathematicians.

a) Aryabhatta b) Brahmagupta c) Varahamihira  
d) Bhaskaracharya e) Srinivasa Ramanujan

a) **Aryabhatta:** Aryabhatta was a great Indian Mathematician. He was born near Patna in about 476 A.D and Lived near Patna from about 476 A.D to 550 A.D. The Mathematical part of the Aryabhatiya covers Arithmetic, algebra, planetringometry and spherical trigonometry.

#### Contribution to Mathematics

1. He gave formula for the area of circle 2. He gave formula for the area of triangle 3. He gave the value of  $\pi$  as 3.1416 4. He prepared arithmetic tables. 5. He gave the formula to find the square root 6. He prepared tables for sine 7. He explained how to find out cube root 8. He gave the procedure for finding out the volume of a prism 9. The place value system now we are using is given by him. 10. He explained the procedure for finding the circumference of a circle.

b) **Brahmagupta:** Brahmagupta was an Indian Mathematician born in 598 A.D in B hinmal Brahmagupta wrote many books for Mathematics and astronomy. These Include Brahmasphutasiddhanta, cadamakela.

#### Contributions to Mathematics:

1. He gave four different Methods of Multiplication *GAUMUTRIKA, KHANDA, BHEDA, Ista* 2. One of the most significant In Put of Brahmagupta to Mathematics was Introduction of "zero" 3. 'Brahmgupta's work on Indeterminate equations displays his great power. 4. He gave the value of pi as square root ten to be accurate and 3 as the practical value. 5. He gives rules for the gross area of a triangle and quadrilateral.

c) **Varahamihira:** Varahamihira made important contributions to Mathematics. He was also an astrologer and is considered among the greatest Acharyas of modern astrology.

He has gifted us with the following treatises on astrology: + Yoga yatra + Brihat Samhita + Laghu Jaatak + Vivahapatal

d) **Bhaskaracharya:** Born : 1114 in Vijayapura Died : 1185 in UJJain

Bhaskaracharya is also known as Bhaskara-II or as Bhaskaracharya this latter name meaning Bhaskara, the Teacher.

**Contributions to Mathematics:** 1. Equations leading to more than one solution are given by Bhaskaracharya. 2. He understood about zero and Negative Numbers 3. He gave two methods of multiplication in his Lilavati 4. He had explained the concepts of permutations and combination. 5. Bhaskara for the first time brought the Idea of Infinity while dividing a Number by zero. 6. He gave the formula for area of sphere. 7. He also dealt with cubic and Biquadratic equations 8. He studied many Diophantine problems.

e) **Srinivasa Ramanujan:** Born : 22-12-1887 in Erode Died : 26-04-1920 in Kumbakonam

Srinivasa Ramanujan was one of Indians Greatest Mathematical Geniuses. He made substantial contributions to the analytical theory of numbers and worked on elliptic functions, continued Fractions and Infinite series.

**Contributions to Mathematics:** 1. He did great work on Magic squares 2. He worked on divergent series 3. His

Mocheta functions are using in preparing medicine for cancer  
 4. He made substantial contributions to the analytical theory of Numbers and worked on elliptic functions and infinite series 5. Ramanujan Independently discovered results of KUMMEL, Gauss and other on hyper. Geometric series 6.1729 is the smallest Number which can be expressed as the sum of two cubes in two different ways

$1729 = 1^3 + 12^3 = 9^3 + 10^3 = 1729$  is called as Ramanujan Number.

4. Write a short note on contribution of the following western Mathematicians

- a) Euclid b) Pythagoras c) Renedescarte  
 d) Geroge Cantor

**Euclid: (330 B.C to 295 B.C)** Euclid is the most prominent Mathematician of antiquity best known for his treatise on Mathematics. "The Elements". The Elements of Euclid consists of 13 Books.

Book	Topics Included
I	Congruence, parallels and Pythagoros theorem
II	Algebraic Identities, areas
III	Circles
IV	In scribed and circumscribed polygons
V	Proportion treated geometrically
VI	Similarity of polygons
VII, VIII, IX	Arithmetic treated geometrically
X	Incommen surable magnitudes
XI, XII	Solid geometry and the Method of exhaustion

**b) Pythagoras: Born : 569 BC**

Died : 500 - 475 BC

Pythagoras was the father of Greek Mathematics astronomy and philosophy.

In mathematics the Pythagoreans made very great progress particularly in the Field of Numbers and geometry of solids and areas.

**Contribution:** 1. He is credited to have discovered the proof on the theorem of a right angled triangle 2. Pythagoras studied perfect numbers with veneration and Interest 3.He was the first discoverer the earth is a sphere in space 4. He solved equaltions  $a(a - x) = X^2$  by geometrical means 5. Pythagoras was one of the first Mathematician to class all numbers as odd or even. 6. He proved the proposition relating to the sum of the angles of a triangle (  $180^0$ ) 7. Pythagoras For the First time was able to furnish a proof of the fact that  $\sqrt{2}$  is irrational.

**C) Renedes carte:** Renedescartes ( 1596 - 1650 A.D) was on the leaders in the development of mathematics. He laid foundation for analytic Geometry and also made a number of contribution to the modern algebra.

#### Contributions to Mathematics:

1. Descartes professed that the abstract quantity  $a^2$  could represent length as well as an area 2. He invented the convention of representing unknowns in equations by x,y and z and known by a, b and c 3. His work Lageometric Includes his application of algebra to geometry from which we now have Cartesian geometry.

He published two Books 1. Meditations 2. Discourse on method. His work changed the face of mathematics because of his contribution towards Analytical Geometry.

#### d) Gerogecantor:

Born: 03 -03 -1845 in St. Peterburg

Died : 06 - 01 -1918 in Halle.

He Invented set theory, which has become a Fundamental theory in Mathematics. Cantor established the Importance of two sets, defined Infinite and well - ordered sets, and proved that the real numbers are more numerous than the natural numbers.

**Contributions to Mathematics:** In 1873 cantor proved the rational numbers were countable i.e they may be placed in

one-ones correspondence with the natural numbers. He also showed that the algebraic numbers i.e the numbers which are roots of polynomial equations with Integer coefficients, were countable. He had proved that the real numbers were countable proved harder cantor Introduced Fundamental constructions in set theory. In 1883, cantor divided the Infinite into the transfinite and the absolute.

### 5. How do you correlate Mathematics with other subjects

**Ans :** Mathematics is a subject which has made a great contribution to the development of all subjects. Mathematics is the gate way and key to all sciences - Bacon

**1. Mathematics and Physics:** All the laws of physics are expressed In Mathematcial language. Mathematical calculations occur at every step in physics.

A few more examples are as under

$$S = \mu t + \frac{1}{2} at^2$$

$$V = \mu + at$$

**2. Mathematics and chemistry:** All chemical combinations are governed by certain mathematical laws. All chemical compounds have their constituent elements in a definite ratio e.g. chemical equations are balanced by counting the number of atoms on either side

**3. Mathematics and Biology:** Bio Mathematics is another science which has been developed in recent years. It is an illustration of the application of Mathematics.

**4. Mathematics and Economics:** In Economics, Mathematics principles and language are Frequently applied to describe and Interpret social Phenomenona.

**5. Mathematics and Fine arts:** Mathematics is the pivot of all arts. The Following views express the relationship between Mathematics and Fine arts Pythagoras said " Where harmony is there are Numbers"

**6. Mathematics - Language:** Maths cannot be learned without the use of language.

## UNIT - 2

### AIMS AND OBJECTIVES OF TEACHING MATHEMATICS

#### 1. What is the Need for establishing General objectives for Teaching Mathematics.

**Ans :** Objective is something that one's efforts or actions intended to attain or accoplish, purpose, goal and target.

Objective as an end towards which a school sponsored activity indirected - Carter V.Good

#### Need for Establishing General Objectives for Teaching Mathematics :

✦ It enable the student to solve the Mathematical problems of his daily life. ✦ It enable him to comprehend the contribution of Mathematics to society. ✦ It develop the power of Logical thinking ✦ It promote the power of concentration in students. ✦ It develop the ability to analyse and to generalise ✦ It provide opportunities for aesthetic enjoyment and recreation.

#### 2. Explain the following concepts.

a) Aims of teaching mathematics b) Values of teaching mathematics c) General objectives of teaching mathematics.

**Aims of Teaching Mathematics :**The word aims refers to goals, targets and broader purposes.

**Aims of Teaching Mathematics at the Elementary level :** These aims can be enlisted as under.

✦ To provide a good start to the student in learning mathematics. ✦ To create in pupils an enduring interest on the subject and to develop a love for it. ✦ To develop in pupils a taste for and confidence in Mathematics. ✦ To prepare pupils for the learning of Mathematics for higher classes.

#### Aims of Teaching mathematics at the Secondary Level

**1. Knowledge aim :** It aims at imparting knowledge which will provide necessary guidance to act in a judicious way.

**2. Cultural aim :** Education should aim at transmitting and enriching out cultural heritage.

**3. Moral aim :** To develop moral values in the students through the learning of mathematics.

**4. Utilitarian aim :** To make the student understand and use the learning of mathematics in their real life.

**5. Disciplinary aim :** To develop logic and reasoning in the students through the teaching of Mathematics that discipline their mind.

**Values of Teaching Mathematics at Secondary Level:** The major values of mathematics are : + Practical or utilitarian value + Disciplinary value + Cultural value + Vocational values + Aesthetic values

**Practical / Utilitarian value :** The practical or utilitarian value of the subject Mathematics is concerned no other subject of the school curriculum can surpass it. Not a single aspect of our life is free from it use. Its importance is next to that of mother tongue. Every one of us uses some Mathematics directly or indirectly in every form of our life.

Napoleon talking about Mathematics said "The progress and the improvement of mathematics are linked to the prosperity of the state.

a) Mathematics as the base of science and technology  
b) utility in day to day life c) Use in business and industry  
+ Informative value + Mathematics is ingrained in nature.

**Disciplinary Value :** According to Locke mathematics is a way to settle in the mind a habit of reasoning. Mathematical learning also helps in developing. So many good virtues and habits like concentration, hardworking, punctuality.

**Cultural value :** In the words of J.W.A Young "Were its back bone removed, our material civilisation would Inevitably Collapse".

Mathematics is also a Pivot for cultural art such as music, Poetry and Painting. The symmetry of a picture or a potrait, the rhythm of music are nothing but Mathematics.

**Vocational Values :** Mathematics has great vocational values. A large number of occupations also require the knowledge of Mathematics in various degrees. Occupation such as banking, accountancy, insurance and many others need knowledge of Mathematics.

**Aesthetic valves :** Mathematics possesses immense aesthetic value. According to Thorndika "Education as a whole should foster the higher impersonal pleasures.

**Objectives of Teaching Mathematics :** Objectives are the specific and precise behavioural to come of teaching a particular topic in Mathematics. The objectives of a topic in Mathematics help in realising some general aim of teaching Mathematics. The characteristics of a good objective are as under.

- 1) It should be specific and precise.
- 2) It should be attainable

**Objectives of Teaching Mathematics at the primary stage :** The objectives at the elementary stage can be supplemented as given A) Knowledge objective B) Ability Objectives C) Appreciation objectives D) Attitude Objectives

**Objectives at the Secondary Stage :** These objectives more or less the same as those enlisted for the entire school stage.

A) Knowledge and understanding objectives B) Skill objectives C) Application objectives D) Attitude objectives E) Appreciation and interest objectives

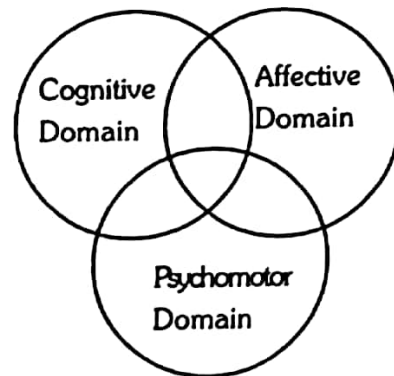
**3. Describe the blooms taxonomy of educational objectives.**

**Ans:** The word Taxonomy is derived from the Greek word "Taxa" meaning arrangement. In the field of education Prof. B.S Blooms have attempted to classify the educational objectives into an hierarchy. He is considered as a pioneer in this field and was the editor of the first volume of "Taxonomy of educational objectives "(1956) produced by an American committee of college and university examiners. He has classified the Taxonomy in to 3 domains as follows.

### The classification of Blooms Taxonomy

COGNITIVE DOMAIN	AFFECTIVE DOMAIN	PSYCHOMOTOR DOMAIN
1. Knowledge	1. Receiving	1. Perception
2. Comprehension	2. Responding	2. Limitation
3. Application	3. Valuing	3. Manipulation
4. Analysis	4. Organisation	4. Precision
5. Synthesis	5. Characterization	5. Articulation
6. Evaluation		6. Naturalization

All these three domains are interrelated as shown in figure below



**1. COGNITIVE DOMAIN:** This domain containing six major classes or categories as proposed by Bloom.

**1. Knowledge:** It involves the recall of specific and universals, methods and processes, or of a pattern, structure of setting

- Knowledge of terminology and facts
- Knowledge of conventions, trends and sequences classification and categories criteria, methodology
- Knowledge of principles and generalizations of theories and structure.

**2. Comprehension:** It represents the lowest level of

understanding and includes translation, interpretation and extrapolation.

**i) Translation:** Translation means that an individual can put a communication into other languages, into other terms, or into another form of communication i.e.,

**a) Translation form one level of abstraction to another:** It means the ability to translate a problem given in abstract terms into concrete or less abstract.

Ex: State the problem in your own words

The ability to translate a lengthy part of a communication into briefer or more abstract terms.

Ex. To explain the whole experiment in two or three sentences.

The ability to translate an abstraction, such as some general principle, by giving an illustration or samples.

Ex. Give example for Newton's third law of motion i.e., for every action there is equal and opposite reaction

To answer the questions given above the students writes the problem in simple language in order to make it concrete.

**b) Translation from symbolic form the another form, or vice-versa.**

It means the ability to translate relationships expressed in symbolic form, including illustrations, maps, tables, diagrams, graphs, mathematical and other formulas, to verbal form and vice versa

Ex. 1 Ability to translate geometrical concepts into verbal terms and into visual terms.

**2. The pupil translates a given problem into an equation.**

**c) Translation from one verbal form to another:** It means the ability to translate non literal statements (Metaphor, symbolism, Irony, Exaggeration) to ordinary language.

Ex. 1. The building is touching the sky

2. The students re-states it as "The building is very high".

It is also the ability to translate from (with or without a dictionary) one language into another language.

**ii) Interpretation:** In order to interpret a communication, one must be able to translate each of the major parts of it. It

includes competence in recognizing the essentials and differentiating them from the less essentials or from the relatively irrelevant aspects of the communication. It requires the ability in abstracting generalization from a set of particulars.

The essential behaviour in interpretation is that when given a communication the student can identify and comprehend the major ideas which are included in it as well as understand their inter-relationships.

**iii) Extrapolation:** To extrapolate one must be able to translate as well as interpret and in addition one must be able to extend the trends or tendencies beyond the given data and findings in order to determine implication, consequences, corollaries, effects, etc. Extrapolation can only be an inference which has some degree of probability. Extrapolation includes.

- a) Drawing conclusions and
- b) Making predictions.

Ex: ✦ Strike a matchstick against the rough surface, what happens? (The Pupil Predicts)

✦ The pupil concludes that all living beings require, oxygen to live

**3. Application:** Application occupies the third position in the hierarchy of the objective under cognitive domain. It requires something more than knowledge and comprehension. It implies the ability to apply an abstraction, method, theory, principle, formula etc. to an unfamiliar or novel situation.

The effectiveness of the teaching program lies in how far students are able to carry over the effects of their learning into situations that they may face in future.

Under the objective application we try to inculcate the following abilities among the students.

- i) Searching familiar element in an unfamiliar situation.
- ii) Using familiar elements to re-structure problem in familiar context.
- iii) Classifying the problem as familiar in type.
- iv) Selecting abstractions (theory, principles, idea, method) suitable to problem type.
- v) Use of abstraction to solve problem.
- vi) Finding solution to a problem

**4. Analysis:** The breakdown of a communication into its constituent elements or parts so that the relative hierarchy of ideas is made clear and/or the relations between the ideas expressed are made explicit.

Analysis refers to the ability to breakdown material into component parts so that its organizational structure may be understood. Learning outcomes here represent a higher intellectual ability than comprehension and application because they require an understanding of both the content and the structural form of the material.

Analysis is attempted at three levels.

- a) Analysis of Elements
- b) Analysis of Relationship
- c) Analysis of Organizational Principals.

**5. Synthesis:** The putting together of elements and parts so as to form a whole. This includes the production of unique communication, of a plan or proposed set of operations and derivation of a set of abstract relations.

**6. Evaluation:** Judgments about the value of material and methods for given purposes. This includes judgments in terms of internal evidence or external evidence.

**i) Internal Evidence:** Judgments in terms of internal evidence is qualitative in nature such as logical accuracy, consistency and other internal criteria.

In internal evidence judgments is made on the basis of a) Accuracy b) consistencies c) reliability d) precision e) exactness

**ii) External Evidence:** In external evidence the judgments are made on the basics of a) results b) Efficiency, c) Economy d) Utility e) Standard, F) Generalization.

Evaluation thus represents use of a standard of appraisal in a complex process which involve some combinations of all other behaviours of knowledge, comprehension, application, analysis and synthesis.

**II. AFFECTIVE DOMAIN:** This domain is concerned with feelings and includes attitudes, interests, values and appreciation. These characteristics are hard to define and evaluate.

The different categories of the affective domain are described as follows:

**1. Receiving :** Receiving means to orient the learner to learn which is the first step. "Sensitivity to the existence of certain phenomena and stimuli, that is, the willingness to receive or attend to them. "Receiving consists of three sub-categories that represent a continuum.

**It includes:** a) **Awareness:** Awareness is almost a cognitive behavior without specific discrimination or recognition of the objective characteristics of the objects.

b) **Willingness to receive:** Willingness to receive is to tolerate a given stimulus not to avoid it. It involves a neutrality or suspended - judgment toward the stimulus.

c) **Controlled or selected attention:** At a somewhat higher level we are concerned with a new phenomenon, the different qualities of a given stimulus into figure and ground at a conscious level.

**2. Responding:** This class comes after the learner has given his attention. "Behaviour which goes beyond merely attending to the phenomena, it implies active attending doing something with or about the phenomena, and not merely perceiving them" sub categories of responding are .

a) **Acquiescence in responding :** It is the first level of active responding after the learner has given his attention ( we might use the word compliance to describe the behaviour)

b) **Willingness to Respond:** It is voluntarily response to outside prompting, the response get social approval.

c) **Satisfaction in response on subjects:** In addition to the willingness to respond, the consent, the assent responding the behaviours is accomplished by a feeling of satisfaction an emotional response generally of pleasure or zeal.

d) Appreciation on subjects and teachers

**3. Valuing:** It includes acceptance of a value, preference for a value and commitment to or a conviction with regard to a certain point of view.

**It includes:**

i) **Acceptance of a value:** At this level we are concerned with the describing of worth to a phenomenon, behavior objects etc. At this level, there is more of a readiness to re-evaluate one's position than at the higher levels.

ii) **Preference for a value:** Behaviour at this level implies not just the acceptance of a value to the point of willing to be identified with it, but the individual is to be sufficiently committed to the value, to pursue it, to seek it out, to want it.

iii) **Commitment:** Belief at this level involves a high degree of certainty, The ideas of conviction, certainty beyond a shadow of doubt "help to convey further the level of behaviour intended.

**4. Organization :** When the learner develops certain values, he encounters situations for which more than one value is relevant. In such a case values are organized into systems.

**It includes :**

i) **Conceptualization of a value :** After developing values the quality of abstraction or conceptualization is added. This permits the individual to see how the value relates to those that he already holds or to new ones that is coming to hold. The process of abstraction involves analysis & differentiation.

ii) **Organization of value system:** Objectives properly classified here are those which require the learner to bring together a complex of value, possibly disparate values and to bring these into an ordered relationships with one another.

**5. Characterizing:** The individual starts acting constantly in accordance with the values he has developed.

**It includes:**

i) **Generalized Set:** The generalized set is that which gives an internal consistency to the system of attitudes and values at any particular moment.

ii) **Characterization:** Objectives, categorized here are more than generalized sets in the sense that they involve a greater inclusiveness and within the group of attitudes, behavior, beliefs or ideas, an emphasis on internal consistency.

### III. PSYCHOMOTOR DOMAIN:

This domain includes those objectives which deal with all motor skills and their perfection through practice.

**1. Perception :** This includes sensory stimulations such as auditory, visual, tactile, taste, smell and kinesthetic (Muscular movement) and also we selection (i.e., directing ways, means etc).

**2. Imitation:** Observing others work and repeating the

same. (Imitating the teacher's good demonstration, drawing, handling of apparatus etc.).

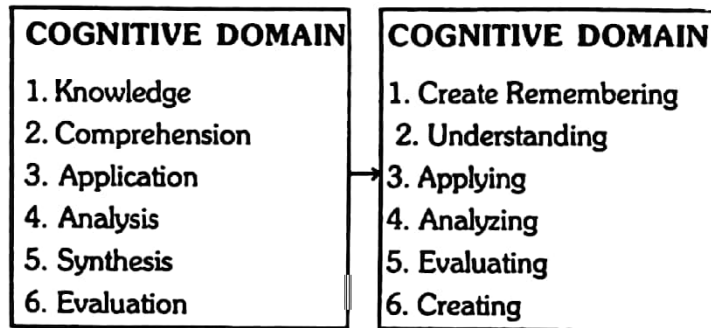
**3. Manipulation:** Acquires skill and confidence by doing things correctly. Learns the mechanism by handling any appliances and involving physically.

**4. Precision :** Performance should be carried out with precision without any confusion. Because one has acquired correct skill and ability he makes resolution of uncertainty, one is capable of automatic performance having in mind the task sequence without any hesitation.

**5. Articulation:** In this stage there should be establishment of relationship in learning by combining and organizing.

**6. Naturalization:** All activities or learning should become natural and habit.

#### Revised Bloom's Taxonomy:



✦ Bloom's taxonomy is a convenient way to describe the degree to which we want our students to understand and use concepts, to demonstrate particular skills and to have their values, attitudes and interests affected.

✦ Bloom's taxonomy can be used in a repeated fashion to first state and then refine course goals.

✦ It can be used to identify which classroom assessment techniques are most appropriate for measuring these goals.

1. Bloom's classification is not applicable to all areas of the curriculum. 2. This classification lays emphasis more on measurable behaviour and does not give importance to

immeasurable work of the pupils. 3. Bloom's educational objectives are not that much helpful to socialize the child. 4. Evaluating the Affective Domain objectives is very difficult.

**Lewtom (1973) and Kelly (1977) have critized this method of classifying educational objectives as:**

1. The three fold classification is somewhat artificial as in practice all three are closely interrelated

2. There is not always agreement on the appropriate classification for certain behaviours.

**4. How do you utilize knowledge resources in teachings Mathematics.**

**Ans: a. on line Knowledge Resources:**

**Data Bases:** ✦ India stot.com ✦ JSTOR

**E-Journals:** ✦ Economist ✦ American Journal of Evaluation

**Publications:** ✦ Library documentation ✦ News paper clippings Index ✦ Library services

**b. OFF Line Knowledge Resources:** ✦ Records ✦ Reports ✦ Books ✦ Comes

Under thin category. That means the resources available other than online are known as offline resources

**5. Explain the specific objectives and teaching points of various content areas in different branches of secondary school mathematics.**

**Ans: Teaching of different branches of Mathematics :**

**The Teaching of Alegebra :** The word Algebra is a corruption of the word 'Al-Jebr'al - Muqabulah' which means the operation of transferring a quantity from one side of an equation to another with a change in sign and Muqubulah means the process of subtracting similar quantities from both sides of an equation.

**Definitions :** Algebra is searching the properties of numbers and quantities through generalized symbols

- Concise Oxford Dictionary

**Aims of Teaching Algebra :** + To implement analytical process + To provide clarity, accuracy and brevity to express the mathematical thoughts through the language of symbolism. + To provide proper training for abstract thinking and reasoning and systematic analysis.

**Teaching Method : Inductive - Deductive Method**  
:The teaching of trigonometry may be started early in secondary schools as it is a combination of arithmetic, algebra and Geometry.

Trigonometry captures the pupils interest by helping him to solve practical problems. It gives new ideas and opens the way to more advanced developments. It provides technique for Physics; suitable approach to solid geometry and may lead to the study of vectors and complex numbers.

**The Method of approach :** There are three ways - the concrete, the graphical and the abstract.

**6. Write the Recommendations of various Educational Committees and Commissions as regards to aim and Objectives of Teaching Mathematics.**

**Ans: Aims of Education According to Indian Education Commission, (1964-66)**

Kothari Commission suggested the following objectives of education a) Increasing productivity b) Social and National Integration c) Maths to be an integral part of general school education d) The purpose of maths teaching linked to growth of Physical and biological Sciences and inturn to technology at the same time encourage logical thinking, reasoning and analysis e) Lack of detailed statement which would link aims to content and pedagogy.

**Recommendations of NCF 2005 for Teaching Mathematics :** Developing Children's abilities for Mathematisation is the main goal of Mathematics education. The narrow aim of school mathematics is to develop useful capabilities, particularly those relating to numeracy - Numbers, Number operations, Measurements, decimals and percentages. The higher aim is to develop the child's resources to think and reason

mathematically, to pursue assumptions to their logical conclusion and to handle abstraction. It includes a way of doing things, and the ability and the attitude to formulate and solve problems.

The emphasis for learning mathematics is that all students can learn and need to learn mathematics.

**Recommendations of National Knowledge Commission**

+ Focus on early childhood Education in view of 0-5 years are crucial for learning. + Education of marginalized groups, respect of diversity and equity + Improved school leadership for managing schools + Professional sharing and exchange between the schools.

**SCF -2011 Recommendations :**

+ Enriching the curriculum to provide for over all development of children rather than remain text book centric. + Making examinations more flexible and integrated into class room life; More focus on assessment for learning than assessment of learning + Keeping the potential of child to learn always in Focus.

**7. Explain the meaning and concept of Academic Standards of CCE.**

**Ans :** We need some specific statements which guide us to develop those skills in Mathematics class room. There statements are named as "Academic Standards".

Academic standards are clear statements about what students must know and be able to do with in a stipulated period to per form skills in a particular content or connecting contents.

**Academic Standards :**

1. Problem Solving :
  - a) Kinds of problems : Problems can take various forms puzzles, word problems, reading data, graphs etc steps in problem solving
  - b) Complexity
2. Reasoning proof
  - 1) Reasoning between various steps
  - 2) Understanding and justifies procedures

- 3) Examining Logical arguments  
 4) Understanding the Notion of proof  
 5) Uses inductive and deductive Logic  
 6) Testing Mathematical Conjectures
3. Communication  
 1) Creating Mathematical expressions  
 2) Explaining Mathematical Ideas in her own words  
 3) Explaining mathematical procedures  
 4) Explaining Mathematical Logic
4. Connections  
 1) Connections concepts with in a mathematical domain  
 2) Making connections with daily life  
 3) Connecting concepts of different mathematical domains  
 4) Connecting concepts to multiple procedures
5. Visualization & Representation  
 1) Interprets and reads data in a table number line, bargraph, pictures  
 2) Making tables, bargraph, pictures  
 3) Mathematical symbols and figures

**8. What is the link between Bloom's Taxonomy & Academic standards ?**

**Ans : Linking Bloom's Taxonomy with academic standards :**

Academic standard	Objectives
1) Problem Solving	1) Application
2) Gives reasons - proving	2) Application, Skill, Understanding
3) Expressing	3) Understanding, Application
4) Associating (Inter linking)	4) Application
5) Visualizing and Representing	5) Skill

## UNIT - 3

### METHODS, APPROACHES AND STRATEGIES IN TEACHING AND LEARNING OF MATHEMATICAL CONCEPTS

**1. Explain the Mathematical concepts**

**Ans :** A concept is a generalization that helps to organize Information into categories. A concept is an abstraction or generalization from experience or the result of a transformation of existing Ideas.

**Definitions:** Concepts are those thoughts which mention things, Incidents, qualifies, etc

- Wood worth

Concept is a process of representing a common property of objects or events

- Morgan

**Nature of Concept:** ✦ Concept is a part of thought process ✦ Concept is the process of discrimination of the common features ✦ concept can be formed without the use of Language.

**Meaning of concept formation:** It refers a generalized Idea about the persons. It is a mental disposition that helps in understanding the meaning of the objects or perceived earlier.

**Types of concept formation:** 1. Indirect experience  
 2. Direct experience 3. Faulty concepts

**Process of concept Formation:** The process of concept formation has three Important phases.

1. Perception 2. Abstraction 3. Generalization

**2. Write about creating awareness among student teachers on various concepts of Arithmetic, Algebra, Geometry, Trigonometry and probability and statistics from classics VI to X.**

**Ans : Awareness about Arithmetic:** We have the Following types of numbers system

a) **Natural Numbers :** These are 1,2,3,4 .....

b) **Whole Numbers :** 0,1,2,3 .....

c) **Integers :** .....-7,-6,-5 ... 0, .... 4,5

d) **Rational Numbers** : All Numbers  $p/q$  where  $p, q$  are Integers and  $q \neq 0$

e) **Irrational Numbers** : It Includes all the Numbers which cannot be written in the form  $p/q$ ,  $q \neq 0$

f) **Real Numbers** : The system of rational and irrational Numbers combined together is called real Number system

**Awareness about Algebra:** Algebra is one of the important branches of Mathematics. In a true sense algebra is a Generalised arithmetic.

#### Operations with Directed Numbers: 1. Addition:

The following four different situations may emerge in the additions of directed Numbers

$$\begin{array}{cccc} \text{a) } +4 & \text{b) } +4 & \text{c) } -4 & \text{d) } -4 \\ +3 & -3 & +3 & -3 \end{array}$$

The help from the real life situations May be take to illustrate the above cases.

**2. Subtraction:** The process of subtraction should directly flow from the process of addition.

**3. Multiplication:** Multiplication may also Involve the following 4 types of the situations.

$$\begin{array}{cc} \text{a) } (+5) \times (+4) & \text{b) } (+5) \times (-4) \\ \text{c) } (-5) \times (+4) & \text{d) } (-5) \times (-4) \end{array}$$

Like Multiplication in arithmetic here also the process of addition May prove useful.

**4. Division:** Division is the Inverse of Multiplication.

**Awareness about Geometry:** Geometry is derived from two Greek words Geo, Metrow. Euclid is the father of Geometry.

**Point:** A point is that which has No part

**Line:** A line is breadth less length

**Straight Line:** A straight line is a line which lies evenly with the points on itself.

#### Awareness about Trigonometry:

**Trigonometric functions:** It as an Important term used in trigonometry. The ratio of different parts of the sides of a right angled triangle are termed trigonometric functions. There are 6 trigonometric functions. They are  $\sin \theta$ ,  $\operatorname{cosec} \theta$ ,  $\cos \theta$ ,  $\sec \theta$ ,  $\tan \theta$ ,  $\cot \theta$

$$\sin \theta = \frac{\text{Height}}{\text{Hypotenuse}} \quad \operatorname{Cosec} \theta = \frac{\text{Hypotenuse}}{\text{Height}}$$

$$\cos \theta = \frac{\text{Base}}{\text{Hypotenuse}} \quad \sec \theta = \frac{\text{Hypotenuse}}{\text{Base}}$$

$$\tan \theta = \frac{\text{Height}}{\text{Base}} \quad \cot \theta = \frac{\text{Base}}{\text{Height}}$$

**Awareness about probability** Probability is the Measure of the Likelihood that an event will occur. Probability is quantified as a number between 0 and 1

$$P(E) = \frac{\text{Number of possible outcomes}}{\text{Total outcomes}} = \frac{m}{n}$$

$$P(E) + P(\bar{E}) = 1$$

**Awareness about Statistics:** Statistics finds wide applications in Economics, Education, Psychology etc. statistics is the study of the collection, analysis, Interpretation and organization of data.

**Measures of central tendency:** The most common measures of central tendency are the Arithmetic Mean, the Median and the mode.

**Range:** The range of sample is the difference between the largest and smallest value.

**Measures of variation:** Range, variance, standard Deviation etc.

### 3. Discuss Inductive Method of teaching Mathematics with special reference to its Meanings, Procedure, Merits and limitations

Inductive Method is based on the process of Induction It leads from concrete to abstract, particular to General and from examples to general rules.

Induction means to provide a universal truth by showing that if it is true for a Particular case, It is true for all such cases. A Formula or a generalisation is thus arrived at through a convincing process of reasoning and solving problems.

Example:  $3 + 5 = 8$   
 $5 + 7 = 12$   
 $9 + 11 = 20$

**Conclusion:** The sum of 2 odd Numbers is an even Number

**Merits:** + It helps in Increasing the pupil - teacher contact  
 + It reduces home work + It is based on experimentation and discovery + Self-activity of the pupils is encouraged in this method

**Draw Backs:** + This method is more laborious and also time consuming + It is applicable only is the understanding of rules at the early stage.

#### 4. Describe Deductive method of teaching mathematics. What are its merits and limitations?

**Ans :** Deductive method is the opposite of Inductive Method. In this method, the rules are given at the very out set. Then the pupils are asked to apply these rules to solve more problems. Here we proceed from abstract to concrete and from general to particular. The formula is accepted by the Learners as a pre-established and well established truth.

**Example:** Area of rectangle = length x breadth. Then the Students may be given problems to be solved with the help of this formula

**Merits:** This Method is short and time-saving + It increases speed and efficiency + It is suitable for all topics

**Demerits:** + The students are generally passive and disinterested + It is unpsychological approach + It demands blind cramming of formulae.

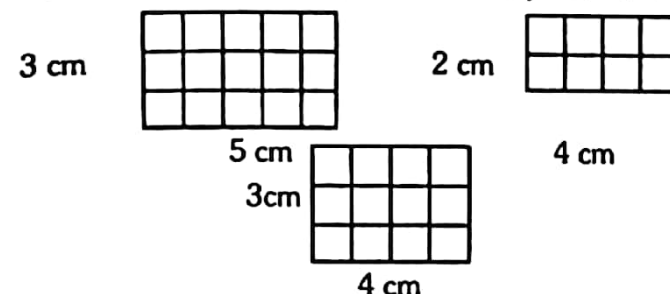
#### 5. What is the place of laboratory method in the teaching of methamatics ?

**Ans :** In the laboratory method, the students are required to do some experiments and practical work and verify certain mathematical truths. Here we proceed from concrete to abstract

The success of the Method depends upon a well equipped mathematics laboratory. It should have geometrical Instruments, sphere, cube, prism etc

**Example:** Area of Rectangle

the students will be asked to draw Number of rectangles of dimensions say  $5 \text{ cm} \times 3 \text{ cm}$ ,  $4 \text{ cm} \times 2 \text{ cm}$ ,  $4 \text{ cm} \times 3 \text{ cm}$  etc. Let them divide each rectangle in to unit square as shown



Area of rectangle = length  $\times$  breadth

**Merits:** + It provides opportunity for Independent work  
 + It Involves discovery by self effort + It is Interesting and enjoyable for the learner.

**Demerits:** + It is a slow method + The method is very expensive + It does not suit most of the topics of the subject

#### 6. Write about Activity based Teaching in Mathematics.

**Ans :** Activity-based Teaching describes a range of pedagogical approaches to teaching. Its core premises include the requirement that learning should be based on doing some hands on experiments and activities. The idea of activity based learning is rooted in the common notion that children are active learners Rather than passive recipients of Information.

**Concept of Activity Based Approach:** According to khanzode "previously teaching meant Nothing than giving. Information and important knowledge. According to Dhand" a learning centre or activity centre is one way of organizing Instruction so that students can direct their own learning.

**Need:** + Learners are encouraged to explore the New knowledge independently + Encourages independence and team learning X) Provides a wide variety of manipulative open-ended and creative activities.

#### 7. Describe the Analytic Method of Teaching Mathematics?

The word 'analytic' is derived from the word 'analysis' which

means to break up or to separate. In this method one moves from unknown to known by adopting the process of analysis. It is the process of unfolding of the problem or of conducting its operation to know its hidden aspects. The problem is analysed into its parts, relationship is discovered and then a solution is found out.

Thus in this method we break up the unknown problem into simpler parts and then see how these can be recombined to find the solution. Thorndike has stated that "all the highest intellectual performance of the mind is analysis". This methods can be illustrated by following examples.

**Procedure**

**Example 1:** x is true if y is true.

y is true if z is true. But z is true if x is true.

**Merits of Analytical Method:**

1. Analytical method is a logical method. It leaves no doubts and convinces the learners. 2. It develops the reasoning power of the students. 3. As the students go through the whole process themselves it helps in a clear understanding of the subject. 4. It encourages students' participation. 5. It is a psychological method.

**Demerits of Analytical Method:**

1. It is a time consuming and lengthy method, so it is uneconomical. 2. It is difficult to acquire efficiency and speed in this method. 3. Below average students fail to follow this method. 4. This method is not suitable for all the topics in mathematics. 5. In this method facts are not presented in a neat and systematic order.

**Application:** An analytical method is a lengthy and not elegant. It is the only method that explains why and where each step is to be taken. It is the method by which student can hope to discover proofs, or to recall when they forget. In mathematics this method is suitable for complicated problems. It analyses the problem into sub-parts and various parts are reorganised and the already learnt facts are used to connect the known with unknown. This method is particularly suitable for teaching of Arithmetic, Algebra and Geometry.

**8. Explain the Synthetic Method in mathematics teaching?**

**Ans:** Opposite to that of analytic method here we proceed from known to unknown. Actually synthesis is the complement to analysis. The word 'synthetic' is derived from the word 'synthesis' in which the smaller constituents or parts of a thing are combined or put together so as to give something new. In this method we combine together a number of facts, perform certain mathematical operations and arrive at the solution. In this method we start with the known data and connect it with the unknown part. It is the

process of putting together known bits of information to reach the point where unknown information becomes obvious and true. It can be demonstrated with the help of the following examples.

**Procedure**

**Example 1:** A is true because B and C are equal to A.

Therefore B is true, and therefore C is true.

**Example 2:** If  $\frac{a}{b} = \frac{c}{d}$

Prove that  $\frac{ac + 2b^2}{bc} = \frac{c^2 + 2bd}{dc}$

$\frac{a}{b} = \frac{c}{d}$  Add  $\frac{2b}{c}$  to both sides,  $\frac{a}{b} + \frac{2b}{c} = \frac{c}{d} + \frac{2b}{c}$

Or,  $\frac{ac + 2b^2}{bc} = \frac{c^2 + 2bd}{dc}$

**Merits:** 1. It is a short and elegant method. 2. It is a neat Method in which we present the facts in a systematic way. 3. It suits majority of our pupils. 4. Majority of topics in mathematics can be taught with this method. 5. It glorifies memories.

**Demerits:** 1. It does not provide full understanding. It leaves many doubts in the mind of the learners. 2. There is no scope of discovery and thinking in this method. 3. A synthetic method shows that every step is true, but does not explain why a particular step was taken. 4. It convinces the reader that the result is true, but does not reveal the process adopted and why the sequence of arguments was selected. 5. This is an unpsychological method.

**Application:** Synthetic method suits the average teacher and average students. It is a time saving and neat method, so teachers usually prefer this method. However, if it follows the analytical method then it gives the best results.

**9. Write about Heuristic Method**

**Ans:** The modern philosophy of mathematics instruction lays greater emphasis on "learning by doing", "activity approach" or "child-centered approach". This is in contrast to the "traditional" or "drill theory".

The word "discovery" is not new. It has been in use under the title "The Heuristic Method". The word heuristic is derived from the Greek word 'heurisko' which means "I find". This method was originally designed and applied by Armstrong for the learning of sciences through experiment. It avoids the shortcomings of the lecture method. The method makes the student an active participant in the learning process and encourages to quicken his interest. It makes the pupils think for themselves. The pupils develop an understanding of the subject. Once the interest is aroused, the pupils work willingly with greater zeal.

The method, being an individual method, is slower than the lecture method. It is very difficult to use in the earlier stages. The teacher using the method must have great patience, a high degree of insight into the workings of the students' mind and skill in the use of questions. Knowledge is not the primary consideration here. Self-confidence, originality, independence of judgement and thinking power are to be developed in the individual to make him an ever successful student. The teacher should not impose or thrust his reasoning, argument and product of thinking on him. Let the child help himself with reasoning and argument.

#### **Pre-requisites of the Heuristic Method:**

**The following are some pre-requisites of the method :**

✦ Since the heuristic method is an "activity approach" "child-centered approach" and "untraditional approach", in mathematic teaching, a lot of preparation is required on the part of a teacher. The work to be carried out by a student should be in accordance with his ability.

✦ A teacher must develop the heuristic attitude within himself.

✦ The questions should be so planned and posed that it may be possible for the students to find the solution independently.

✦ In order to use this method in earlier stages a good deal of guidance is required. This guidance should scientifically be planned.

#### **Procedure :**

**Example 1:** Each student will be given one rectangle and one square card board. They will be asked to discover the points

of similarities and differences between these two geometric models.

**Ask :** A rectangle is different from a square.

**Why?**

1. ....

2. ....

3. ....

**Ask :** What are the points of similarities ?

1. ....

2. ....

3. ....

#### **Heuristic Method and the Teacher :**

The teacher has to adopt the heuristic attitude. The teacher using the discovery method should guide and offer help to the child to develop a positive attitude. This implies that the teacher should try to avoid interfering too much with the work of the students. The teacher's role is one of support and encouragement. He should allow an independent outlook.

Some of the common method labelled as "project method" "problem method", "activity method", "induction method" fall under the discovery approach.

#### **Merits of Heuristic Method :**

1. This method makes the students active participants in the process of learning. 2. It helps the students to think and to discover things independently. 3. A child learns by doing so there is a little scope of forgetting. 4. It is a psychologically sound method. 5. It inculcates in the students the interest for the subject and also develops willingness in them.

**Demerits:** In spite of the fact that this method makes students independent and self-reliant, it has the following demerits and dangers in it:

1. Discovery of a thing needs hard work, patience, concentration, reasoning and thinking powers and creative ability. Thus this method may not be preferred by certain types of students. 2. As this method needs creative and effective planning of the teachers, an average teacher cannot frame true heuristic questions and stimulate pupils' thinking. 3. This method is very slow and the progress is not rapid. Due to slow progress, students

and teachers are not satisfied. 4. It is not a good method for the beginners. 5. When the students do not get help from the teachers, they are likely to consult books, answer books, etc. Such things are more dangerous.

**Conclusion** There is an objection that it is not an independent method. It is an attitude. Any method that keeps up the attitude of making the pupils do, think and discover for themselves is heuristic. It is a combination of several procedures i) questioning ii) giving information as and when needed, iii) eliciting student participation, iv) explaining, guiding, illustrating, stimulating, evoking interest and curiosity, and v) continual checking of the understanding and the reactions of the students.

#### 10. What do you understand by problem - solving Method?

**Ans :** This method generally referred to as Problem Method consists in training the pupils to solve problems. This method is based upon the process of finding out the results by attacking a problem in a number of definite steps. In this method the student is involved in finding out the answer to a given problem and thus actually it is a discovery method. In the words of Yoakan and Simpson, "a problem occurs in a situation in which a felt - difficulty to act is realised. It is a difficulty that is clearly present and recognised by the thinker. It may be purely mental difficulty or it may be physical and involve the manipulation of data. The distinguishing thing about a problem however, is that it impresses the individual who meets it as needing a solution."

**Procedure** The method proceeds in various steps discussed in the following lines.

1) **Recognising the problem.** First of all, we sense the presence of a problem and then identify the problem.

2) **Defining the problem.** The problem is then defined very precisely and accurately.

3) **Collecting relevant data.** Then all sorts of relevant data, which can be helpful in solving the problem, are collected and arranged in proper order.

4) **Organising the data.** The data is then organised in such a way that it can lead to the solution of the problem.

5) **Formulating the tentative solution.** On the basis of the organised data, the students formulates tentative solutions of the problem.

6) **Arriving at the correct solution.** Out of the tentative solutions, a correct solution is found out by a process of reasoning.

7) **Verifying the results.** In Mathematics, we do not accept a conclusion without proper verification. The students are required to verify the conclusion by reversing the process of reasoning.

To illustrate the method let us assume the problem as the one of finding the area of four walls of a room. In this were call the previous knowledge about area of rectangle because the total area is equal to the sum of area of four rectangular walls. This can be verified by actual calculations and the formula so derived may be used in future.

#### Merits of problem-solving Method

i) It prepares the students in problem- solving. This training in solving-problems is quite useful in solving problems in actual life. ii) It stimulates thinking, reasoning and imagination of the students. iii) It develops, a habit of doing work independently, in the students. iv) This method of teaching is quite suitable for mathematics as Mathematics is full of problems. V) It stimulates intellectual curiosity and motivates the students to exert further. Vi) In this method there is ample scope for individual work as a student is free to solve as many problems as he likes.

**Demerits of the problem - Solving Method** i) It is a long drawn out and time consuming method. ii) It is not suitable for all topics in Mathematics. iii) This method is suitable only for bright and creative students. iv) This method is not suitable for students in lower classes. v) This method requires special preparation on the part of the teacher. An average teacher may find it difficult to adopt this method.

**Application** This method trains the pupils in problem-solving. They learn to sense, analyse, reflect, organize and solve the problems. It helps us at every steps in our teaching-learning process. The teacher should carefully select the problems which are real and have definite educational values. The teacher should also prepare himself well for the success of the problem - solving method.

#### 11. What is project method ? Describe its procedures, Merits and Demerits.

**Ans :** This method was given by Dewey - the American

Philosopher, psychologist and practical teacher. The project method is a direct outcome of his philosophy. According to Dr. Kilpatrick, "A project is a unit of whole hearted purposeful activity carried on preferably, in its natural setting". According to Stevenson "A project is a problematic act carried to its completion" in its natural setting". According to Ballard, "A project is a bit of real life that has been incorporated into the school".

The project method is not totally new. Project equivalents are advocated for the adolescent period by Rousseau in Emile (BK-III). A project plan is modified form of an old method called "Concentration-of-studies". The main features of "concentration of studies plan" is that some subject is taken as the core or centre and all other school subjects as they arise are studied in connection with it.

**Project method is based on the following principles:**

i) Learning by doing. ii) Learning by living. iii) Children learn better through association, cooperation and activity.

In this method, a project is taken, which is then completed in a natural and social setting. As the project is carried to completion, the students learn so many things.

**Procedure : Project method generally involves the following steps :**

i) **Providing a situation.** The teacher provides a situation wherein the students feel like working on certain projects

ii) **Choosing.** Then the pupils are helped to choose a project linked to their need.

iii) **Planning.** Pupils then discuss how that project is to be executed? Steps of the procedure are planned and noted down.

iv) **Executing.** The project is then executed as planned. Every body contributes his share of work.

v) **Evaluating.** The project is then evaluated and the possible knowledge is reviewed.

vi) **Recording.** The knowledge gained is then recorded for future reference.

**The following examples illustrate the Method :**

**Example : Problem : Opening a cooperative store :** While opening and managing the store, the pupils learn the elements of shopping such as buying, selling, weighing, measuring and preparing bills, preparing budgets, different ways of saving leading

to the learning of topics like simple interest, stocks and shares insurance etc.

**Example : Problem. Celebration of Republic Day** : In addition to the knowledge of other subjects, the students may learn the following facts of Mathematics:

i) Calculating the estimated expenditure, ii) Tapping various resources of expenditure, iii) Make the adjustments in expenditure while preparing the budget. iv) Keeping an account of receipts and expenses. v) Making purchases.

**Merits of Project Method**

i) It arouses interest of the pupils. ii) It provides knowledge in the integrated form. iii) The facts learnt are easily remembered. iv) There is an opportunity for mutual exchange of views. v) In this method the student is free to work according to his capacity.

**Demerits of the Project Method**

i) It provides the knowledge of mathematics in a very haphazard way but since Mathematics is a sequence subject so its teaching must be systematic. Thus this method is not quite suitable for teaching of Mathematics. ii) It does not provide the necessary drill work which is essential to have mastery of the topic. iii) It does not suit the fixed curriculum.

**Place of Project Method in Mathematics :** This method is not suitable for teaching of Mathematics and so must not be used as a regular method of teaching. The subject is learnt only incidently and there is no sufficient drill work which is essential for mastery of a topic in Mathematics. Mathematics being a sequence subject can not be taught by this method. Moreover, it is not possible to cover all the topics through this method.

However, the projects are useful to arouse interest, to encourage initiative and to provide a sense of achievement to the students. These integrate the knowledge of Mathematics with other subjects. These also provides real life situations to apply the learnt facts of Mathematics.

Some small projects can be occasionally undertaken o provide necessary supplements to regular teaching. Costly projects should be avoided. The teacher should select certain projects which can be undertaken in the school, without upsetting regular teaching of the subject.

## UNIT - 4

### PLANNING FOR TEACHING- LEARNING MATHEMATICS

#### 1. Discuss the concept of Micro Teaching

**Ans : Micro teaching concept and meaning:** Micro teaching was designed by Dwight W. Allen of Stanford University in 1960. It was experimentally used in teacher training programmes in 1960-67. Micro teaching is a procedure in which a student teacher practices teaching with a reduced number of pupils in a reduced period of time with emphasis on a narrow and specific teaching skills

**Definitions:** "Teaching strategy with reduced class strength pupils and time is called micro teaching - **Dwight W. Allen**

Micro teaching as a system of controlled practice that makes it possible to concentrate on specific teaching skills and to practice teaching under controlled conditions - **Allen and Ryan**

#### Objectives of micro teaching:

✦ To develop useful teacher education programmes ✦ To identify new teaching skills and encourage research ✦ To bring out behavioural change in teacher ✦ To improve the efficiency of teaching through supervision

**Nature and Characteristics:** ✦ Micro teaching is a new experiment in field of teacher education ✦ It gives opportunity to get the needed feedback of their performance from the teacher after exhibiting their skill.

#### Elements or Components of Micro-Teaching :

1. Time 5 to 10 min
2. Content : Small concept
3. Students 5 to 10 number
4. Training 5. Skills 6. Process 7. Learning 8. Form 9. Mediality 10. Feedback

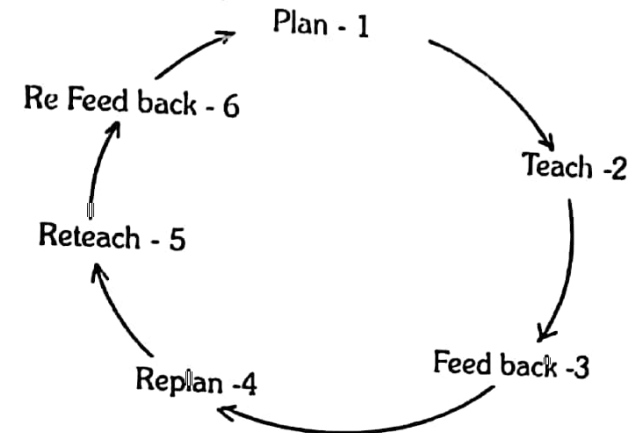
**Stages of Micro Teaching :** Three phases of Micro Teaching

**1. Knowledge acquisition :** This is the first phase of Micro Teaching. It includes collection of data.

**2. Skill acquisition :** This is the working phase of Micro teaching program.

**3. Transferring phase :** This is the last and Major phase of Micro teaching.

**Steps in Micro Teaching :** 1) Selection of Micro Lesson 2) Micro Lesson Plan 3) Teaching 4) Discussion and Feedback 5) Rectifying the defects in Lesson plan 6) Re-teaching 7) Recriticism and Feedback



#### Procedure of Micro Teaching

**Method of micro teaching:** In a micro teaching procedure the student teacher is involved in a scaled down teaching situation - in terms of class size, class time and teaching skills. The tasks may include practising and mastering of a specific teaching skill such as explaining, questioning, introducing, mastering of specific teaching strategies, flexibility use of instructional materials and class room management.

The short lesson given to peer group students is recorded at least on an audio cassette or a video tape if available and the student teacher gets to hear or see for him self/her self in the lesson immediately. The people who attend the lesson are asked to fill in rating questionnaires and evaluate specific aspects of the lesson. The supervisor also records and suggests remedial measures. If asked to re teach, the student teacher replaying his lesson and immediately re teaches the lesson to another group of peer students which is observed, recorded and feedback is provided this cycle

continues until he masters the specific skill. The micro teaching cycle is represented below. Micro teaching cycle

**Merits :** + Micro Teaching helps in reducing time and energy as there is no room for trail and error + Micro teaching helps in easing the complexities of normal class room teaching + The quality in traditional teaching increases.

**Limitations :** + It is artificial to teach using only one skill. + It is a time consuming and costly affair and requires costly media technology.

## 2. Write about Micro teaching skills in Mathematics?

### 1. SKILL OF INTRODUCING A LESSON

The behaviours included i.e. the components of the skill of introducing a lesson are : i) Using previous knowledge and ii) Using appropriate devices (desirable behaviours) and iii) lacking in continuity and iv) Uttering irrelevant statements (undesirable behaviours).

#### **Desirable beahviours : i) Using previous knowledge:**

The previous knowledge refers to knowledge already possessed by the pupils. They will be acquiring knowledge from various sources like class room, friends, books etc. If any new knowledge is to be added to this previous knowledge, there should be a logical continuity between them. In other words, mind cannot receive any new knowledge unless there is a continuity with the relevant previous knowledge. Then only the new knowledge gets integrated with the previous knowledge.

**ii) Using appropriate Device :** 'Device' refers to the technique that the teacher uses while introducing a lesson. Such devices can be a) Use of examples.analogies/similarities, b) Questioning, c) Lecturing/ describing / narrating/ illustrating, d) Story telling e) Role playing/dramatization f) Audio-visual aids and g) Experimentation/ demonstration

#### **Undesirable Behaviours :**

**i) Lack in continuity :** Continuity refers to the sequences of ideas or information being presented. While introducing a lesson, continuity breaks when the statement made or questions asked by the teacher are not logically sequenced.

**ii) Uttering Irrelevant Statements or Questions :** A statement or a question which a teacher utters while introducing a lesson is said to be irrelevant when it is not related to the aim of the lesson.

#### **Rating scale for the skill of introducing a Lesson.**

Name of the Student teacher .....

Roll No .....

Topic ..... Class .....

Name of the Supervisor .....

Date ..... Time duration .....Teach / Re-teach

Components	Not at all	Very much
Teachers used previous knowledge Of the pupils	0	1 2 3 4 5 6
The device used was appropriate	0	1 2 3 4 5 6
There were instances of lack in Continuity	0	1 2 3 4 5 6
Teacher uttered irrelevant Statements and Questions	0	1 2 3 4 5 6
Almost every question of the teacher	0	1 2 3 4 5 6
Was followed by correct pupils responses	0	1 2 3 4 5 6
On the whole, the introducing of the lesson was effective	0	1 2 3 4 5 6

### 2.SKILL OF EXPLAINING A CONCEPT

The skill of explaining may be defined as the art of learning the use of interrelated appropriate statements by the teacher for making the pupils understand the desired concept, phenomenon or principle.

**Components of the Skills :** The skill of explaining a concept or phenomenon consists of two types of behaviour -

desirable and undesirable. In the practice of the skill, the occurrence of the desirable behaviours is to be increased where that of the undesirable behaviours is to be decreased and extinguished.

#### **Desirable Behaviours :**

**1. Using appropriate beginning and concluding statements :** Beginning statement is an opening statement announcing what is going to be explained by the teacher. It prepares the pupils mentally to receive the explanation.

**2. Using explaining links :** Explaining links in the form of words and phrases are meant for establishing links or continuity in the statements used for explaining a concept, phenomenon or principle. Some of these linking words and phrases generally used for explaining are listed below.

**3. Covering Essential Points :** The explanation given for the understanding of a given concept or principle should be as complete as possible. The completeness is determined by the scope of the concept or principal as specified in the instructional objectives. It should aim for covering all the essential points leading to clear understanding of the desired concept or principle.

**4. Testing pupils Understanding :** This component behaviour involves asking for appropriate questions from the pupils to ascertain whether the purpose of explaining the concept or principle has been achieved or not.

#### **Undesirable behaviour :**

**1. Using irrelevant statement :** This behaviour covers the statements not related to the concept or principle being explained. The statements, instead of helping the pupil to understand the concept, create confusion and distract the attention of the pupils.

**2. Lacking continuity in Statements :** This behaviour involves missing links or break in the logical sequence of the interrelated statements by the teacher for explaining a concept or phenomenon.

**3. Lacking Fluency :** Fluency relates to the flow of uninterrupted statements for explaining a concept or principle. In case where a teacher lacks influence, he may be seen to show the following types of behaviours. i) does not speak clearly ii) utters incomplete or half sentences iii) tries to reformulate or correct his

statements in the midway of a sentence or a statement and iv) uses fumbling ideas or inappropriate words or statements.

**4. Using in appropriate vocabulary, vague words and phrases. This behaviour consists of the following undesirable aspects :**

i) Use of vocabulary not known to the pupils or in appropriate to their age, grade and maturity level.

ii) Use of certain vague words and phrases (like) infact, some what, you see, you know, I mean, actually, probably, perhaps almost, a little etc obstructing the understanding of an explanation.

#### **3. SKILL OF STIMULUS VARIATION**

The skill of stimulus variation includes the behaviours, namely (i) movements ii) gestures iii) change in speech pattern iv) focusing v) change in interaction styles vi) pausing and vii) Oral-visual switching.

**Movements :** One teacher is teaching from the table without moving away from it. Another teacher is continuously walking through out the class while teaching. The third teacher moves in the class but every movement has a purpose. You will definitely agree that the third teacher is the most capable of securing and sustaining pupil's attention at high level.

Hence, in order to secure and sustain attention in pupils you have to move about in the class. This movement should be within the limits so that pupil's attention level is maintained high.

**Gestures :** The various gestures that you can use in the class to draw pupils attention are head, hand and body movements. Using such gestures, you will be more expressive and dynamic in your presentation in lass. (Change in speech pattern).

Whenever you want to express emotions or feelings, you can modulate your voice. This sudden variation in this stimulus will attract attention of the pupils.

**Focusing :** Here you use such behaviours that direct or focus pupils attention to a particular point which the pupils have to notice or observe. Such behaviours can include certain verbal statements (Verbal focusing), or gestures or movements (gestural focusing), and both verbal statements and gestures (Verbal and gestural focusing).

**Change in Interaction Styles :** When two or more persons communicate with each other orally there is said to be oral interaction between them. In a classroom there can be three styles of interaction among pupils and teacher - a) Teacher pupils or teacher - group interaction b) teacher - pupil interaction and c) pupil - pupil interaction.

**Pausing :** Pausing means introducing silence during talk. In the classroom, if you as a teacher, are continuously talking or asking questions without giving time to pupils to respond, pupils lose their attention in the lesson.

**Oral - Visual Switching :** As a teacher, generally you will be either telling something to the pupils (information) through (Oral medium) or showing something to them (through visual medium) sometimes you will be doing both simultaneously (information through Oral-visual media). Each medium of giving information has its own advantages and disadvantages.

#### 4. SKILL OF ILLUSTRATING WITH EXAMPLES

Skill of illustrating with examples may be defined as the art of judicious selection and proper presentation of the suitable examples in order to generalize a concept, idea or principle with a view to its understanding and proper application.

**Components of the skill :** The main components of the skill of illustrating with example can be named as below.

i) **Formulating relevant examples :** An example is said to be relevant when it is related to the concept or principle being explained and helps effectively in its proper understanding.

ii) **Formulating simple examples :** Simple examples are those examples which are based on the pupil's past experiences and suit their level of maturity.

iii) **Formulating interesting examples :** An example is said to be interesting when it is capable of capturing and maintaining the attention, interest and curiosity of the pupil for the proper understanding of an idea, concept or principle.

**Using appropriate media for examples :** Examples are conveyed to the pupils through some particular media, verbal or non-verbal like story telling, analogy, concrete objects, maps, pictures, models and experimental demonstration.

#### **Making use of inductive - deductive Approach :**

The skill of illustrating with examples involves two aspects i) understanding a concept or establishing a rule/principle and ii) Using or applying the established or understood rule, principle or concept.

#### 5. SKILL OF QUESTIONING

Questioning is a major device in any teaching learning situation. Meredith G. Gall (1970) reports that about 60% of the teachers' questions require to recall the facts, about 20% require students to think and 20% require procedural responses and classroom management.

Questioning is an important teaching skill that a teacher must learn. One of the aspects of this skill is the "fluency in questioning" which means the rate of meaningful questions put per unit time. The meaningful questions are those which possess (a) Structure b) Process and c) Product.

**Structure :** It includes grammatical part and the content part which when taken together convey the aim of the question.

A well structured question should possess

- i) Grammatical correctness (Grammatically Correct Language)
- ii) Conciseness (brief)
- iii) Relevancy (exactly related to the topic)
- iv) Specificity (Specific i.e. expecting for a single answer 2 only)

**Process :** Process means the way of asking the questions which includes the following aspects.

i) **Speed of asking question :** Questions should be asked by the teacher neither too hurriedly nor too slowly. Teacher should give brief pause after the question so that the pupils understand the question clearly.

ii) **Voice of the Teacher :** It should be audible and clear. Teacher should put the question in a pleasant tone in a friendly manner.

Apart from these there are certain hints like questions should not be repeated unnecessarily by the teachers and at the same

time answers should not be repeated by pupils for a number of times in which case, the pupils may not listen the earlier responses.

**D) Product :** Product means the answer or response given by the pupils. If the pupils do not give correct response, teacher should search for the reasons for non response and find remedies. Another aspect of the skill of questioning is "Skill of probing questions". Which includes 5 components as follows :

- i) Prompting Technique (Giving hints to the pupils)
- ii) Seeking further information i.e. getting more information from the pupils.
- iii) Refocusing technique which means to ask a related question on what the pupil has already studies.
- iv) Redirection technique i.e. to direct the questions to many pupils.
- v) Increasing pupils critical awareness i.e. to elicit a rationale for the answer.

## 6. SKILL OF REINFORCEMENT

The skill of reinforcement involves the teacher to use more and more positive reinforces and to decrease the use of negative reinforces so that the pupil's participation in the class maximized.

**The salient points to be remembered in this skill are as follows :** 1) A positive reinforcement means strengthening of desirable behavior. It increases pupil participation in the class. 2) Negative reinforcement means weakening of undesirable behaviour. It decreases pupils participation in the class.

## 7. SKILL OF APPROPRIATE USE OF TEACHING - LEARNING MATERIAL (TLM)

Teaching Learning Material which are also called as audio-visual aids make the teaching interesting and effective and hence make the learning easy. They provide learning through the sensory organs like seeing, listening and both seeing, listening together and help for speedy learning.

Therefore every teacher should possess the skill of preparing appropriate teaching aids and also make use of them correctly. This skill includes the following aspects.

- i) Selection ii) Preparation iii) Presentation

**Selection :** Teacher should select a teaching aid keeping in view the following aspects .....

### Teaching aid should be

- 1) According to the age, intelligence and experience of the pupils
- 2) It should be interesting and motivating & purposeful.
- 3) It should be able to achieve the set objectives.
- 4) It should be a true representative of the actual object.
- 5) Cost should be reasonable
- 6) It should be available.

**Preparation :** Both the teacher and pupils should get prepared for using the teaching aid.

This includes (1) As far as possible locally available material should be used for preparation of teaching aid.

2) Teachers should receive some training in the preparation of aids.

3) Teachers should prepare some of the aids by themselves and students may associate in preparation.

### Presentation :

1) Before presenting the teaching aids, teachers should visualize their usage.

2) Adequate care should be taken in handling the aid.

3) Teacher should learn all the techniques of displaying the teaching aids successfully.

## 8. LINK PRACTICE AND INTEGRATION OF SKILLS

Micro teaching is often criticized on account of its analytical view of teaching. There is feeling that teaching cannot be or should not be broken down into pieces in the form of various teaching skills and component behaviours. Teaching is not just a combination of these isolated bits and therefore a mere acquisition or mastery over the different teaching skills does not make one an effective teacher.

### 3. Define unit ? Explain the steps in Unit Planning / Lesson Plan.

**Ans : Unit plan (or) lesson plan :**

The planning for a unit is known as unit plan. A unit may have several lessons a unit also includes the procedure of presentation of the subject matter that means the unit is not only

a block of content but also a method in it self

"Unit is as large a block of related subject matter as can be overviewed by the learner" - Preston

"A unit is an out line of carefully selected subject matter. Which has been Isolated because of its relationship to pupils needs and interests - Samford

**Characteristics of a good unit:** 1. The aims should be clear and well defined 2. It should consider the previous experiences of the students 3. It should keep in view the needs, capabilities and interests of the students 4. It should have similar type of content

**Steps involved in developing a unit:**

**1. Preparation:** By knowing the overall idea of a unit by the teacher, pupils are motivated.

**2. Knowing the previous experiences:** The second step that should follow motivation is testing the previous knowledge of the students.

**3. Presentation:** This step provides new experiences to the students

**4. Organization of the learning:** Students should be provided opportunities to organize their learning.

**5. Summarization:** At the end of the unit, the entire unit is summarized in a systematic order to bring all the learning together.

**6. Review and drill:** For this review of the unit or reteaching of main points, drilling for difficult points should be done

**7. Evaluation:** This last step is meant to check the achievement levels of the students

**Advantages:**

✦ It creates Interest and curiosity in the learners ✦ It is based on aims and objectives of teaching ✦ It develops the content knowledge in the teacher

**Disadvantages:**

✦ Evaluation is difficult to do at lower stages

✦ It requires committed and hard working teachers

**C.C.E Model unit plan**

**Class :** \_\_\_\_\_ **Subject :** \_\_\_\_\_ **No.of Periods** \_\_\_\_\_  
**Name of the Unit :** \_\_\_\_\_

Period	Concept	Teaching Strategies	TLM	Evlauation/ C.C.E.

**4. Write a period Plan.**

**PERIOD PLAN**

**Class:** \_\_\_\_\_ **Topic :** Fractions,  
Proper Fractions, Improper fractions

**Subject :** Mathematics **Duration :** 45 min

**1. Introduction :**

1. Good Morning children
2. Introducing the concept by asking questions

**Questions**

Children here is an apple how is it

I want share this apple with my one friend equally what to do ?

I want share the same apple with three friends

Q. Four parts together make

Q. Each equal part represent

Q. When an apple is divided into two equal parts each part is called by

Q. How can you represent half of one apple.

**Expected answer**

Round

Cut it into two equal pieces

Again cut two half pieces into two equal parts

Are apple Fourth part of one apple

Half of the one apple

**4. The subject - matters - its nature and organisation :** + Child centeredness + psychological sequence + objectives of teaching mathematics + adequate exercises + free from ambiguity of language.

**5. Other essential features:** + It should be easily available in the market. + It should be published by a reputed publisher. + It should inculcate the habit of heuristic attitude.

**2. Write critical analysis of existing secondary school mathematics text books.**

**Ans : Analysis of content in mathematics textbooks of standards prescribed by government of Andhra Pradesh** + The content is according to prescribed syllabus and every aspect of the syllabus is adequately covered. + It is in accordance with the aims and objective of teaching mathematics in that particular class. + The content presented in the text books are accurate and up-to-date. It includes the recent developments in the mathematics relating to the content dealt with. + The content of the text book have a direct practical and social utility value. + Oral mathematics finds its due place. + The answers given at the end of each section are correct. + It satisfies the demands of examination. + It provides for individual differences and meets the needs of students of varying abilities, interests and attitudes. + The subject matter in the text book is carefully organised with reference to the logical as well as the psychological considerations which make teaching effective. + The content is organised in the increasing order of difficulty. Principle of vertical correlation is followed to relate the present knowledge with the past and future. + It facilitates the use of analytic, synthetic, inductive deductive problem solving and heuristic approaches to teaching. + The language used is simple and easily understandable and within the grasp of the pupils. + The presentation of the subject matter is attractive and interesting with appropriate illustrations in terms of pictures diagrams and figures. + The illustrations are accurate clear and appropriate. + It provides adequate opportunities to motivate the students to solve problems by presenting adequate number of worked out problems and problems constructed from

daily life situations requiring the students to apply mathematical principles and formulae for their solution. + The content is based on the present needs and capabilities of the children and meets the physical, intellectual, emotional and social needs of the pupils. + The content helps the children in living a wholesome and self-fulfilling life. + The content reflects growth and movement of life. The content accommodates the latest developments in mathematics, science and information technology. + The problems and theories that form a part of the mathematics is real and helps in solving everyday life problems. + The content facilitates rational and original thinking. + The content provides a variety of activities keeping in view the requirements of the students of different communities, regions, (rural or urban) and socio-economic strata. + The content provides uniformity in terms of the content and objectives and variety in terms of the activities and experiences in terms of their academic, social, intellectual and environmental requirement.

**Conclusion** Though the mathematics textbook is an indispensable tool for both the teacher and the pupil, a teacher has to use certain discrimination and take precautions while using it.

**3. Explain different Audio, Visual and Multimedia resources.**

**Ans : Teaching Material is classified as 1) Audio aids 2) Visual aids 3) Audio visual aids**

**Importance of teaching aids :** + The audio visual aids are best attention compellers + It saves time and the learning is more solid and durable + It helps in bringing vivid reality into the class room + The pupils get chance to touch, feel, handle and manipulate + They arouse interest and motivate the pupils to action and stimulate physical and mental activity.

**Audio Resources :**

**1) Radio :** Radio listening help students as bank of knowledge. It is instructional aid. By utilizing the rich educational offering of radio.

**Merits :** + It brings a sense of participation on the part of

the pupils. + It is a mean of supplementing, vitalizing, correlating and modernizing the material of text books.

**Limitations:** + Radio programmes are not updated + Not giving importance by the teachers.

**2. Tape-Recorder :** A tape recorder can be used to record lecturers of eminent speakers. This is auditory material which can also be profitably used by a teacher, especially for introducing a lesson.

**Merits :** + It brings a sense of participation on the part of the pupils + It adds variety to the class-room technique and removes the monotony.

**Limitations :** + There is a lack of Tape-Recorder sets. + There is no provision in the time table for listening to the tape-recorder talks.

#### Visual Resources :

**1) Charts :** The charts play a significant role in making the mathematical ideas clear and comprehensive the charts help in creating a suitable atmosphere in the class room, and in elucidating various points.

**Examples of the use of charts :** Charts can cover a wide range of mathematical topics such as : a) Charts on sets, fractions, units of measurement etc are also useful (b) charts can also be used while teaching different kinds of angles, circle, cones etc.

**2. Models :** Models are the important visual teaching devices. Models are concrete objects, some considerably larger than the real object, some small replicas of objects which are too large.

**Examples of the use of Models :** Take a rectangular piece of cardboard to explain its perimeter + Pupils may be asked to prepare a model of cube of clay and may be used to teach the volume.

#### Audio visual aids :

**1. Educational Television :** It is called as queen of audio visual aids. It is also means of mass communication. It

combines the radio and the potentialities of the film.

**Merits :** + It is a best mass media. + These bring the real world into the classroom + More sensory organs are activated.

**Limitations :** + Too expensive to prepare + All the concept can't be explained.

**2. Educational Films :** Educational Films make the concept realistic, clear and durable. The education films can thus supplement the work of a class teacher and are quite use in helping pupils to gain new experiences.

**Way of using Educational Films :** + The film should have direct bearing on the class room teaching + Follow up the film through activities - written work or practical application of visual experience.

#### 4. Explain ICT based pedagogical tools ?

**Ans:** ICT is the information and communication Technologies. Worldwide research has shown that ICT can lead to improved student learning and better teaching methods. ICT has a positive impact on student achievement, especially in terms of knowledge, comprehension, practical skill and presentation skill in subject areas such as Mathematics, Science and Social study.

The ICT tools in Education can be divided into three categories. They are

**1) Input sources :** Visualiser / Document cameras + Student Response System + PC + Application software + slate / Tablet

**Output sources :** Projector, Interactive White Board, Display : Monitor, T.V. etc.

**Others :** Digital Camera, Switcher, Digital recorder and other technology.

Generally, the following ICT and multimedia resources can be used in teaching Physical Sciences:

+ Virtual Learning Environment + Interactive White Boards + You tube videos + Internet + Websites / Blogspots / Chatroony + Video Conferences + Voice Projection Systems + Cameras - Digital / still / Mobile phone + Projector + Multimedia players etc

**5. Write about Community Resources in Mathematics.**

**Ans :** Resources in Mathematics include human and material resources.

The teacher (human resource) is concerned with the management of instructional materials and is a repetition of knowledge which he transmits to the learners. There is much to be said for the use of human resource other than the teacher as resources for learning.

Some persons other than the teacher can be invited to contribute their knowledge and experience to the students

Students can be asked to conduct interview with people to gather information from people.

Material resources consist of the major tools the teacher employs in transmitting knowledge, e.g. Environment resources, printed materials which could be text books or semi text (i.e. charts, maps, pictures, photographs etc) and non text which include models, real objects, video, films and audio aids.

**6. How do you handle hurdles in utilizing the resources ?**

**Ans : 1. Social and ethical hurdles** a) Secularity of the content b) Gender Equity c) Democracy d) Respect for elders e) Respect for the disabled f) Respect for the religions g) concern for animals h) Respect for the environment i) Plagiarism and cyber cheating j) Illegal downloads and software piracy.

**2. Technical Hurdles :** a) Colour b) Speed c) smoothness. in Animation d) Use of screen e) Special Effects f) Music

**3. Suggestions for overcoming Hurdles :** a) Narration b) Teacher Friendliness c) Teacher development and skill development d) Attitude and Easy Access