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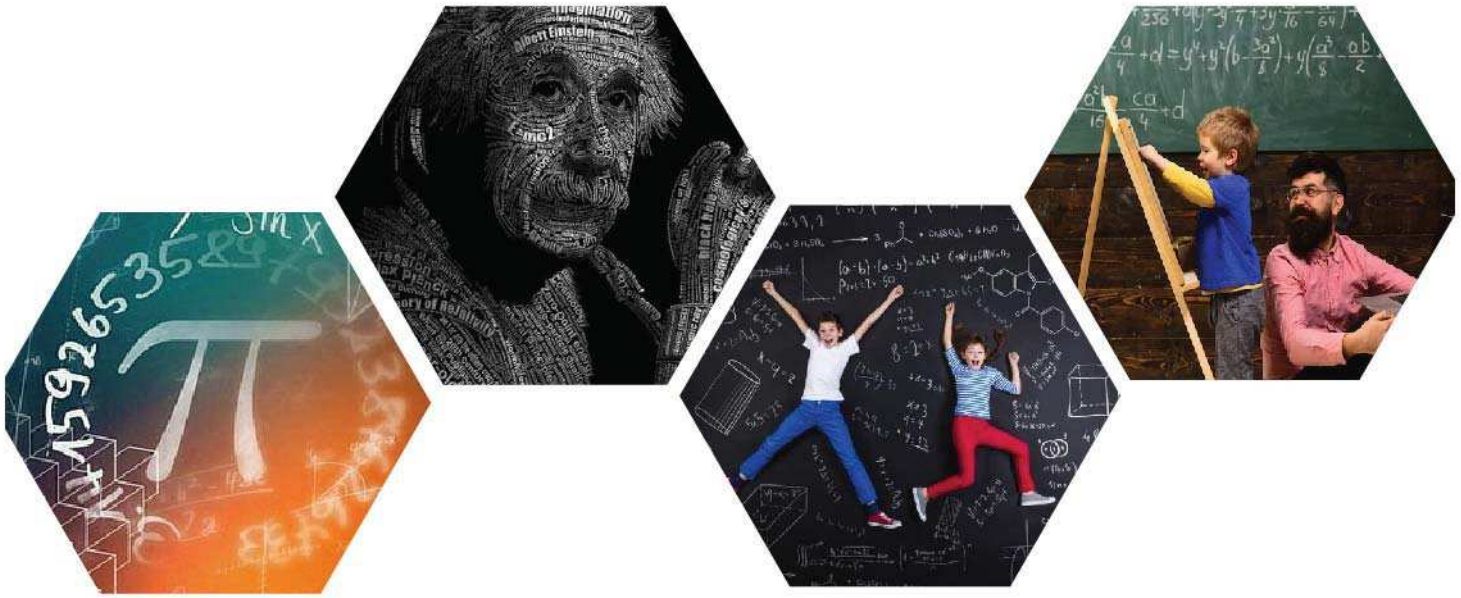
BABA MOHAN DAS COLLEGE OF EDUCATION

SELF LEARNING MATERIAL - B.Ed. 1st YEAR

PEDAGOGY OF MATHEMATICS



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UNIT I

Aims, Objectives and Values of Teaching Mathematics

Structure

1.1 INTRODUCTION

In this unit let us get acquainted with various definitions of mathematics and historical development of mathematics. The place of mathematics in other curricular subjects such as physical science, biological science, arts and language , later on the value of mathematics is also discussed. The teaching of mathematics with the aim of teaching mathematics is also introduced in the unit.

1.2 OBJECTIVES

At the end of this unit the learners will be able to

- Understand the characteristics and development of mathematics.
- Understand and appreciate the role of mathematics in the development of modern society.
- Understand the relationship between mathematics and various subjects.
- Know the values of mathematics education
- Understand the need for objective based teaching of mathematics
- Specify objectives of mathematics teaching.

1.3 DEFINITION OF MATHEMATICS

Oxford English Dictionary (1933) defines mathematics as "The abstract science which investigates deductively the conclusions implicit in the elementary conceptions of spatial and numerical relations, and which includes as its main divisions geometry, arithmetic, and algebra" "The study of the measurement, properties, and relationships of quantities and sets, using numbers and symbols" - American Heritage Dictionary, 2000. "The science of structure, order, and relation that has evolved from elemental practices of counting, measuring, and describing the shapes of objects" –(Encyclopaedia Britannica).

Earlier Aristotle defined mathematics as "the science of quantity". In Aristotle's classification of the sciences, discrete quantities were studied by arithmetic, continuous quantities by geometry. Augusta Comte's definition tried to explain the role of mathematics in coordinating phenomena in all other fields: "The science of indirect measurement" (1851). The "indirectness" in Comte's definition refers to determining quantities that cannot be measured directly, such as the distance to planets or the size of atoms, by means of their relations to quantities that can be measured directly.

According to Kant "Mathematics is the indispensible instrument of all physical researches". Gauss stated "Mathematics is the queen of sciences and arithmetic is queen of all mathematics". Bacon said "Mathematics is the gateway and key to all sciences". All the

above definitions emphasis mathematics as a tool especially suited for dealing with scientific concepts. According to Lindsay, “Mathematics is the language of physical sciences and certainly no more marvellous language was created by the mind of man”. This definition reveals the unique nature of the mathematics language with its signs, symbols, terms and operations, which can handle ideas with a precision and conciseness that is unknown to any other language.

1.4 MEANING OF MATHEMATICS

The word mathematics comes from the Greek word ‘máthēma’, which, in the ancient Greek language means "that which is learnt", "what one gets to know" .The word máthēma is derived from ‘manthano’, while the modern Greek equivalent is ‘mathaino’, both of which mean "to learn". In Greece, the word for "mathematics" came to have the narrower and more technical meaning "mathematical study" even in classical times. Its adjective is ‘mathēmatikós’ meaning "related to learning" or "studious", which likewise further came to mean "mathematical". In Latin, and in English until around 1700, the term mathematics more commonly meant "astrology" (or sometimes "astronomy") rather than "mathematics"; the meaning gradually changed to its present one from about 1500 to 1800.

Mathematics is commonly defined as the study of patterns of structure, chance, and space; more informally, one might say it is the study of figures and numbers. In the formalist view, it is the investigation of axiomatically defined abstract structures using logic and mathematical notation; other views are described in philosophy of mathematics.

1.5 BRIEF HISTORY OF MATHEMATICS

Mathematics starts with counting. It is not reasonable, however, to suggest that early counting was mathematics. Only when some record of the counting was kept and, therefore, some representation of numbers occurred can mathematics be said to have started.

In Babylonia mathematics developed from 2000 BC. Earlier a place value notation number system had evolved over a lengthy period with a number base of 60. It allowed arbitrarily large numbers and fractions to be represented and so proved to be the foundation of more high powered mathematical development.

Number problems such as that of the Pythagorean triples (a,b,c) with a2+b2 = c2 were studied from at least 1700 BC. Systems of linear equations were studied in the context of solving number problems. Quadratic equations were also studied and these examples led to a type of numerical algebra. Geometric problems relating to similar figures, area and volume were also studied and values obtained for π.

The Babylonian basis of mathematics was inherited by the Greeks and independent development by the Greeks began from around 450 BC. Zeno of Elea's paradoxes led to the atomic theory of Democritus. A more precise formulation of concepts led to the realisation that the rational numbers did not suffice to measure all lengths. A geometric formulation of irrational numbers arose. Studies of area led to a form of integration.

The theory of conic sections shows a high point in pure mathematical study by Apollonius. Further mathematical discoveries were driven by the astronomy, for example the study of trigonometry. The major Greek progress in mathematics was from 300 BC to 200 AD. After this time, progress continued in Islamic countries. Mathematics flourished in particular in Iran, Syria and India. This work did not match the progress made by the Greeks but in addition to the Islamic progress, it did preserve Greek mathematics. From about the 11th Century Adelard of Bath, then later Fibonacci, brought this Islamic mathematics and its knowledge of Greek mathematics back into Europe. Major progress in mathematics in Europe began again at the beginning of the 16th Century with Pacioli, then Cardan, Tartaglia and Ferrari with the algebraic solution of cubic and quadratic equations. Copernicus and Galileo revolutionised the applications of mathematics to the study of the universe.

The progress in algebra had a major psychological effect and enthusiasm for mathematical research, in particular research in algebra, spread from Italy to Stevin in Belgium and Viète in France. The 17th Century saw Napier, Briggs and others greatly extend the power of mathematics as a calculatory science with his discovery of logarithms. Cavalieri made progress towards the calculus with his infinitesimal methods and Descartes added the power of algebraic methods to geometry. Progress towards the calculus continued with Fermat, who, together with Pascal, began the mathematical study of probability. However the calculus was to be the topic of most significance to evolve in the 17th Century.

Newton, building on the work of many earlier mathematicians such as his teacher Barrow, developed the calculus into a tool to push forward the study of nature. His work contained a wealth of new discoveries showing the interaction between mathematics, physics and astronomy. Newton's theory of gravitation and his theory of light take us into the 18th Century. However we must also mention Leibniz, whose much more rigorous approach to the calculus (although still unsatisfactory) was to set the scene for the mathematical work of the 18th Century rather than that of Newton. Leibniz's influence on the various members of the Bernoulli family was important in seeing the calculus grow in power and variety of application.

The most important mathematician of the 18th Century was Euler who, in addition to work in a wide range of mathematical areas, was to invent two new branches, namely the calculus of variations and differential geometry. Euler was also important in pushing forward with research in number theory begun so effectively by Fermat. Toward the end of the 18th Century, Lagrange was to begin a rigorous theory of functions and of mechanics. The period around the turn of the century saw Laplace's great work on celestial mechanics as well as major progress in synthetic geometry by Monge and Carnot.

The 19th Century saw rapid progress. Fourier's work on heat was of fundamental importance. In geometry Plücker produced fundamental work on analytic geometry and Steiner in synthetic geometry. Non-euclidean geometry developed by Lobachevsky and Bolyai led to characterisation of geometry by Riemann. Gauss, thought by some to be the greatest mathematician of all time, studied quadratic reciprocity and integer congruences. His work in differential geometry was to revolutionise the topic. He also contributed in a major way to astronomy and magnetism.

The 19th Century saw the work of Galois on equations and his insight into the path that mathematics would follow in studying fundamental operations. Galois' introduction of the group concept was to herald in a new direction for mathematical research which has continued through the 20th Century. Cauchy, building on the work of Lagrange on functions, began rigorous analysis and began the study of the theory of functions of a complex variable. This work would continue through Weierstrass and Riemann.

Algebraic geometry was carried forward by Cayley whose work on matrices and linear algebra complemented that by Hamilton and Grassmann. The end of the 19th Century saw Cantor invent set theory almost single handedly while his analysis of the concept of number added to the major work of Dedekind and Weierstrass on irrational numbers. Analysis was driven by the requirements of mathematical physics and astronomy. Lie's work on differential equations led to the study of topological groups and differential topology. Maxwell was to revolutionise the application of analysis to mathematical physics. Statistical mechanics was developed by Maxwell, Boltzmann and Gibbs. It led to ergodic theory. The study of integral equations was driven by the study of electrostatics and potential theory. Fredholm's work led to Hilbert and the development of functional analysis.

Check your progress

Note : a) Choose the correct answer

b) Check your answers with the answers given at the end of the unit.

1. Mathematics is the indispensible instrument of all physical researches was stated by

   a) Gauss b)Bacon c) Kant d) Lindsay

2. Until around 1700, the term mathematics more commonly meant

   a) Maths b) Geometry c) Mathematical d) Astrology

3. ---------- added the power of algebraic methods to geometry.

   a) Cavalieri b) Descartes c) Pascal d) Barrow

1.6 NATURE AND CHARACTERISTICS OF MATHEMATICS

The characteristics of mathematics that makes it unique among other subjects are:

Logical Sequence

The modern characteristics of logical derivability and axiomatic arrangement are inherited from the ancient Greek tradition of Thales and Pythagoras and are epitomized in the presentation of Geometry by Euclid (The Elements). It has not always been this way. The earliest mathematics was firmly empirical, rooted in man's perception of number (quantity), space (configuration), time, and change (transformation). But by a gradual process of experience, abstraction, and generalization, concepts developed that finally separated mathematics from an empirical science to an abstract science, culminating in the axiomatic

science that it is today. It is this evolution from empirical science to axiomatic science that has established derivability as the basis for mathematics.

This does not mean that there is no connection with empirical reality, quite the contrary. But it does mean that mathematics is, today, built upon abstract concepts whose relationship with real experiences is useful but not essential. These abstractions mean that mathematical fact is now established without reference to empirical reality. It may certainly be influenced by this reality, as it often is, but it is not considered mathematical fact until it is established according to the logical requirements of modern mathematics.

Thus logical sequence becomes a main characteristic of mathematics. To put in simple words, the study of mathematics begins with few well – known uncomplicated definitions and postulates, and proceeds, step by step, to quite elaborate steps. Mathematics learning always proceeds from simple to complex and from concrete to abstract. It is a subject in which the previous knowledge has a greater influence. For example, algebra depends on arithmetic, the calculus depends on algebra, dynamics depends on the calculus, analytical geometry depends on algebra and elementary geometry and so on. Even within these topics, the same dependence is found.

Abstractness

Mathematics is abstract in the sense that mathematics does not deal with actual objects in much the same way as physics. But, in fact, mathematicsl questions, as a rule, cannot be settles by direct appeal to experiment. For example, Euclid's lines are supposed to have no width and his points no size. No such objects can be found in the physical world. Euclid's geometry describes an imaginary world whch resembles the actual world sufficiently for it is a useful study for surveyors, carpenters and engineers.

Infinity is something that we can never experience and yet it is a central concept of mathematics. Our whole thinking is based on the assumption that there are infinitely many numbers, so that counting need never stop; that there are infinitely many fractions between 0 and 1, that there are infinitely many points on the circumference of a circle etc. We have no way of knowing and justifying that it is so because we cannot observe and count all these. Infinitely, then, it is not a concept corresponding to any object that we have seen or likely to see. It is an abstract concept.

Again someone whose thinking was essentially physical might refuse to believe in negative numbers on the ground that you cannot have a quantity less than nothing. Still more, such a person would refuse to believe in the square root of minus one.

Children form concepts out of experience and lead to certain structures. Furthermore, the same structure should, if possible, be met in different situations. Children eventually learn that there is something about four beats, four chairs, four chocolates, four friends and eventually they extract the notion four. This process of abstraction comes from their experiences of dealing with discrete objects. However, all mathematical concepts cannot be learned through experiences with concrete objects. Some concepts can be learned only through their definition and they may not have concrete counterparts to be extracted from. Most of the mathematical concepts are such concepts without concretization and hence they are abstract. The concept of prime numbers, concept of probability, concept of function, the concept of limit, the concept of continuous functions are all abstract in the sense they can be learnt only through their definitions and it is not possible to provide concrete objects to correspond to such concepts. Even those concepts which one argues to be concrete are also abstract. For example, one could argue that concepts such as point, a line, a ray, a diagonal, a circle etc., can be learnt through observation of concrete instances and therefore, they are concrete. But a line drawn on a board, or a dot (point), a figure of a circle, are all mere representations of the concepts and they are not objects themselves. Moreover, a student learning a concept by mere observation of such instances can form wrong concepts. Fr example, a student can identify a figure which is not quite a circle as a circle. If a child has learned the concept by its definition as 'closed curve on which every point is equidistant from a fixed point called center', the child looks for the correct conditions for a curve to be a circle. Wherever possible, it is always advisable to provide the suitable concrete experiences which will lead to a generalization forming an abstract concept.

Mathematical Language and Symbolism

Another most important characteristic of mathematics which distinguishes it from many other subjects is its peculiar language and symbolism. Lindsay says, "Mathematics is the language of physical sciences and certainly no more marvellous language was ever created by the mind of man". Man has the ability to assign symbols for objects and ideas. Mathematical language and symbols cut short the lengthy statements and help the expression of ideas or things in the exact form. Mathematical language is free from verbosity and helps into the point, clear and exact expression of facts.

Over the course of the past three thousand years, mankind has developed sophisticated spoken and written natural languages that are highly effective for expressing a variety of moods, motives, and meanings. The language in which Mathematics is done has developed no less, and, when mastered, provides a highly efficient and powerful tool for mathematical expression, exploration, reconstruction after exploration, and communication. Its power (when used well) comes from simultaneously being precise (unambiguous) and yet concise (no superfluities, nothing unnecessary). But the language of mathematics is no exception to being used poorly. Just as any language, it can be used well or poorly.

The language for communication of mathematical ideas is largely in terms of symbols and words which everybody cannot understand. There is no popular terminology for talking about mathematics. For example, the distinction between a number and a numeral could head the list. A number is a property of a set; that property tells how many elements there are in a set. A numeral is a name or a symbol used to represent a number. Essentially, to distinguish between a number and a numeral is to distinguish between a thing and the name of a thing. If the things considered are physical entities, there seems t be little difficulty in making distinctions. But if things are abstract entities such as those who deal within mathematics, it becomes considerably more difficult to make the distinction between the name of the thing and its referent, the things itself.

Since numbers are abstractions and cannot be perceived by any of the five senses, they are often confused with their names. A teacher ought to be very careful t use correct terms, since this helps children to learn and think better. It is important that a student understands the distinction between a number and a numeral so that he may realise the difference between actually operating with numbers and merely manipulating symbols representing those numbers. This is only one item in regard to precision of language. There are many others, such as distinguishing between the line and picture of a line, a point and the dot used to represent a point, to list a few.

In earlier times, mathematics was in fact, fully verbal. Now, after the dramatic advances in symbolism that occurred in the mercantile period (1500s), mathematics can be practiced in apparent symbolic shorthand, without really the need for very many words. This, however, is only shorthand. The symbols themselves require very careful and precise definition and

characterization in order for them to be used, computed with, and allows the results to be correct.

Understanding mathematics is realizing what symbolism corresponds to the structure that has been abstracted. It is not enough for children to understand mathematics; it is necessary for them to speak mathematics; in other words to handle symbols. This corresponds to speaking a language as opposed to understanding a language. The process of speaking of the mathematical language runs as follows: an abstraction process, followed by a symbolization process, followed again by the learning of the use of the symbols. There are great dangers in a purely symbolic treatment. By purely symbolic, it is meant that no reference is being made to the entities symbolized while the symbols are being used. The danger is that the symbols have not acquired the same firm meanings as other word symbols currently used in the language used by the children; the amount of experience which lies behind the vocabulary used in their own languages is enormous. It is not possible to hope to put the same amount of experience behind mathematical symbols. Symbolic or even verbal statements of a concept are meaningless unless the symbolism is related to something real and concrete. Thus, if children are presented with symbols before they have abstracted the concepts that the symbols represent – the only way they can deal with them is associatively. They treat them as nonsense and learn by rote. In arithmetic and algebra, students' do not deal with facts, but with symbols. The child who is poor in mathematics is unable to see what concepts the symbols stand for, what the concepts themselves are abstracted from, and hence what the symbols communicate.

The symbols of mathematics constitute a language which is gradually developed by and for the pupil. This language must be acquired just like any other languages and there is need for translating this language into one's own mother tongue. Long periods of training with patience and endurance are needed to make the students feel at home with this language. The training that mathematics provides in the use of symbols is an excellent preparation for other sciences. The use of symbols makes the mathematics language more elegant and precise than any other language. For example, the commutative law of addition and multiplication in real number system can be stated in the verbal form as: 'the addition and multiplication of two real numbers is independent of the order in which they are combined'. This can be stated in concise form as: $a+b = b+a$, and $axb=bxa$, .

Almost all mathematical statements, relations, operations are expressed using mathematical symbols such as and so on. It is highly impossible to prepare a comprehensive list of all the mathematical symbols. Anyone, who wants to read and communicate effectively in the mathematical language, has to be well versed in the mathematical symbols and their definite uses.

Check your progress

Note : a) Choose the correct answer

b) Check your answers with the answers given at the end of the unit.

4. ---------- is something that we can never experience and yet it is a central concept of mathematics.

a) Calculus b) Infinity c) Algebra d) Fractions

5. Mathematical language is free from

a)ideas b) Clarity c) verbosity d) infinity

1.7 MATHEMATICS AND ITS RELATIONSHIP WITH OTHER SUBJECTS

Mathematics with arts

The arts and mathematics involve students understanding of relationships between time and space, rhythm and line through the experience of these abstract concepts in various arts forms and mathematical ideas. Mathematically related aesthetic considerations, such as the golden ratio, are used across visual, performing and multi-modal arts forms.

Mathematics with civics and citizenship

The concepts developed in the study of mathematics are applicable to a range of civic and citizenship understandings. Mathematical structure and working play essential roles in key aspects of our society as well as key civics concepts. Particular aspects of civics and citizenship require mathematical understanding, including concepts of majority rule, absolute majority, one vote one value representation and proportional voting systems.

Mathematics in Geography

Geography is nothing but a scientific and mathematical description of our earth in its universe. The dimension and magnitude of earth, its situation and position in the universe the formation of days and nights, lunar and solar eclipses, latitude and longitude, maximum and minimum rainfall, etc are some of the numerous learning areas of geography which need the application of mathematics. The surveying instruments in geography have to be mathematically accurate. There are changes in the fertility of the soil, changes in the distribution of forests, changes in ecology etc., which have to be mathematically determined, in order to exercise desirable control over them.

Mathematics with communication

Mathematics structure and working mathematically play essential roles in understanding natural and human worlds. Developments of the languages of mathematics are crucial to its practical application. Students learn to use the language and concepts of mathematics both within the discipline itself and also its applications to modelling and problem solving across the other domains. In this process they employee a range of communication tools for illustrating relationships and displaying results such as Venn diagrams and tree diagrams.

Mathematics with English

Mathematics, including the use of conjectures and proof, has clear links to the development of structures and coherent argument in speaking writing. Mathematical structure is strongly related to semantics syntax and language and to the use of propositions and quantifiers embedded in principled argument in natural languages.

Mathematics with health and physical education

In health and physical education, mathematics provides tools and procedures which can be used to model situations and solve problems in areas such as:

1. Scoring different sporting events involving time distance, weight and number as variables.

2. Calculating percentage improvement in results from data collected through fitness testing or performance in physical activities.

Mathematics with humanities-economics

The economics and mathematics are related through the use of mathematics to model a broad range of economic, political and social phenomena. Examples include the use of statistical modelling and analysis in a census, sampling populations to predict election outcomes, and modelling and forecasting economic indicators such as the consumer price index and business confidence.

Mathematics with history

The study of history includes the analysis and interpretation of a range of historical information including population charts and diagrams and other statistical information. The concepts and skills developed in mathematics support student understanding and interpretation of a range of history sources and their presentation as evidence in demonstration historical understanding.

Mathematics with science

The knowledge and skills students engage within the various dimensions of mathematics support students in their studies of all aspects of science. In science students use measurement and number concepts particularly in data collection estimation of error analysis and modes of reporting. The mathematics domain supports students in developing number handling skills. To collect the records interpret and display data appropriately, looking for patterns, drawing conclusions and making generalizations. Predictions for further investigations, extrapolations and interpolations may be made from their own experimental results or from reliable second and data.

Mathematics in Biological Sciences

Biomathematics is a rich fertile field with open, challenging and fascination problems in the areas of mathematical genetics, mathematical ecology, mathematical neuron- physiology, development of computer software for special biological and medical problems, mathematical theory of epidemics, use of mathematical programming and reliability theory in biosciences and mathematical problems in biomechanics, bioengineering and bioelectronics.

Mathematical and computational methods have been able to complement experimental structural biology by adding the motion to molecular structure. These techniques have been able to bring molecules to life in a most realistic manner, reproducing experimental data of a

wide range of structural, energetic and kinetic properties. Mathematical models have played, and will continue to play, an important role in cellular biology. A major goal of cell biology is to understand the cascade of events that controls the response of cells to external legends (hormones, transport proteins, antigens, etc.). Mathematical modeling has also made an enormous impact on neuroscience. . Three-dimensional topology and two-dimensional differential geometry are two additional areas of mathematics when it interacts with biology. Its application is also very important to cellular and molecular biology in the area of structural biology. This area is at the interface of three disciplines: biology, mathematics and physics. In Population Dynamics, we study deterministic and stochastic models for growth of population of micro-organisms and animals, subject to given laws of birth, death, immigration and emigration. The models are in terms of differential equations, difference equations, differential difference equations and integral equations.

In Internal physiological Fluid Dynamics, we study flows of blood and other fluids in the complicated network of cardiovascular and other systems. We also study the flow of oxygen through lung airways and arteries to individual cells of the human or animal body and the flow of synovial fluid in human joints. In External Physiological Fluid Dynamics we study the swimming of micro organisms and fish in water and the flight of birds in air.

In Mathematical Ecology, we study the prey predator models and models where species in geographical space are considered. Epidemic models for controlling epidemics in plants and animals are considered and the various mathematical models pest control is critically examined. In Mathematical Genetics, we study the inheritance of genetic characteristics from generation to generation and the method for genetically improving plant and animal species. Decoding of the genetic code and research in genetic engineering involve considerable mathematical modelling. Mathematical theory of the Spread of Epidemics determines the number of susceptible, infected and immune persons at any time by solving systems of differential equations. The control of epidemics subject to cost constraints involves the use of control theory and dynamic programming. We have also to take account of the incubation period, the number of carriers and stochastic phenomena. The probability generating function for the stochastic case satisfies partial differential equations which cannot be solved in the absence of sufficient boundary and initial conditions.

In Drug kinetics, we study the spread of drugs in the various compartments of the human body. In mathematical models for cancer and other diseases, we develop mathematical

models for the study of the comparative effects of various treatments. Solid Biomechanics deals with the stress and strain in muscles and bones, with fractures and injuries in skulls etc. and is very complex because of non symmetrical shapes and the composite structures of these substances. This involves solution of partial differential equations. In Pollution Control Models, we study how to obtain maximum reduction in pollution levels in air, water or noise with a given expenditure or how to obtain a given reduction in pollution with minimum cost. Interesting non- conventional mathematical programming problems arise here.

Mathematics in Chemistry

Math is extremely important in physical chemistry especially advanced topics such as quantum or statistical mechanics. Quantum relies heavily on group theory and linear algebra and requires knowledge of mathematical/physical topics such as Hilbert spaces and Hamiltonian operators. Statistical mechanics relies heavily on probability theory. Other fields of chemistry also use a significant amount of math. For example, most modern IR (Infra Red) and NMR (Nuclear magnetic resonance) spectroscopy machines use the Fourier transform to obtain spectra. Even biochemistry has important topics which rely heavily on math, such as binding theory and kinetics. Even Pharmaceutical companies require teams of mathematicians to work on clinical data about the effectiveness or dangers of new drugs. Pure scientific research in chemistry and biology also needs mathematicians, particularly those with higher degrees in computer science, to help develop models of complicated processes.

All chemical combinations and their equations are governed by certain mathematical laws. Formation of chemical compounds is governed by mathematical calculations. For instance, water is a compound; its formation is possible when exactly two atoms of hydrogen combines with one atom of oxygen. Without this strict observance of the mathematical fact, the preparation is improbable. In the manufacture of any chemical, there is some mathematical ratio in which different elements have to be mixed. For estimation of elements in organic compounds, the use of percentage and ratio has to be made. Molecular weights of organic compounds are calculated mathematically.

CHECK YOUR PROGRESS

Note : a) Choose the correct answer

b) Check your answers with the answers given at the end of the unit.

6.---------- is nothing but a scientific and mathematical description of our earth in its universe.

a) Mathematics b) Physics C) Geography d)History

7. Three-dimensional topology and two-dimensional differential geometry are two additional areas of mathematics with

a)Physics b) Chemistry c) Biology d) Bio Chemistry

1.8 Values of Mathematics

Mathematics has got many educational values which determine the need of teaching the subject in schools. These values can be studied under the following heads:

1. Practical Value

Mathematics has great practical value. Everyone uses some mathematics in every form of life. A common man sometimes can do without reading or writing but he cannot do without counting and calculating. Any person who is ignorant of mathematics can be easily cheated. He will always be at the mercy of others. We have to make purchases daily. We buy cloth, food items, fruit, vegetables, grocery etc.

We have to calculate how much we have to pay for everything. A house-wife also needs mathematics for looking after her house, preparing family budgets and estimates, writing various expenses and noting down various household transactions. Mathematics is needed by all of us whether rich or poor, high or low. Not to speak of engineers, bankers, accountants, businessmen, planners etc., even petty shopkeepers, humble coolies, carpenters and labourers need mathematics not only for earning their livelihood but also to spend wisely and save for future. Whoever earns and spends uses mathematics.

We are living in a world of measurements. We have to measure lengths, areas, volumes and weights. We have to fix timings, prices, wages, rates, percentages, targets, exchanges etc. In the absence of these fixations, the life in the present complex society will come to a standstill.

There will be utter confusion and chaos. Just think if a fairy descends on earth and removes all mathematics. There will be no calendar, no maps, no accounts, no fixations or measurements, no industrial activity, no plans or projects. Thus we see that mathematics has

tremendous value or application in our daily life. It is essential for leading a successful social life.

2. Cultural Value

Mathematics has got a great cultural value which is steadily increasing day by day. Mathematics has made a major contribution to our cultural advancement. The progress of our civilisation has been mainly due to the progress of various occupations such as agriculture, engineering, industry, medicine, navigation, rail road building etc. These occupations build up culture. Mathematics makes direct or indirect contribution to the development of all occupations. Hogben says, "Mathematics is the mirror of civilisation".

The history of mathematics shows how mathematics has influenced civilisation and culture at a particular time. Progress in mathematics, of Greeks and Egyptians in the past led to their cultural advancement and the progress of their civilisation. Mathematics is a pivot for cultural arts such as music, fine arts, poetry and painting. Perhaps that is why the Greeks, who were the greatest geometers of their times, were quite adept in fine arts.

3. Disciplinary Value

Mathematics trains or disciplines the mind also. It develops thinking and reasoning power. According to Locke, "Mathematics is a way to settle in the mind a habit of reasoning." Mathematics is 'an exact and definite science'. Every student of mathematics has to reason properly without any prejudices or unnecessary biases. Reasoning in mathematics has the characteristics of simplicity, accuracy, objectivity, originality etc.

Besides reasoning, mathematics has the following disciplinary values also.

(a) Development of the power of concentration. The faculty to concentrate one's mind can only be learnt by the study of mathematics.

(b) Development of inventive faculty. The study of mathematics develops inventive faculty of the students. The solving of a difficult problem in mathematics is just like making a discovery.

(c) Will power. Mathematics develops patience and perseverance in the students. It strengths their will power

In addition to practical, cultural and disciplinary values, mathematics has so many other values. Mathematics teaches the art of economical living. It teaches economy in time, speech, thought and money. Thus we see that mathematics has many educational values which show the increasing importance of the subject in schools and in social life.

Mathematics has got its cultural value and it is steadily increasing day by day. It has been truly said that mathematics is the mirror of civilization. On the other hand mathematics is a way to settle the habit of reasoning in the human mind. It trains or disciplines the mind. Mathematical truths are definite and exact. So that mathematical correctness of a human mind goes along with his/her accurate decision making ability. Modern civilization is the result of the correct decision making ability of human being that is analogous to the decision maker's quantitative ability.

Study of mathematics helps in developing thinking, reasoning in diction analysis, synthesis, generalization, discovery subject and it helps in creating international understanding also for a sound and productive vocational life, mathematical ability and knowledge is an essential requirement. Mathematics demands hard work from the learner so the learner of mathematics learns to be hard working in every aspect of his/her life. Since the entire aspect of our life is interrelated with mathematics, there is no escape from mathematics of life and livelihood.

1.9 NEED AND IMPORTANCE OF OBJECTIVE- BASED TEACHING OF MATHEMATICS

Teaching is a career that guides the thoughts of the next generation and training the students to think clearly. It calls for a combination of skills demanded by few other professions. Identifying the objectives of teaching of mathematics provide a tested, sound, structured methodology for overcoming a great number of the issues identified as current problems in secondary and higher education today. Hence an objective based teaching is imperative.

An objective based teaching is a reflective exercise that addresses the question: What do students need to know in order to derive maximum benefit from the educational experience. It is a systematic sharing of knowledge (learning content) and an understanding of how knowledge can be comprehended and shared in different ways. It is also a change in focus that affects the students' role: accepting responsibility for their own learning.

Some of the common objectives of teaching of mathematics are

- Teaching and learning of basic numeracy skills to all pupils.
- Teaching of practical mathematics (arithmetic, elementary algebra, plane and solid geometry, trigonometry) to most pupils, to equip them to follow a trade or craft.
- Teaching of abstract mathematical concepts (such as set and function) at an early age
- Teaching of selected areas of mathematics (such as Euclidean geometry) as an example of an axiomatic system and a model of deductive reasoning
- Teaching of selected areas of mathematics (such as calculus) as an example of the intellectual achievements of the modern world
- Teaching of advanced mathematics to those pupils who wish to follow a career in Science, Technology, Engineering, and Mathematics (STEM) fields.
- Teaching of heuristics and other problem-solving strategies to solve non-routine problems.

1.9.1 AIMS IN TEACHING MATHEMATICS

Develop a good understanding of numbers and the number system

1. Maximising their counting ability.

2. Achieving a sound grasp of the properties of numbers and number sequences including negative numbers.

3. Achieving a good understanding of place value and ordering, including reading and writing numbers.

4. Understanding the principles and practice of estimating rounding.

Improving speed

1. Achieving a good understanding of number operations and relationships.

2. Achieving rapid mental recall of numbers facts

3. Maximizing the ability to undertake calculation using pencil and paper methods.

To develop a good ability solve problem

1. Developing the ability to make decisions. E.g deciding which operation and method of calculation to use.
2. Improving the ability to solve problems involving numbers in context.

Check your progress

Note : a) Choose the Correct Answer

b) Check your answers with the answers given at the end of the unit.

8) Mathematics is the mirror of civilisation was said by

a) Hogben b)Locke c) Newton d) Pascal

9) An example of the intellectual achievements of the modern world

a) elementary geometry b) calculus c) Euclidean geometry d) Trigonometry

---

1.9.2 STATING INSTRUCTIONAL OBJECTIVES

The instructional objectives are based on the Blooms Taxonomy of objectives. Bloom's Taxonomy was created in 1956 under the leadership of educational psychologist Dr Benjamin Bloom in order to promote higher forms of thinking in education, such as analyzing and evaluating concepts, processes, procedures, and principles, rather than just remembering facts (rote learning). It is most often used when designing educational, training, and learning processes.

The Three Domains of Learning

Cognitive: mental skills (knowledge)

Affective: growth in feelings or emotional areas (attitude or self)

Psychomotor: manual or physical skills (skills)

Objectives should be **SMART**

S*pecific*: The teacher should state clearly what the student should know/be able to do, and at what level.

M*easurable*: The teacher must be able to conceive of how their attainment might be assessed

***A**ttainable*: by the students

***R**ealistic*: Could be seen as similar to attainability, but refers to their appropriateness to the overall task. "Valid" in assessment-speak.

***T**ime*: appropriate or achievable within the time-span of the session/lesson/course

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1.9.3 GENERAL INSTRUCTIONAL OBJECTIVES

An instructional objective is an intended outcome of instruction that has been stated in appropriate general terms to encompass a domain of student performance. It must be further defined by a set of specific learning outcomes. Objectives can be helpful in instructional planning, during the teaching/learning process, and when assessing student progress. Instructional objectives are often either ignored (by both teachers and students) or are, at best, occasionally referred to. The specification of instructional objectives using Blooms Taxonomy Cognitive domain is as follows.

Knowledge : the pupil acquires knowledge of terms, concepts, symbols, definitions, principles, processes and formulae of mathematics at the secondary stage.

Specification:

To demonstrate the achievement of above objectives, the pupil

1. Recalls or reproduces
2. Recognizes

Understanding : the pupil develops understanding of terms, concepts, symbols, definitions, principles, processes, and formulae of mathematics at the secondary stage.

Specification:

The pupil'

1. Give illustrations.
2. Detects errors and correct them.
3. Compares.
4. Discriminates between closely related concepts
5. Estimates the results
6. Interprets
7. Verifies

Application : the pupil applies his knowledge and understanding of mathematics to unfamiliar situation.

Specifications:

The pupil,

1. Analyses and finds out what is required.
2. Finds out the adequacy, superfluity or relevancy of data
3. Establishes relationship among the data
4. Suggests alternative methods
5. Generalises
6. Infers

Skill : to acquire skills of computation, drawing geometrical figures and grapes reaching tables, charts, graphs etc.

The pupil acquires skill in

1. Drawing geometrical figures and graphs
2. Reading tables, charts, graphs etc.

Specifications: The pupil,

1. Carries out oral calculations with ease and speed.
2. Carries out written calculations with ease and speed.

Instructional Objectives are the foundation for teaching, learning and assessments in education. Not only are they the first step in establishing the validity of our instructional methods and assessments, they actually serve to expedite the process of systematic course development. The learning outcomes associated with these objectives are the common thread that is woven through all aspects of an instructional course. Objectives provide the structure that helps educators to organise and communicate their instructional intent, they direct the development of teaching and learning strategies, and they focus the basis for developing measurement instruments.

Check your progress

Note : a) Choose the Correct Answer

b) Check your answers with the answers given at the end of the unit.

10. An intended outcome of instruction that has been stated in appropriate general terms to encompass a domain of student performance

a) Aim b)Goal c) Objective d)Instructional Objective

11. Detecting errors and correcting them comes which Cognitive Domain of Blooms Taxonomy

a) Knowledge b)Understanding c) Application d) Skill

1.10 LET US SUM UP

In this unit we have discussed the brief history of mathematics and the origin of the word mathematics. The relationship of mathematics with other subjects such as biological science, geography, Chemistry, Language and Arts are also reviewed. Later on the practical value and cultural values of mathematics in everyday life is also discussed. Stating Instructional objectives using Blooms Taxonomy Cognitive domain is also given.

1.11 UNIT END EXERCISE

1. Sketch the history of Mathematics.
2. Write about the characteristics of Mathematics.
3. Explain the role of values in mathematics.
4. Write the instructional Objectives for a mathematics lesson.

1.12 ANSWERS TO CHECK YOUR PROGRESS

1. c 2. d 3. c 4. b 5. c 6. c 7. c
8. a 9. b 10.d 11.b

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UNIT II

Planning and Implementation of Instruction

Structure

2.1 INTRODUCTION

In this unit we shall discuss the concept of microteaching and the various teaching skills. It helps the learner to fine tune his teaching skill. The origin of microteaching, how it is used to train teacher trainees is also discussed. The planning of a lesson and a unit is also discussed.

2.2 OBJECTIVES

At the end of this unit you will be able to:

- Understand the meaning of microteaching.
- Know the definitions of microteaching.
- Understand the steps in microteaching.
- List the phases of microteaching
- Differentiate micro and macro lesson plan
- Understand the need to link lessons
- List the components of a lesson plan

Micro-teaching is one of the recent innovations in the field of educational technology. It offers a new model for improving teaching. It has been found to be an effective modem strategy for modification of classroom behaviour of teachers. The concept underlying micro-teaching, assumes that teaching consists of various skills. Practice-teaching becomes effective only on acquisition of specific skills. All these teaching skills which go to make good teaching can be defined, observed, measured and controlled by means of practice. Micro-teaching is now accepted as an efficient instrument of teacher training. It provides a controlled setting for making various experiments in teaching methods. It has the advantage of providing self-evaluation of one's performance. It allows the teacher trainee to practice any one skill on his/her own, and then combine it with others when it has been mastered.

2.3.1 Meaning of microteaching

Microteaching is a method which enables teacher trainees to practice a skill by teaching a short lesson to a small number of pupils. Usually a micro lesson of 5 to10 minutes is taught to four or five fellow students. A supervisor, using an appraisal guide, usually rates the lesson and then discusses it with the teacher trainee, where closed circuit television (CCTV) is

available the appraisal guide may be redundant. The teacher trainee may alter his/her approach if necessary and later re teaches the lesson to another group of pupils. This lesson is also rated by the supervisor and then analysed and discussed with the teacher- trainee. The major premise underlying the concept of microteaching is that the complex teaching act can be split into component skills; each simple, well – defined and limited. These skills can be identified, practiced, evaluated, controlled and acquired through training. Micro teaching implies micro-element that systematically attempts to simplify the complexities of the teaching process.

2.3.2 Definitions

Microteaching has been defined in several ways Allen D.W and Eve, A.N. (1968) defined microteaching as "a system of controlled practice that makes it possible to concentrate on specific teaching behaviour and to practice teaching under controlled conditions"

Allen, D.W (1966) defined microteaching as "a scaled down teaching encounter in class size and class time". Buch, M.B (1968) has given a comprehensive definition of microteaching as a "teacher education technique which allows teachers to apply clearly defined teaching skills to carefully prepared lessons in planned series of 5 to 10 minutes. It encounters with a small group of real students, often with an opportunity to observe the results on videotape"

Passi,B.K(1976) writes that "the most important point in microteaching is that teaching is practiced in terms of definable, observable, measurable and controllable teaching skills".

Flanders, Ned .A.(1960): Micro teaching programme is organised to expose the trainee to an organised curriculum of miniature teaching encounters, moving from the less complex to the more complex. Young (1969) "Micro-teaching is a safe practice ground for student-teachers; class room management problem can be minimised and focussed upon separately as a component skill.

CHECK YOUR PROGRESS

Note : a) Choose the Correct Answer

b) Check your answers with the answers given at the end of the unit.

1. Time taken for a Micro Teaching Lesson is

   a) 30 - 40 minutes b) 20- 30 minutes c) 15 – 20 minutes d) 5-10 minutes

2. Microteaching is a scaled down teaching encounter in class size and class time was stated by

   a) Flanders b) Passi c) Allen d)Young

2.3.3 Origin

Micro teaching was first introduced at Stanford University, USA in 1963 by Dwight W. Allen and his co-workers. The Stanford teacher education program staff members sought to identify isolate and build training programmes for critical teaching skills. There are general teaching skills that can be applied at many levels, for teaching many different subjects. Microteaching, has since then, been refined and applied not only in teacher training but also business, nursing and the army. Research in India and other developing countries have shown that conventional micro teaching methods help to improve teaching competencies. The first effort made by Allen and Ryan resulted in identifying fourteen skills. Singh, L.C(1979) makes reference to twenty two general teaching skills. Menon, et al (1983) has suggested a list of seventy four skills. These skills have been chosen as they foster teacher – pupil interaction, particularly as they belong to the four areas of motivation, presentation, recapitulation and questioning. These are the skills of set induction, demonstration, blackboard writing, explaining, stimulus variation, questioning and reinforcement

In India D.D.Tiwari was the first to take up this work in 1967 at the Government Central Pedagogical Institute at Allahabad. This was followed by G.B.Shah who tried an experiment in microteaching with the help of a tape recorder in the faculty of Education and Psychology, Baroda in 1970. A major contribution to the microteaching as a teaching device was made in 1974 at the Technical Teachers' Training Institute. The fisrt book on microteaching in India was written by N.L.Dosajh under the caption 'Modification of Teacher Behaviour through MicroTeaching(1977).

2.4 ADVANTAGES OF MICRO TEACHING

- Micro teaching is useful for developing teaching efficiency in pre service and in service teacher education programmes.
- Micro teaching can be either in real class room conditions or in simulated conditions.
- The knowledge and practice of teaching skills can be given by the use of micro teaching.
- Microteaching is a training device for improving teaching practice and prepares effective teachers.
- It focuses attention on teaching behaviour to modify and improve in the desired direction.

- Micro teaching is an effective feedback device for the modification of teacher behaviour.
- Microteaching minimizes the complexities of the normal classroom teaching by scaled down teaching.
- Micro teaching permits increased control and regulates teaching practice.
- The demonstrations of model lessons in micro teaching are possible through video-lessons and short films.

2. 5 DRAWBACKS (LIMITATIONS) OF MICRO TEACHING

- Micro teaching tends to reduce creativity of teachers.
- Its application to new teaching practices is limited.
- It requires competent and suitably trained teacher educators for its successful implementation.
- Micro teaching alone may not be adequate. It needs to be supplemented and integrated with other teaching techniques.
- Microteaching is very time consuming technique.
- The list of skills is not exhaustive and does not apply to all subjects.
- Too much fragmentation of skills is not considered convention or practical for training.
- Some skills tend to overlap each other.

Different skills are required for different stages and for different subjects which are difficult to formulate and achieve. Only a few basic skills such as questioning, explaining, stimulus variation, management of class are common and can be developed.

2.6 PHASES OF MICRO TEACHING

Clift (1976) described the following as the phases of micro teaching.
1. Pre-active phase (knowledge acquisition phase)
2. Interactive phase (skill acquisition phase)
3. Post-active phase (Transfer phase)

I Knowledge Acquisition Phase (Pre-active Phase) →

Observe Demonstration Skill	Analyse and Discuss Demonstration

II Skill Acquisition Phase →

Prepare Micro Lesson	Practise Skill	Evaluate Performance

(Inter-active Phase)

Re- Teach

III Transfer Phase → (Post – active Phase)

Transfer of Skill
To actual
Teaching Situation

Check your progress

Note : a) Choose the Correct Answer

b) Check your answers with the answers given at the end of the unit.

3. An experiment in microteaching with the help of a tape recorder in the faculty of Education and Psychology was done by

a) D.D Tiwari b) G.B.Shah c) N.L.Dosajh d) Menon

4. Microteaching is a training for improving

a) lessons b) teaching aids c) teaching practice d) Syllabus

2.7 STEPS IN MICRO TEACHING

1. Orientation of the student teachers: It involves providing necessary information and theoretical background about micro teaching on the following aspects :

- concept of micro teaching.
- significance of using micro teaching.
- procedures of micro teaching micro .
- requirements and setting for adopting micro teaching technique.

2. Discussion of teaching skills : In this step the concept of teaching skill is clarified to the teacher trainee . He develops knowledge and understanding about :

- analysis of teaching into different component teaching skills.
- significance of these skills in classroom teaching.

- component teaching behaviours of different teaching skills.

3. Selection of a particular teaching skill: The teacher trainee selects a particular teaching skill for practice.

4. Presentation of a model demonstration lesson: A demonstration lesson in that particular teaching skill is presented before the teacher trainee. This stage is known as modelling. Demonstration can be given in a number of ways.

- By exhibiting a film or a video tape.
- By making them to listen to an audiotape.
- By arranging a demonstration lesson from a live model ie by the teacher educator or some expert.
- By providing written material such as hand book, guide etc.

5. Observation of the model lesson and criticism. : An observation schedule is designed for the observation of the lesson and is distributed to the teacher trainee. A critical appraisal of the model lesson is made by the student teachers on the basis of the observation and analysis.

6. Preparation of micro lesson plan: For practicing the demonstrated teaching skill the student teacher prepares a micro lesson plan. For this he may take guidance and help from the teacher educator, books etc.

7. Creation of micro-teaching setting : The Indian model of micro-teaching developed by NCERT gives the following setting. –

- No. of pupils - 5-10
- Type of pupils - real pupils or preferably peers
- Type of supervisors - teacher educators or peers.
- Time duration for micro-teaching lesson –6 minutes
- Time duration for micro-teaching cycle – 36 minutes

This duration is divided as:

Teaching – 6 minutes

Feedback - 6 minutes

Re-plan – 12 minutes

Re-teach – 6 minutes

Re-feedback –6 minutes

8. Practice of the Skill: Under this step the student teacher teaches a micro-lesson to a micro-class. This lesson is observed by the teacher educator and the peer group with the help of the appropriate observation schedule. The lesson can be recorded using an audiotape or video tape.

9. Feedback: Immediate feedback is given by the teacher educator and the peer group.

10. Re-planning: On the basis of the feedback the student teacher re-plans the lesson. About 12 minutes is given for this purpose.

11. Re-teaching: The session lasts 6 minutes and the student teacher reteaches his icro lesson on the basis of his replanned lesson.

12 Re-feedback: The student teacher is provided re-feed back on the re-taught micro lesson.

13. Integration of the skills: This is the last step and is concerned with the task of integrating several skills individually mastered by the student teacher. It is helpful in bridging a gap between training in isolated teaching skills and the real teaching situation faced by a teacher.

Check your progress

Note : a) Choose the Correct Answer

b) Check your answers with the answers given at the end of the unit.

5. As per NCTE guidelines in microteaching number of pupils for a microteaching lesson is

a) 3-5 pupils b) 5-7 pupils c) 5-10 pupils d) 10-13 pupils

6. In microteaching immediate feedback is given

a) teacher educator only b) peer group only c) self d) both teacher educator and peers

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2.8 TEACHING SKILLS

Teaching skills are specific instructional activities and procedures that a teacher may use in the class room. (Gage 1968). Skill is an act of teaching. (Allen). A teaching skill is a group of teaching acts/ behaviours intended to facilitate pupils learning activity directly or indirectly.

Characteristics of Teaching Skills

 Teaching skills have three basic components perception, cognition and action.

 Teaching skills have three basic dimensions- non verbal behaviour, openness and nature of moves in teaching to which the skill belongs.

2.8.1Some Teaching Skills

1. The skill of Questioning
2. The skill of Reinforcement.
3. The skill of probing.
4. The skill of explaining.
5. The skill of stimulus variation.
6. The skill of introducing a lesson.
7. The skill of illustrating with examples.
8. The skill of using blackboard.
9. The skill of silence and non verbal cues.
10. The skill of using audio – visual aids.
11. The skill of recognizing attending behaviour.
12. The skill of achieving closure.

2.8.2 Skill of Stimulus Variation

The skill of stimulus variation covers the activities the teacher can introduce to vary the presentation methods used in a lesson. This skill is concerned with three main areas of teaching, they are

1. The manner, voice and teaching style of the teacher

2. The media and materials used during teaching
3. The teacher/ pupil relationship during the class.

Components

1. Movement
2. Gestures
3. Voice modulation
4. Focussing
5. Change in interaction style
6. Pausing
7. Oral- visual switching

2.8.3 Skill of Reinforcement

Reinforcement skill can increase student's involvement in their lessons in a number of positive ways. The skill is being used when the teacher reinforces good behaviour with a smile, when the teacher praises a good answer, or encourages a slow learner. Such positive reinforcement strengthens desirable behaviour, increases student participation. Negative reinforcement, on the other hand weakens undesirable behaviour.

Components

1. Positive verbal
2. Positive nonverbal
3. Negative verbal
4. Negative non verbal
5. Wrong use of reinforcement
6. Inappropriate of reinforcement

2.8.4 Skill of Explaining

Explaining can be defined as an activity to bring about a concept, principle, etc. It is an activity to fill up a gap in someone's understanding. The skill of explaining aims at making sure that the explanation is understood. All teachers should strive to perfect the skill of explaining accurately and effectively.

Components

- **Desirable behaviour**

1. Beginning statement

2. Explaining
   Clarity
   Fluency
   Planned repetition
3. Concluding statement
4. Questions to test pupils understanding

- **Undesirable behaviour**

1. Irrelevant statement
2. Lacking in continuity
3. Inappropriate vocabulary
4. Lacking in fluency
5. Vague words and phrases

2.8.5 Skill of Probing Questions

Probing is used when the students reply is correct but insufficient, because it lacks depth. Asking a number of questions about the response given to the first question. Such techniques that deal with pupil responses to your question are included in the skill of probing questioning.

The five components of the skill of probing questioning are

1. Prompting Technique

Prompting is a technique of probing or going deep into the pupil's initial response and leading him from no response to the expected response. This involves the teacher to give clues or hints to the pupil and ask leading questions.

2. Seeking Further Information

It consists of asking the pupil to supply the additional information to bring initial response to the criterion level or the expected level.

3. Refocussing

This technique consists of enabling the pupil to view his response in relation to other similar situations. It requires the pupil to relate a completely acceptable answer to other topics already studied by him.

4. Re direction technique

Redirection technique involves putting or directing the same question to several pupils for response. This is mostly used for the purpose of probing and for increasing pupil participation.

5. Increasing critical awareness technique

This technique mainly involves asking "how" and "why" of a completely correct or expected response. It is used to elicit a rationale for the answer

Check your progress

Note : a) Choose the Correct Answer

b) Check your answers with the answers given at the end of the unit.

7. Teaching skills have ---------- basic components.

a) 2 b) 3 c)4 d) 5

8. One of the component of skill of probing questions

a) explaining b) concluding statement c) beginning statement d) refocussing

2.8.6 Skill of using Black Board

The black board or chalkboard is the visual aid most widely used by teachers for class room interaction. It is one of the quickest and easiest means of illustrating an important point. No doubt teaching can be made effective by skilful use of blackboard. Matter once written on the blackboard can be erased easily and new materials added as the lesson progress.

The components of the skill of use of black board are:-

- Legibility (L)
- Size and alignment (SA)
- High lighting main points (HMP)
- Utilization of the space (US)
- Correctness (C)
- Position of the teacher (PT)
- Eye contact with pupils (ECP) and
- Cleaning of black board (CB)

2.8.7 Skill of Demonstration

Demonstration is an activity or process of teaching involving the showing of specimens or experiments or devices to explain and describe the concerned concept, idea, teaching point etc., in the teaching – learning process. That process makes the subject matter concrete with real life situation. The demonstration in teaching makes learning simpler and meaningful to the learner.

The components of demonstration skill are:

- Appropriate topic, concepts, ideas, and teaching points
- Sequence order of presentation
- Adequacy of manipulative skill
- Creation of appropriate situation
- Generalization
- Appropriate topic, concepts, ideas and teaching points

Appropriate topic, concepts, ideas, and teaching points

The demonstration should be appropriate to the topic, concept, idea and teaching point. The appropriate specimens, experiments, or devices should be related to the topic, concept and teaching point in the demonstration to make teaching effective.

Sequence order of presentation

The presentation material such as specimens or experiments or devices should be arranged in sequence order and presented in a systematic way. The sequential procedure in presentation of material indicates better preparation of the teaching learning activity.

Adequacy of manipulative skill

In the demonstration of experimentation, the instruments or equipment should be repeatedly displayed in the teaching – learning process. Adequate manipulative or manual skills would certainly result in creating interest in the minds of the learners.

Creation of Appropriate Situation

In the demonstration process appropriate physical situation with proper aids, instruments, diagrams, gestures, movements etc. should convey the idea appropriately. The demonstration arouses the curiosity of the learner.

Generalization

Whenever the demonstration comes to an end, the teacher should conclude the theory and frame a rule or a principle. The teacher performs the demonstration to consolidate the learned points with the help of the learners

2.8.8 Need for link lesson in Micro Teaching

In microteaching technique, teaching skills are practiced one by one separately. At a time, only one skill can be practiced. While practicing one skill, the use of that particular skill is maximized and other related skills may also be exhibited taking indirect role. Skills practiced in isolation have no meaning unless they are integrated in teaching.

Hence after attaining mastery in various skills, opportunity should be given to the teacher trainees to teach in real situations integrating the skills mastered already. So a separate training programme is necessary for this purpose. This programme is called Link practice.

Link practice is a bridge between microteaching and full-class teaching where microteaching skills are effectively integrated and transferred.

There is a big contrast between microteaching and full class teaching. In microteaching, there is a scaled down process in terms of class room size, skills, scope of the lesson, time etc. Micro teaching is practiced under stimulated conditions. In macro teaching in addition to the existence of macro elements, there are also class room management problems. In link practice, the trainees are given chance of teaching real pupils.

There are many methods for link practice. One of the methods is that after practicing three sub skills separately, the trainee may combine all the three sub skills in a lesson of 10 minutes. The trainee then practices another three sub skills separately and links them. The trainee then combines all the six sub skills in a single lesson of 15 minutes. And so on till the entire sub skills are combined in a macro lesson of 40 minutes and teaching a full class.

Link practice sessions are arranged with about 20 pupils for about the normal class period i.e. 20 minutes. The trainee prepares a series of eight short lessons on single unit and teaches

each lesson for 20 minutes using appropriate skills particular to the content. The number of lessons used in link practice is flexible but selected topic should be adequately covered. The teaching skills namely 'Set Induction' and Closure cannot be practiced in microteaching session in isolation. So, in link practice, the trainees include these skills also. At the end of each lesson, the trainee should get feedback about the lessons.

Check your progress

Note : a) Choose the Correct Answer

b) Check your answers with the answers given at the end of the unit.

9. The process that makes the subject matter concrete with real life situation

a) demonstration b) explaining c) lecturing d) questioning

2.9 MACRO PLANNING INVOLVES THE FOLLOWING

Knowing about the profession: The teacher should get to know which content area and study skills should be taught or practiced in the course, what materials and teaching aids are available, and what methods and techniques can be used.

Knowing about the institution: The teacher should get to know the institution's arrangements regarding time, length, frequency of lessons, physical conditions of classrooms, and exam requirements.

Knowing about the learners: The teacher should acquire information about the students' age range, sex ratio, social background, motivation, attitudes, interests, learning needs and other individual factors.

2.9.1Unit Plan

A unit plan is developed by the teacher and serves as a long-range plan. It contains multiple lessons that are related. Unit planning begins with identifying the particular content to be taught and your goals for learning outcomes.

2.9.2 Principles for Good Lesson Planning

Aim: the realistic goals for the lesson

Variety: various activities and materials to ensure high motivation and interest

Flexibility: more teaching methods and techniques and do not just read your teaching plan

Learn ability: the planned contents and tasks should be within the learning capability of the students. Doing things that are beyond or below the students' coping ability will diminish their motivation (Schumann, 1999). It should be slightly higher than the present proficiency of the students

Linkage: the teaching steps should be linked with each other. That is, there should be coherence.

2.10 LESSON PLAN

Lesson plan" usually refers to a single lesson, designed for one class period. However, it can also refer to a sequence of such plans designed for a unit of study. (Such a sequence may be called a unit plan). Lesson plan is a teaching outline of the important point of a lesson arranged in order in which they are to be presented; It may include objectives, points to be made, questions to be asked, reference to materials, assignments etc..

An ideal lesson plan must have the following essential elements;

- Knowledge of Student's entering behaviour-. The teaching method will be advantageous only when the nature of the pupils is known along with knowledge of the subject matter.

- Knowledge of the Subject. The teacher should know his subject well. If he has no clarity about his subject he will fail to clarify various facts and events of the lesson. He should read the whole lesson plan which he has prepared. He should not read the text-book only, but also read other supplementary books and the available material concerning the topic.

- General Knowledge of other related Subjects: The pupil teacher should possess general knowledge of all the subjects, because the knowledge is a complete unit and it cannot be divided into different water tight compartments.

- Clarity of Objectives: There should be clarity of objectives to make the both pupils and the teachers active to achieve them.

- Division in Units: While preparing the lesson plan, the teacher should divide the topic in units. This simplifies the preparation of the lesson plan. it is acquired easily by both the pupils and the teachers.

- Flexibility: The lesson plan is a slave not the master of the teacher. Hence, the teacher is free to make changes in the lesson plan in order to create attraction and interest in the lesson.

- Knowledge of the Principles and Strategies of Teaching: The teacher must know the principles of teaching, maxims of teaching, teaching methods and techniques so that he may use the teaching methods and techniques in the lesson plan.

- Time duration Sense: The teacher should have time sense. He should clearly know how much time he will take to present the lesson before the pupils and how many activities can be performed in the prescribed durations.

- Clarity about Previous Knowledge: While preparing the lesson plan, the teacher should know the previous knowledge of the pupils because the new knowledge imparted on the basis of previous knowledge is easily stabilized.

- Knowledge of Class Level: The teacher should know the class-level for which level of the students to prepare the lesson plan.

- Use of Instructional material: While preparing the lesson plan the teacher should decide at what step the material aid is to be used and what is to be clarified with that aid. This maintains the neutrality and interesting feature of the lesson plan.

Check your progress

Note : a) Choose the Correct Answer

b) Check your answers with the answers given at the end of the unit.

10. A lesson plan usually refers to a

a) unit b) syllabus c) lesson d) subject

2.11 CONCLUSION

Micro-teaching is to help a student to improve his own teaching. It is concerned with development and modification of discrete classroom teaching skills. Micro-teaching involves study of a specific teaching skill or to start with. The teacher-trainee may be introduced to the skill through a modelling i.e. the mode of introducing the skill to the student.

FORMAT OF LESSON PLAN

1 Programme : 5. Lesson Title:

2. Course :

3. Lesson Number : 6. Entering Behaviour :

4. Date & Time : 7. Specific Instructional objectives:

Phase	Instructional events		Resources / Aids	Time (in minutes)
	Teacher Activity	Student Activity		

2.12 LET US SUM UP

In this lesson we have seen the concept of microteaching in training teacher trainees. We also discussed the teaching skills that has to be learnt and practiced by a teacher in the class. We also learnt how to plan a lesson, the components of a lesson plan and unit plan for use in daily classrooms.

2.13 UNIT END EXERCISE

1. Define micro teaching. Write a note on microteaching cycle.

2. Write a brief note on teaching skills.

3. Prepare a lesson plan in your subject using the format given.

2.14 ANSWERS TO CHECK YOUR PROGRESS

1.d	2.c	3.b	4.c	5.c	6.d
7.b	8.d	9.a	10.c		

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UNIT III

Strategies of Teaching Mathematics

Structure

3.1 INTRODUCTION

Teaching mathematics needs to know multi-techniques, methods, and strategies, approaches that breaks the monotony of the teaching and sustains the interest of the learners in learning mathematics. This unit recommends that students be taught with apt method which means the selection of right method for right unit. This will positively develop the mathematical attitude of the students by which teachers could make the classroom alive. Each method has its own uniqueness and validity in maths teaching. Some modern techniques of mathematics teaching are also prescribed in this unit.

3.2 OBJECTIVES

At the end of this unit the learners will be able to

- Know about mathematics teaching
- Understand different approaches, methods and techniques in mathematics teaching
- Know about modern techniques in mathematics teaching

3.3 MATHEMATICS TEACHING

The main aim of mathematics education in schools is the mathsmatisation of the child's thought processes. In the words of David Wheeler, it is "more useful to know how to mathematise than to know a lot of mathematics". According to George Polya, we can think of two kinds of aims for school education: a good and narrow aim that is turning out employable adults who contribute to social and economic development. A higher aim is developing the inner resources of the growing child. With regard to school mathematics, the former aim specifically relates to numeracy. Primary schools teach numbers and operations on them, measurement of quantities, fractions, percentages and ratios: all these are important for numeracy. The high aim focuses on developing a child's inner resources. The role that mathematics plays is mostly about thinking. Clarity of thought and pursuing assumptions to logical conclusions is central to the mathematical enterprise. There are many ways of thinking, and the kind of thinking one learns in mathematics is an ability to handle abstractions. Even more importantly, mathematics offers is a way of doing things like to be able to solve mathematical problems, and more generally, to have the right attitude for problem solving and to be able to attack all kinds of problems in a systematic manner.

In the Indian context, there is a concern which has an impact on school education, namely that of universalisation of schooling. This has two important implications for the discussion on curriculum, especially mathematics. Firstly, schooling is a legal right, and mathematics being a compulsory subject of study, access to quality mathematics education is every child's right. Keeping in mind the Indian reality, where few children have access to expensive material and mathematics education that is affordable and enjoyable to every child. This implies that the mathematics taught is situated in the child's lived reality, and that for the system, it is not the subject that matters more than the child, but the other way about. Secondly, in a country where nearly half the children drop out of school during the elementary stage, mathematics curricula cannot be grounded only on preparation for higher secondary and university education. Still have a substantial proportion of children exiting the system after Class VIII. It is then fair to ask what eight years of school mathematics offers for such children in terms of the challenges they will face afterwards.

3.4 CONCEPT AND MEANING OF APPROACHES

Think of the approach to teaching as a description of how to go about teaching the students. This description explains what is needed when it is taught. Typically it might be described as follows:

- The sorts of teaching and learning activities that have planned (lecture, tutorial, self-directed learning, case study, workshop, workplace learning);
- Ways in which trying to engage students with the subject matter (provide students with basic facts, relate new knowledge to what students already know, build in interaction, be passionate, be enthusiastic);
- The ways in which to support the students (encourage questions, set formative assessments, and provide constructive feedback).

A description of the approach to teaching includes:

- The mode or manner of teaching (lecture, tutorial, bedside teaching, laboratory work);
- Some understanding of how people learn (learning theory);
- Some understanding of how to facilitate learning (qualities of the teacher such as passion, principles for good teaching practice such as providing timely and constructive feedback, putting educational theory into practice).

There is no "best teaching approach". However, there are some recognised teaching methods together with a range of learning theories and some principles for good practice in education. Being a reflective teacher and striving for excellence in teaching means considering each aspect of teaching approach to ensure that your approach is to facilitate student learning.

Learning Theories

A brief summary of three of the main theories is provided below. In fact, it is possible to subscribe to all three views, depending on the subject matter being taught to students.

1. Objectivists conceive of learning as a process in which learners passively receive an objective body of knowledge that is transmitted to them. Teaching should be structured to transmit the required knowledge to the learner.
2. Cognitivists view learning as a process of in which learners add new components to their cognitive structure - the structure through which human's process and store information - and/or in which learners re-organize their cognitive structure. Teaching strategies should help students to reorganize their existing cognitive structures/acquire new elements in their cognitive structure.
3. Constructivists believe that learners construct their own reality or at least that learners interpret reality based upon their interpretations of their experiences. This entails that

an individual's acquisition of knowledge is a function of their prior experiences, mental structures, and the beliefs that are used to interpret objects and events. Teaching should be structured to help students to relate new knowledge to existing knowledge so that what is learned is meaningful for the learner. When this happens, recall and application of knowledge improves.

Principles for Good Practice in Undergraduate Education

These following 7 principles for good practice have been established on the basis of a review of over fifty years of educational research.

1. Encourages contacts between students and faculty.
2. Develops reciprocity and cooperation among students.
3. Uses active learning techniques.
4. Gives prompt feedback.
5. Emphasises time on task.
6. Communicates high expectations.
7. Respects diverse talents and ways of learning.

Any "approach" to teaching students might make use of these principles.

Check your progress

Notes:

1. Write your answers in the space given below.
2. Compare your answers with those given at the end of the unit.

1. Aim of Mathematics Education is

a) Teaching Numbers b) Teaching formulas c) Mathematisation of child's thought process

2. Teaching strategies should help students to reorganize their existing cognitive structures/acquire new elements in their cognitive structure is a learning view of

a) Cognitivists b) Constructivists c) both Cognitivists and Constructivists

3. List any two good practices in undergraduate education.

3.5 METHODS AND TECHNIQUES

The term teaching method refers to the general principles, pedagogy and management strategies used for classroom instruction. Choice of teaching method depends on what fits to

your educational philosophy, classroom demographic, subject area(s) and school mission statement. Teaching theories primarily fall into two categories or "approaches" — teacher-centered and student-centered.

Maths teachers must teach the building blocks of maths, such as number sense and operational skills, boosting students' ability to think about problems. They need to incorporate aspects of language - including reading and writing - into their subject and provide direct instruction on methods of exploration. Additionally, maths teachers must motivate students to try and teach them to persevere when problems are challenging.

The Best Methods and Strategies for a Quality Maths Program

Methods for Teaching Maths

Regarding a method of instruction, it is meant how content is being taught. This runs the gamut from style of instruction - for example, lecture vs. hands-on - to materials used.

Use Visuals

Many students need to see a lesson in addition to hearing it. While explaining an operation or skill, use a visual or graphic to help get the point across. This can be as simple as showing the lesson on a document camera using a video or other technology tool. Children do best when instruction is paired with a visual; using a visual as a stand-alone teaching device is not always effective. The teacher should vary the usage to keep students engaged.

Make Connections

Our brains are machines that thrive on connections. In fact, long-term memory is a complicated web of neurons, or brain cells, banded together. To help students make sense of concepts, provide them with connections to the real world or previously taught lessons. We should always begin a new lesson with a reminder of the last. Also, we should pay close attention to how students react to the connections the teacher makes.

Use Assessments

Maths is typically a progression-based subject. Skills build one upon another, and the order in which they're taught is predetermined. Because of this, a maths teacher doesn't have to think much about what to teach when, but it is necessary to use assessments to determine student understanding. Formative assessments, or informal assessments meant to check in on student learning and drive future instruction, should be used frequently. This can help teachers identify students who struggle and allow additional small group or one-on-one instruction. Formative assessments aren't usually taken for grades. Students need to feel comfortable with their exploration of a subject without fear of their performance being used for grading.

Strategies and techniques

Maths is all about problem solving using strategies. Sometimes, there's only one way to solve a problem, but many times, there are multiple avenues to the answer. When teaching, model several strategies for understanding and exploring a concept, encourage students to apply high-level skills when given problems and focus on the thought process involved in the solution. Although maths usually only has one right answer, being able to reason through the steps to find the answer is the most important part of being a successful maths student. We want our students to be mathematical thinkers. This means they need to think strategically about solving maths problems. A strategy, then, is a way teachers instruct for maximum benefit. Teachers use strategies to help students learn maths as well. Thinking about how to best deliver a lesson is foremost in quality teaching.

Check your progress

Notes:

a) Chose the correct answer.

b) Compare your answers with those given at the end of the unit.

4. Teachers are requested to select teaching methods based on ……..……

a) the interest of the parents

b) the interest of the teacher himself/herself

c) the direction given by the administration

d) the teaching subject and classroom demographic

3.6 APPROACHES

3.6.1 Constructivist Approach

Major theoretical approaches to learning and teaching mathematics have been developed from three psychological perspectives of human learning.“The most basic responsibility of constructivist teachers, is to learn the mathematical knowledge of their students and how to harmonize their teaching methods with the nature of that mathematical knowledge” (Steffe & Wiegel, 1992, p. 17). This is the planning whereby teachers plant powerful mathematical ideas in a personally meaningful context for students to investigate. Cobb, Wood, and Yackel (1993) further elaborate on teachers' responsibility in the mathematics classroom as playing the dual role of fostering the development of conceptual knowledge among students and facilitating the constitution of what is often referred to as taken-as-shared knowledge in the

classroom community. This is the teaching in which, without direct access to one another's understanding, members of the classroom community achieve through social interaction a sense of some aspects of knowledge being shared, promoted by classroom social norms understood by members as constituting effective participation in the mathematics classroom community.

The main tenet of constructivist learning is that people construct their own understanding of the world, and in turn their own knowledge. However, any theory of learning has ramifications beyond the scope of learning itself. Simply put, subscribing to a constructivist view of learning affects teaching, classroom practices, and student classroom behavior.

Constructivism in the classroom

The various forms of constructivism present different implications when it comes to pedagogical concerns. According to Paul Ernest (1996) the forms of constructivism identified above all lead to the following pedagogical implications:

- Sensitivity toward and attentiveness to the learner's previous constructions. This includes using students' previous conceptions, informal knowledge, and previous knowledge to build upon.
- Using cognitive conflict techniques to remedy misconceptions. Engaging in practices like this allows students to trouble their own thinking, and it is through this conflict that they will develop their own meanings, or at least seek to rectify the conflict.
- Attention to metacognition and strategic self-regulation. This follows from the previous suggestion when students think about their thinking, and become responsible for their learning.
- Use of multiple representations. In science and especially mathematics, multiple representations offer more avenues with which to connect to students' previous conceptions.
- Awareness of the importance of goals for the learner. This awareness of goals refers to the difference between teacher and learner goals, and the need for learners to understand and value the intended goals.
- Awareness of the importance of social contexts. Various types of knowledge occur in various social settings for instance informal (street) knowledge versus formal (school) knowledge. (p. 346)

In addition to the suggestions proposed by Ernest, Brooks and Brooks (1999) offer five guiding principles of constructivism that can be applied to the classroom.

1. The first principle is posing problems of emerging relevance to students. A focus on students' interests and using their previous knowledge as a departure point helps students engage and become motivated to learn. The relevant questions posed to the students will force them to ponder and question their thoughts and conceptions.

2. Another guiding principle is structuring learning around primary concepts. This refers to building lessons around main ideas or concepts, instead of exposing students to segmented and disjoint topics that may or may not relate to each other. "The use of broad concepts invites each student to participate irrespective of individual styles, temperaments, and dispositions"

3. The third principle is seeking and valuing students' points of view. This principle allows for access to students' reasoning and thinking processes, which in turn allows teachers to further challenge students in order to make learning meaningful. To accomplish this, however, the teacher must be willing to listen to students, and to provide opportunities for this to occur.

4. Adapting curriculum to address students' suppositions is the fourth principle. "The adaptation of curricular tasks to address student suppositions is a function of the cognitive demands implicit in specific tasks (the curriculum) and the nature of the questions posed by the students engaged in these tasks (the suppositions)"

5. The final principle is assessing student learning in the context of teaching. This refers to the traditional disconnect between the contexts/settings of learning versus that of assessment. Authentic assessment is best achieved through teaching; interactions between both teacher and student, and student and student; and observing students in meaningful tasks.

Characteristics of Constructivist teachers

1. Encourage and accept student autonomy and initiative.
2. Use raw data and primary sources, along with manipulative, interactive, and physical materials.
3. Use cognitive terminology such "classify," "analyze," "predict," and "create" when framing tasks.
4. Allow student responses to drive lessons, shift instructional strategies, and alter content.
5. Inquire about students' understandings of concepts before sharing their own
6. Understanding of those concepts.

7. Encourage students to engage in dialogue, both with the teacher and with one another.
8. Encourage student inquiry by asking thoughtful, open-ended questions and
9. Encouraging students to ask questions of each other.
10. Seek elaboration of students' initial responses.
11. Engage students in experiences that might engender contradictions to their initial hypotheses and then encourage discussion.
12. Allow significant wait time after posing questions.
13. Provide time for students to construct relationships and create metaphors.
14. Nurture students' natural curiosity through frequent use of the learning cycle model.

Check your progress

Notes:

a) Chose the correct answer.

b) Compare your answers with those given at the end of the unit.

5. People construct their own understanding of the world, and in turn their own knowledge is

   a) Constructivist approach b) Discovery method c) Deductive method d) both a & c

6. A follower of constructivism is expected to

   a) motivating b) structuring their learning concepts c) valuing student's point of view d) a, b & c

3.6.2 Discovery Approach

Discovering Algebra, Discovering Geometry, and Discovering Advanced Algebra textbook series covers the topics offered in traditional algebra, geometry, and advanced algebra courses. But the discovering Mathematics approach may be different from what you experienced when you studied these courses. In the past, students were asked to spend a lot of time in symbolic manipulation before they were given the opportunity to develop a solid understanding of what they were doing. Many students cannot succeed in such an environment. The teacher and text cannot furnish enough examples to carry over to a new situation or problem. As a result, many students are limited, unable to do more than mechanical manipulations. They don't know when to apply what problem-solving strategy. Even students who pass are reluctant to continue on in mathematics.

All students can learn maths better. ***Discovering Mathematics*** works to have all students reach deep understanding of maths through investigating interesting and novel problems in cooperative groups using technology appropriately and practicing skills. The Discovering Mathematics authors know from their own teaching experience that all students can experience more success in mathematics. When the focus is on understanding concepts and problem-solving strategies instead of just memorizing formulas, all students can be more successful. To say that all students can learn maths does not mean the courses have been watered down. In fact, even very successful maths students will find they are challenged, learn more, and remember longer with the Discovering Mathematics approach. That's because the concepts and methods are not isolated from real-world applications and the mathematics that students study is closer to what is needed by both employment-bound and college-intending students.

In ***deep understanding of maths*** classes it is recommended at certain times "Just do it; don't ask why." But there are logical reasons behind maths methods and ideas, and the people who understand these reasons succeed at maths. Discovering Mathematics books help more students understand the reasons. Because the concepts make sense to students, they remember the methods and can apply them to new problems. To help with that understanding, Discovering Mathematics books offer a more visual approach and acknowledge the need for a gradual development of mathematical ideas. Students are asked to demonstrate comprehension orally and understanding the maths can make it more fun and increase the chance that students will use maths in their lives.

Investigating: The way something makes sense to one person, though, it might not make sense to someone else. The heart of Discovering Mathematics lessons is the investigations. Students work together on the activity. They each develop their own understanding and benefit from sharing ideas and suggestions offered by others. Students learn there are many approaches to solving problems. They also learn they are individually responsible for describing what they have learned.

Interesting problems: Students are more interested in class if the problems they investigate are related to the real world. Many of the hands-on investigations involve problems that students might see in their lives outside school.

Novel problems: In life we all need to be good at solving problems that don't exactly fit into a model we know. To help prepare students to use maths in their lives, many investigations in Discovering Mathematics pose problems that students haven't already been told how to

solve. Thus they learn skills of problem solving, rather than learning only how to solve particular types of problems.

Cooperative groups: Students are not expected to do all this learning by themselves. Many students make sense of mathematical ideas best in interaction with other people. They think best out loud, or they get ideas from others. And they understand better from seeing other students' viewpoints. The Discovering Mathematics series supports cooperative group work, in which the teacher works as a partner to student groups. Group work not only helps students learn better; it also teaches essential teamwork skills.

Technology: Computers and calculators surround us, so working with them in these classes teaches students skills that will be useful later on. Technology also helps keep students interested. Used appropriately, technology can make mathematics more visual, more logical, and more fun. Most importantly, technology tools allow students to investigate many more situations than they can explore by hand, thus helping them see patterns that lead to deeper understanding of concepts. Technology helps shift the responsibility of learning mathematics to the learner.

Practicing skills: As students investigate, they are practicing basic skills. After students have figured out a concept, they will continue to apply their skills to additional practice problems. The Discovering Mathematics books support an approach to maths that brings about better understanding of concepts and skills. Instead of solving one type of problem after another, students engage in investigations, examples, and exercises that allow them to build up their own bank of skills and concepts. Students learn to describe how and why something is true. Instead of working alone, students bounce ideas off their peers. Because they have been personally involved in the development of skills and concepts, students can successfully approach test problems even if they have forgotten a particular method or formula.

Check your progress

a) Chose the correct answer.

b) Compare your answers with those given at the end of the unit.

7. Discovery approach makes the learners

   a) just to memorise

   b) understanding the concepts and problem solving strategies

   c) mechanical manipulation

   d) emphasising on books

3.7 INDUCTIVE AND DEDUCTIVE METHODS

3.7.1 Inductive Method

Inductive method is to move from specific examples to generalization and deductive method is to move from generalization to specific examples.

A Child observes a rising of sun and getting of darkness after the setting of sun this he observes every day.

Conclusion: “The Sun Rises Everyday and Also Sets Everyday”

A child eats green apple every time and feels its sour taste.

Conclusion: All the green apples are sour in taste

Principles of inductive method

It is proceeding from Concrete to Abstract, Particular to general, Example to formula and Direct Experiencing. Conclusions are based on repetition at many times. Child concludes after each observation. Child generalizes after many observations. A child measures each and every triangle and concludes that, “Sum of angles in every triangle is equal to 180 degrees”.

Examples for inductive method

A) Ask students to draw a few sets of parallel lines with two lines in each set. Let them construct and measure the corresponding and alternate angles in each case. They will find them equal in all cases. This conclusion in a good number of cases will enable them to generalise that "corresponding angles are equal; alternate angles are equal." This is a case where equality of corresponding and alternate angles in a certain sets of parallel lines (specific) helps us to generalize the conclusion. Thus this is an example of inductive method.

B) Ask students to construct a few triangles. Let them measure and sum up the interior angles in each case. The sum will be same (= 180°) in each case. Thus they can conclude that "the sum of the interior angles of a triangle = 180°). This is a case where equality of sum of interior angles of a triangle (=180°) in certain number of triangles leads us to generalise the conclusion. Thus, this is another example of inductive method.

C) Let the mathematical statement be, S (n): 1 + 2 + ……+ n =. It can be proved that if the result holds for n = 1, and it is assumed to be true for n = k, then it is true for n = k +1 and thus for all natural numbers n. Here, the given result is true for a specific value of n = 1 and we prove it to be true for a general value of n which leads to the generalization of the conclusion. Thus, it is also an example of inductive method.

Merits of the method

- Scientific Method
- Content becomes crystal clear to students , as they develop on their own formula/ laws / Principle
- Based on Actual Observation and Experimentation.
- Thinking is Logical
- Suitable for beginners
- Increases Pupil – Teacher Relationship
- Home Work is reduced.

Demerits of the method

- Not suitable for all topics
- Time Consuming Method
- Laborious Method
- Not Suitable for all types of students
- Un- prepared teacher cannot make use of this method

Check your progress

Notes:

a) Chose the correct answer.

b) Compare your answers with those given at the end of the unit.

8. Inductive method is …

a) specific method b) general method

c) to move from specific examples to generalization

d) to move from generalization to specific examples

3.7.2 Deductive method

It is a method of reasoning by which concrete applications or consequences are deducted from general principles or theorems are deduced from definitions and postulates.

"All the green apples are sour in taste" The child may be told that he should never eat the green apple because they are sour. Afterwards he may verify this fact by tasting green apples.

Principles of Deductive Method

It is proceeding from Abstract to Concrete, General to Particular, and Formula to Examples. Students are given formula/rules/laws/principles directly.

Examples of deductive method

a) We have an axiom that "two distinct lines in a plane are either parallel or intersecting" (general). Based on this axiom, the corresponding theorem is: "Two distinct lines in a plane cannot have more than one point in common" (Specific).

b) We have a formula for the solution of the linear simultaneous equations as and (general). The students find the solutions of some problems like based on this formula (specific).

Merits of this method

- Time Saving Method
- Suitable to all topics
- Suitable to all Students
- Glorifies Memory
- Useful at Revision Stage
- Speed and efficiency
- Mostly Used at Higher Stage level

Demerits of this method

- Not a psychological Method
- No Originality and Creativity
- Blind Memorization
- Educationally Unsound.
- Students are Passive Learners.
- Reasoning is not clear

Check your progress

Notes:

c) Chose the correct answer.

d) Compare your answers with those given at the end of the unit.

9. Deductive method is …

a) known as inductive method b) general method

c) to move from specific examples to generalization

d) to move from generalization to specific examples

3.8 ANALYTIC METHOD

It proceeds from unknown to known, 'Analysis' means 'breaking up' of the problem in hand so that it ultimately gets connected with something obvious or already known. It is the process of unfolding of the problem or of conducting its operation to know its hidden aspects. Start with what is to be found out. Then think of further steps and possibilities which may connect the unknown with the known and find out the desired result. In its original sense the verb 'to analyze' means to loosen or separate things that are together about analysis, Thorndike says that all the highest intellectual performance of the mind is analysis. It is logical method. It leaves to doubts and convinces the learner. It facilitates understanding. It also strengthens the urge to discover facts. The steps in its procedure are developed in a general manner. No cramming of a fixed steps and a set pattern is necessitated. Each step has its reason and justification. The student is throughout faced with such questions as "how to prove the equality of two angles?" "What are the possible ways of resolving a statement into simpler elements etc?" thus the student grapples with the problem confidently and intelligently. The learner gains in comprehension and skill.

3.9 SYNTHETIC METHOD

It is the opposite of the analytic method. Here one proceeds from known to unknown. In practice, synthesis is the complement of analysis. To synthesis is to place together things that are apart. It starts with something already known and connects that with the unknown part of the statement. It starts with the data available or known and connects the same with the conclusion. It is the process of putting together known bits of information to reach the point where unknown information becomes obvious and true. It is a short and elegant method. It glorifies memory. It is logical.

Comparison between Analytic Method and Synthetic Method

Analytic method	**Synthetic method**
Meaning: Analysis means breaking up into components	**Meaning:** Synthesis means combining the elements to get something new.
Leads from: Unknown to known Conclusion to hypothesis Abstract to concrete	**Leads from:** Known to unknown Hypothesis to conclusion Concrete to abstract

Complex to simple	Simple to complex
Method: A method of discovery and thought A psychological method	**Method:** A method for the presentation of discovered facts. A logical method
Time: Lengthy, laborious and time consuming	**Time:** Short, concise and elegant.
Sequence: Valid reasons to justify every step in the sequence.	Sequence: No justification for every step in the sequence.
Learning: Encourages meaningful learning.	**Learning:** Encourages rote learning Easy to rediscover Once forgotten not easy to recall
Encourages: Encourages originality of thinking and reasoning	**Encourages:** Encourages memory work
Learning: Informal and disorganized	**Learning:** Formal, systematic ad orderly
Thinking: Process of thinking	**Thinking:** Product of thinking
Participation: Active participation of the learner	**Participation:** Learner is a passive listener

Check your progress

Notes:

a) Chose the correct answer.

b) Compare your answers with those given at the end of the unit.

10. Analytic method is .....

a) known to unknown b) unknown to known

c) combining the elements d) a & b

11. Hypothesis to conclusion, Concrete to abstract, Simple to complex are the characteristics

a) synthetic method b) analytic method c) direct method d) indirect method

3.10 PROBLEM SOLVING METHOD

The child is curious by nature. The learner wants to find out solutions of many problems, which sometimes are puzzling even to the adults. The problem solving method is one, which involves the use of the process of problem solving or reflective thinking or reasoning. Problem solving method, as the name indicated, begins with the statement of a problem that challenges the students to find a solution.

Definitions

Problem solving is a set of events in which human beings were rules to achieve some goals – Gagne. Problem solving involves concept formation and discovery learning – Ausubel.

Steps in Problem Solving / Procedure for Problem solving

***1. Identifying and defining the problem*:**

The student should be able to identify and clearly define the problem. The problem that has been identified should be interesting challenging and motivating for the students to participate in exploring.

2. Analyzing the problem:

The problem should be carefully analyzed as to what is given and what is to be finding out. Given facts must be identified and expressed, if necessary in symbolic form.

3. Formulating tentative hypothesis

Formulation of hypothesis means, preparation of a list of possible reasons of the occurrence of the problem. Formulating of hypothesis develops thinking and reasoning powers of the child. The focus at this stage is on hypothesizing – searching for the tentative solution to the problem.

4. Testing the hypothesis:

Appropriate methods should be selected to test the validity of the tentative hypothesis as a solution to the problem. If it is not proved to be the solution, the students are asked to formulate alternate hypothesis and proceed.

5. Verifying of the result or checking the result:

No conclusion should be accepted without being properly verified. At this step the students are asked to determine their results and substantiate the expected solution. The students should be able to make generalisations and apply it to their daily life.

Example:

Define union of two sets. If A={2,3,5}. B={3,5,6} And C={4,6,8,9}.

Prove that A U (B U C) = (A U B) U C

Solution:

Step 1: Identifying and Defining the Problem

After selecting and understanding the problem the child will be able to define the problem in his own words that

1. The union of two sets A and B is the set, which contains all the members of a set A and all the members of a set B.
2. The union of two set A and B is express as 'A U B' and symbolically represented as A U B = {x ; x Î A or x Î B}
3. The common elements are taken only once in the union of two sets

Step 2: Analysing the Problem

After defining the problem in his own words, the child will analyse the given problem that how the problem can be solved?

Step 3 : Formulating Tentative Hypothesis

After analysing the various aspects of the problem he will be able to make hypothesis that first of all he should calculate the union of sets B and C i.e. (B U C). Then the union of set A and B U C. thus he can get the value of A U (B U C). Similarly he can solve (A U B) U C

Step 4: Testing Hypothesis

Thus on the basis of given data, the child will be able to solve the problem in the following manner

In the example it is given that U

B U C = {3,5,6} U {4,6,8,9}

= {3,4,5,6,8,9}

A U (B U C) = {2,3,5} U {3,4,5,6,8,9}

= {2,3,4,5,6,8,9}

Similarly,

A U B = {2,3,5,6}

(A U B) U C = {2,3,4,5,6,8,9}

After solving the problem the child will analyse the result on the basis of given data and verify his hypothesis whether A U (B U C) is equals to (A U B) U C or not.

Step 5 : Verifying of the result

After testing and verifying his hypothesis the child will be able to conclude that A U (B U C) = (A U B) U C. Thus, the child generalizes the results and applies his knowledge in new situations.

Merits of this method:

- This method is psychological and scientific in nature
- It helps in developing good study habits and reasoning powers.
- It helps to improve and apply knowledge and experience.
- This method stimulates thinking of the child
- It helps to develop the power of expression of the child.
- The child learns how to act in new situation.
- It develops group feeling while working together.
- Teachers become familiar with his pupils.
- It develops analytical, critical and generalization abilities of the child.
- This method helps in maintaining discipline in the class.

Demerits of this method:

- This is not suitable for lower classes
- There is lack of suitable books and references for children.
- It is not economical. It is wastage of time and energy.
- Teachers find it difficult to cover the prescribed syllabus.
- To follow this method talented teacher are required.
- There is always doubt of drawing wrong conclusions.
- Mental activities are more emphasized as compared to physical activities.

Conclusion

Problem solving method can be an effective method for teaching mathematics in the hands of an able and resourceful teacher of mathematics.

3.11 LABORATORY METHOD

Laboratory method is based on the maxim “learning by doing.”

- This is an activity method and it leads the students to discover mathematics facts.

- In it we proceed from concrete to abstract.
- Laboratory method is a procedure for stimulating the activities of the students and to encourage them to make discoveries.
- This method needs a laboratory in which equipments and other useful teaching aids related to mathematics are available.
- For example, equipments related to geometry, mathematical model, chart, balance, various figures and shapes made up of wood or hardboards, graph paper etc.

Procedure of Laboratory method

- Aim of The Practical Work: The teacher clearly states the aim of the practical work or experiment to be carried out by the students.
- Provided materials and instruments: The students are provided with the necessary materials and instruments.
- Provide clear instructions: Provide clear instructions as to the procedure of the experiment.
- Carry out the experiment: The students carry out the experiment.
- Draw the conclusions: The students are required to draw the conclusions as per the aim of the experiment.

Example for Laboratory method

Sum of three angles of a triangle is 180 degree. "How we can prove this in the laboratory.

Aims:

To prove that sum of the three angles of a triangle is equal to two right angles or 180 degree.

Materials and instruments:

Card board sheet, pencil, scale, triangle and other necessary equipments.

Procedure:

In the laboratory pupils will be given on cardboard sheet each and then they are told how to draw triangles of different sizes on it. After drawing the triangles they cut this separately with the help of scissors.

Observation:

Student will measure the angles of the triangles drawn and write these in a tabular form.

Figure	Angle A +B+C	Total

no.	Angle A	Angle B	Angle C	
1	90	60	30	180
2	120	30	30	180
3	60	60	30	180

Calculation: after measuring the angles of different triangles in the form of cardboard sheet. We calculate and conclude their sum.

In this way by calculating the three angles of a triangle the students will be able to conclude with inductive reasoning that the sum of three angles of a triangle is 180 degree or two right angles.

Merits of this method

- The method is based on the principle of learning by doing.
- This method is psychological as we proceed from known to unknown.
- It is based on the student's self pacing.
- It helps in making clear certain fundamental concepts, ideas etc.
- It develops the self-confidence and teaches the students the dignity of labour.
- The children learn the use of different equipments, which are used in laboratory.
- It develops in the child a habit of scientific, enquiry and investigation.
- This method presents mathematics as a practical subject.
- It stimulates the interest of the students to work with concrete material.
- It provides opportunities for social interaction and co-operation among the students.
- It is child-centred and therefore it is a psychological method.
- It helps the students to actively participate in the learning process and therefore the learning becomes more meaningful and interesting.

Demerits of this method

- This method can be used for a small class only.
- It requires a lot of planning and organization.
- This method is suitable only for certain topics.
- This method it is not possible to make progress quickly.
- This method requires laboratory equipped with different apparatus.
- All mathematics teachers cannot use this method effectively.

- It is an expensive method. All schools are not able to adopt this method.
- This method has very little of theoretical part in it.

Conclusion

In conclusion we can say that this method is suitable for teaching mathematics to lower classes as at this stage teaching is done with the help of concrete things and examples.

Check your progress

Notes:

a) Chose the correct answer.

b) Compare your answers with those given at the end of the unit.

12. ..... involves the use of the process of problem solving or reflective thinking or reasoning.

a) problem solving method b) laboratory method c) analytic method

d) direct method

13. ..... the merits of laboratory method.

a) Child-centred method b) active participation of the children

b) Learning by doing d) only for small class

3.12 PROJECT METHOD

Project method is of American origin and is an outcome of Dewey's philosophy or pragmatism. However, this method is developed and advocated by Dr.Kilpatrick. Project is a plan of action (oxford's advanced learner's dictionary). Project is a bit of real life that has been imported into school. A project is a unit of wholehearted purposeful activity carried on preferably in its natural setting – Dr.Kilpatrick. A project is a problematic act carried to completion in its most natural setting – Stevenson.

Basic principles of project method

Psychological principles of learning

1. Learning by doing
2. Learning by living

3. Children learn better through association, co-operation and activity.

Psychological laws of learning

1. Law of readiness
2. Law of exercise
3. Law of effect

Steps involved in project method

1) Providing / creating the situations

The teacher creates problematic situation in front of students while creating the appropriate situation student's interest and abilities should be given due importance.

2) Proposing and choosing the project

While choosing a problem teacher should stimulate discussions by making suggestions. The proposed project should be according to the rear need of students. The purpose of the project should be well defined and understood by the children.

3) Planning the project

For the success of the project, planning of project is very import. The children should plan out the project under the guidance of their teacher.

4) Execution of the project

Execution of the project: every child should contribute actively in the execution of the project. It is the longest step in the project.

5) Evaluation of the project

When the project is completed the teacher and the children should evaluate it jointly discussed whether the objectives of the project have been achieved or not.

6) Recording of the project.

The children maintain a complete record of the project work. While recording the project some points like how the project was planned, what discussion were made, how duties were assigned, hot it was evaluate etc. should be kept in mind.

Merits of this method

- This is based on various psychological laws and principles.
- It develops self-confidence and self-discipline among the students
- It provides ample scope for training.
- It provides score for independent work and individual development.
- It promotes habits of critical thinking and encourages the students to adopt problem-solving methods.

- This method the children are active participants in the learning task.
- This is based on principle of activity, reality, effect, and learning by doing etc.
- It develops discovery attitude in the child.
- It provides self-motivation as the students themselves select plan and execute the project.

Demerits of this method

- The knowledge is not acquired in a sequential and systematic manner
- It is very difficult to complete the whole syllabus by the use of this method.
- It is economical.
- Textbooks and instructional materials are hardly available.
- The project method does not provide necessary drill and practice for the learners of the subject.
- The project method is uneconomical in terms of time and is not possible to fit into the regular time table.
- Teaching is disorganized
- This method is not suitable for a fixed curriculum.
- Syllabus cannot be completed on time using this method

Conclusion

Project method provides a practical approach to learning. It is difficult to follow this method for teaching mathematics. However this method may be tried along with formal classroom teaching without disturbing the school timetable. This method leads to understanding and develops the ability to apply knowledge. The teacher has to work as a careful guide during the execution of the project.

Check your progress

Notes:

a) Chose the correct answer.

b) Compare your answers with those given at the end of the unit.

14. Project method is the outcome of

a) Pragmatism b) Realism c) Existentialism d) Modernism

3.13 MODERN TECHNIQUES OF MATHEMATICS TEACHING

3.13.1 Brainstorming:

Brainstorming is a teaching strategy for releasing ingenuity and for enhancing critical thinking, especially in mathematics where in higher order thinking skills of students should be more developed. Students can use this to come up with ideas until the group decides for the best solution. Brainstorming is an excellent teaching strategy that many maths teachers neglect to incorporate into their regular classroom practices. Some teachers don't think they have time, some teachers don't recognize the value of it, and some teachers have never even thought about having students brainstorm. Brainstorming can be done at various times throughout a unit of study or lesson. It serves a slightly different purpose and has different benefits depending on when you use it in the course of a lesson or unit.

Motivation in a mathematics class is indispensable, although it is a reality that all students should be properly motivated, especially the poorly motivated ones, the teacher should not cease in finding ways to deliver the lesson at hand deliberately and accurately. One way to do this is through brainstorming, more so, when a teacher wants to expand a subject matter into the values arena, he or she can often use the power of brainstorming to uncover non obvious connections. The teacher can also ask students to think open-mindedly about a topic to generate lots of ideas without worrying if any of their ideas is reasonable or not. He or she might asks students sitting in a small or large group, to create as long a list of alternatives, say balancing the home budget or doing mental long division. If a mathematics teacher truly hopes to release ingenuity and encourage productive thinking, then he or she needs to use brainstorming techniques. Brainstorming is a key tool that applies to most problem-solving and complicated mathematical concepts. In fact, brainstorming strategy is an assumed component in many subject areas not only in education, but also in other sectors of the society. Here are some basic rules for the teacher.

a. Encourage free expression of ideas. One thing to make clear is that the only bad idea is the one that isn't expressed. The goal is productive thinking.
b. Encourage everyone's participation. Be sure everyone who is involved.
c. Avoid killer phrases that close down communication.
d. Sort the results.

Benefits of Brainstorming in the Maths Classroom

Activates schema: Our brains, loves to make associations. We learn and recall information best when we're able to connect it other things we already know. Having students brainstorm before beginning a lesson or unit allows their brains to activate things they already know

about the topic. So when students begin to acquire new learning on the topic, they are able to associate it with their prior knowledge.

Helps set a baseline for learning: Brainstorming prior to a lesson or unit of study allows both teachers (and students) to get an idea of how much a student knows about the topic. As the teacher moves through the unit of study, have students revisit their brainstorming tools (where they recorded their ideas) and either add new ideas to the list or correct misconceptions. Doing this gives students a sense of what they know.

Helps identify misconceptions: Students bring misconceptions to the classroom every day. Misconceptions are a part of learning. Brainstorming before a lesson, shines a light on any misconceptions that students bring to the discussion. Identifying misconceptions before the teacher begins the lesson allows to address ideas that will get in the way of new learning.

Helps guide teaching and differentiation: Brainstorming lets the teacher to see who has no prior knowledge or understanding, who has a little prior knowledge, and who already knows a lot about the topic

Improve student's perception about their level of mathematical understanding: Many students have a very low perception of their maths abilities because they associate maths with computation. Most students don't realize that they know much more about maths than they think. Recognizing what they know about maths helps students build confidence and changes perceptions about their abilities.

3.13.2 Quiz Technique

Quick quizzes throughout the day can help teachers assess the effectiveness of their instruction, as well as student understanding of the concepts taught.

Five tips to simplify the process

Teachers are feeling increased pressure to accurately assess their students' academic progress while, at the same time, assessing and improving their own competence in the classroom. As necessary as ongoing assessment is for both teachers and students, many teachers complain that constant testing stifles their creativity and destroys student interest, at a time when motivation is mandatory for the current crop of media-saturated students. Teachers can apply these simple steps throughout the day to learn how the students and the teacher can make us of.

Determine what you want to learn from a quiz:

The primary function of these frequent classroom quizzes is to evaluate student learning in relation to the teachers' instructional methods.

Be sure quizzes are developed around content-related questions:

Quizzes will be determined by the content-related questions asked. Always include a very simple question and a more complex question to determine how well they've mastered the concept.

Evaluate quizzes, don't grade them:

The answer alone will measure student understanding and the teacher's teaching effectiveness, and allow seeing where the student stands. Looking at the question(s) students answered incorrectly will help the teacher determine where there might have been a gap in instruction, or where students became confused.

Create simple, easy-to-use quizzes:

Quizzes should include three to five questions and take no longer then ten minutes to complete. The idea is to ask students two questions about the concept currently being taught and one question about another topic. The first concept question should be difficult; the second concept question should be easier. Together, they will help to see how well students understand the concept.

An alternative to a simple 2-3 question quiz is to incorporate a video quiz to help assess student learning in another modality. When using a web-based quiz-making format, we easily can add this type of instructional method to the quiz to help students apply learning to different modalities and to assess students in all learning styles.

Make students know what they are doing:

Explain to students the goals for quizzes. Frequent quizzes can frighten some students and cause test anxiety. We should simply explain to students' right from the beginning that, in the class, the students will be taking frequent short quizzes and that they will not be graded; they are simply meant to let know whether the teacher have taught the material in a way they have understood.

Check your progress

Notes:

a) Chose the correct answer.

b) Compare your answers with those given at the end of the unit.

15. Brain storming is a

a) Teaching Method b) Teaching activity c) Teaching strategy d) Approach

3.13.3 Seminar Method

The seminar method is the most modern and advanced method of teaching. A seminar is an advanced group technique which is usually used in higher education. It is an instructional technique it involves generating a situation for a group to have a guided interaction among themselves on a theme. It refers to a structured group discussion what usually follows a formal lecture or lectures often in the form of an essay or a paper presentation on a theme. The seminar method integrates such skills of reading and writing with presentation skills. This seminar method is employed to realize the higher objectives of cognitive & affective domains. The higher learning process requires the interactive and integrated methodologies based on the psychological principles. The seminar method applies such technique of human interaction / intervention with the learning and teaching experiences. Seminar is a teaching technique for higher learning. A specific subject or topic is delivered as an article or report in the seminar.

Advantages and special features of Seminar Method:

- This seminar method gives good motivation and learning experience.
- Help to evaluate the learn-ability of learners.
- Regulate the creating and organizing of facts and information.
- Dissemination and retrieval of information is scientifically managed.
- Develop the self reliance and self confidence.
- Also inculcates the responsibility and cooperative nature.
- This method is the best for socialization.
- Students' interaction is possible in participation and production of teaching learning process.
- Traditional monotony is abolished in this method.
- Ensures the understand ability and enhances the capability of the students learning.
- Seminar is always subject / theme specific, so that sufficient knowledge about the concerned subject can be developed.
- The presenter or the reader of the article can get further clarifications in his subject.
- Develop the questioning skills.
- The data processing and analysis also play a vital role in this method.
- This makes teaching and learning process lively.
- The student receives good information from his teacher and the fellow students.

- A seminar does not end in the premises after the completion of discussion, the group in
- Smaller groups carry on the discussion in informal settings in off campus. This is certainly a strong advantage of using seminar method.

Disadvantages

- The chance that the speakers may be sharing incorrect knowledge, or not at all knowledgeable themselves
- The chance that attendees will expect too much from a seminar and thus be disappointed. Realism must a rule in seminar. These are not "instant answers" to anything.

Conclusion

There are various methods of teaching and learning but participative learning is the preferred method today. The learners become familiar with the presentation skills as well as the skills necessary for the research work. With the help of the seminars, it is possible to see the gradual changes taking place in the approach of the students. The classroom atmosphere becomes more academic. The students are encouraged to go to the library and read the books more frequently. The teacher also gets more involved in the work; which further results in to greater job satisfaction.

3.13.4 Discussion Technique

It has been assumed above that discussion does assist the development of understanding. According to Cockcroft (1982), Mathematics teaching at all levels should include opportunities for discussion between teacher and pupils and between pupils themselves. Thought is not merely expressed in words; it comes into existence through them. From personal experience it is clear to me that human beings are often able to develop clarity of thought through the process of talking. Intuitively it follows that this should apply to mathematical understanding. Mathematical language is important to allow access to mathematical understanding, and as Vygotsky (1986) discusses, pupils develop their understanding of the meaning of words by observing how they are used by others and practising their use. Not all talk, even about mathematics, directly contributes to the growth of understanding. Clarkson (1973) states that it was found that verbal interaction between children may be extremely productive of ideas and development in certain settings. Preparation, even priming, for such a task can be crucial to the success of the effort, and the role of sensitive adult intervention may be crucial. (page 4). Experience in the mathematics classroom and within the wider school environment bears out the idea that pupils need to be

guided in how to discuss, i.e. engage in 'purposeful talk,' (Simmons, 1993). Therefore it is necessary for the teacher to not just provide time for pupils to discuss but also to structure their experiences to build up their ability to use such time productively.

Developing understanding

Using the terminology of Skemp (1976), Brissenden (1988) asserts the importance of discussion in learning mathematics for the following reason: We should aim for 'relational understanding' (knowing why rules work), and 'logical understanding' (being able to explain them to others) rather than the 'instrumental understanding' (using rules without knowing why they work) which results from learning mainly by imitation, as at present. In looking at the worth of discussion in the mathematics classroom, Brissenden (1988) relates this to Mathematics:

- explaining a method
- arguing logically in support of an idea
- criticising an argument logically, including one's own
- evaluating the correctness of an idea, or its potential in attacking a problem
- speculating, conjecturing, entertaining an idea provisionally
- accepting an idea provisionally and examining the consequences
- keeping track of a discussion, reviewing
- coping with being stuck, supporting others in difficulty

3.13.5 Scenario building Technique

Scenario building is a method of understanding and planning for outcomes of an uncertain future. In essence, it is a method for envisioning possible futures for complex systems to understand major drivers of future change.

Audience

Variations on a theme of scenario building could be used in classes of different levels. It could be used as a brainstorming exercise, or as an in-depth numerical modelling lab stretched over several weeks.

Skills and concepts that students must have mastered

- Non-linearity
- Feedback
- The general concept of a system model (conceptual/mathematical)
- Uncertainty, adaptive planning are to be mastered.

How the activity is situated in the course

This activity could be used as a culminating project, as a stand-alone exercise, or as part of a sequence of exercises depending on how extensively the modelling component was developed.

Content/concepts goals for this activity

To help illustrate for students an approach for bounding the possible future states of a complex system when there is high uncertainty. To determine what parameters the system is most sensitive to.

Other skills goals for this activity

Scenario development can be adapted to include skills such as conceptual or mathematical model building, consensus building, or community capacity building.

Description of the activity/assignment

"A scenario is a plausible, simplified, synthetic description of how the future of a system might develop, based on a coherent and internally consistent set of assumptions about key driving forces and relationships among key variables" (Millennium Ecosystem Assessment, 2005).

Determining whether students have met the goals

Students are able to envision future scenarios, describe how likely or unlikely they are, articulate what drivers would lead to each scenario and the uncertainty associated with those drivers.

Check your progress

Notes:

a) Chose the correct answer.

b) Compare your answers with those given at the end of the unit.

16. Seminar method ....

a) develops self-reliance and self confidence

b) best for desocialisation

c) a good traditional method

d) reduces questioning skills

3.14 LET US SUM UP

This unit clearly explains the concept and approaches in mathematics teaching. Different techniques and methods of teachings are dealt in this unit along with its merits and demerits. Modern teaching techniques also presented here in this unit. Teachers can utilise these methods and techniques in their teaching of mathematics and get benefit out it.

3.15 UNIT-END ACTIVITIES

1. Make assignments on different teaching methods in Mathematics teaching.
2. Make a chart on the views of Constructivists on Mathematics teaching.
3. Discuss with the students about inductive and deductive methods in Mathematics teaching.
4. Problem solving method is apt for Maths teaching – arrange a debate for the students.
5. Give a problem to your students and see how they use brain storming method.
6. Arrange a Seminar in Mathematics Teaching.

3.16 ANSWERS TO CHECK YOUR PROGRESS

1. c	2. a	3. any two	4. d	5. a	6. d	7. b	8. c
9. d	10. b	11. a	12. a	13. d	14. a	15. c	16. a

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UNIT V

Models of Teaching Mathematics

Structure

5.1. INTRODUCTION

Simplifying mathematics teaching is an art since most of the mathematics students feels that mathematics is a complicated subject. This ideology could be uprooted only by making teaching effective using effective teaching modles. Undoubtedly teaching models play a vital role in arousing the interest of students. Hence it is the prime duty of mathematics teachers to adopt suitable models in their mathematics teaching according to the sample, the size of the

sample and the content of subject dealt. In that way, this chapter throws light on different models in mathematics teaching.

5.2 OBJECTIVES

At the end of this unit the learners will be able to

- Know about different models of teaching mathematics
- Understand different mathematical concepts in mathematics teaching
- Know about FIACS

5.3 MODELS OF TEACHING MATHEMATICS AND CLASSROOM INTERACTION

5.3.1 Explicit teacher model

The purpose of explicit teacher modelling is to provide students with a clear, multi-sensory model of a skill or concept. The teacher is the person best equipped to provide such a model.

- Teacher both describes and models the math skill/concept.
- Teacher clearly describes features of the math concept or steps in performing math skill.
- Teacher breaks math concept/skill into learnable parts.
- Teacher describes/models using multi-sensory techniques.
- Teacher engages students in learning through demonstrating enthusiasm, through maintaining a lively pace, through periodically questioning students, and through checking for student understanding.

There are eight essential components of explicit instruction:

1. Concept/skill is broken down into critical features/elements.
2. Teacher clearly describes concept/skill.
3. Teacher clearly models concept/skill.
4. Multi-sensory instruction (visual, auditory, tactile, kinaesthetic)
5. Teacher thinks aloud as she/he models.
6. Teacher models examples and non-examples.
7. Cueing
8. High levels of teacher-student interaction

Implementation of the Strategy

1. Ensure that your students have the prerequisite skills to perform the skill.
2. Break down the skill into logical and learnable parts
3. Provide a meaningful context for the skill (e.g. word or story problem suited to the age & interests of students).
4. Provide visual, auditory, kinaesthetic (movement), and tactile means for illustrating important aspects of the concept/skill (e.g. visually display word problem and equation, orally cue students by varying vocal intonations, point, circle, highlight computation signs or important information in story problems).
5. "Think aloud" as performing each step of the skill (i.e. say aloud what you are thinking as you problem-solve).
6. Link each step of the problem solving process (e.g. restate what you did in the previous step, what you are going to do in the next step, and why the next step is important to the previous step).
7. Periodically check student understanding with questions, remodelling steps when there is confusion.
8. Maintain a lively pace while being conscious of student information processing difficulties (e.g. need additional time to process questions).
9. Model a concept/skill at least three times before beginning to scaffold the instruction.

Merits of Instructional Strategy

- Teacher as model makes the concept/skill clear and learnable.
- High level of teacher support and direction enables student to make meaningful cognitive connections.
- Provides students who have attention problems, processing problems, memory retrieval problems, & metacognitive difficulties an accessible "learning map".
- Links between sub skills are directly made, making confusion and misunderstanding less likely.
- Multi-sensory cueing provides students multiple modes to process and thereby learn information.

Check your progress

Notes:

a) Write your answers in the space given below.

b) Compare your answers with those given at the end of the unit.

1. Explicit model is

   a. a model that breaks the concepts into elements

   b. a multisensory model

   c. a bi-sensory model

   d. a & b

   .....

5.3.2. The Path-Smoothing Model

The main features of the model, is the essential methodology which is to smooth the path for the learner: They are,

1. The teacher or text states the kind of problem on which the class will be working. The teacher or text attempts to classify the subject matter into a limited number of categories and to present them one at a time. There is an implicit assumption that, from the exposition, pupils will recognize and identify with the nature of the problem being posed.
2. Pupils are led through a method for tackling the problems. The key principle is to establish secure pathways for the pupils. Thus it is important to present ways of solving problems in a series of steps which is as short as possible, and often only one approach is considered seriously. Teachers question pupils, but usually in order to lead them in a particular direction and to check that they are following.
3. Pupils work on exercises to practice the methods given aimed at involving learners more actively. These are usually classified by the teacher or text writer and are graded for difficulty. Pupils repeat the taught processes until they can do so with the minimum of error.
4. Revision Longer term failure is dealt with by returning to the same or similar subject matter throughout the course.

Although this model emphasizes repetitive rather than insightful activities, almost all teachers who use it as their basic approach will also consciously offer some insightful experiences. They will, for example, attempt plausible explanations, or encourage pupils to gather data about particular cases before offering a generalization. However, there is usually a pressure of time felt by teachers, and consequently by their pupils, to move on to the 'work', which is

perceived as doing exercises. The teacher may find the time to offer explanations but not to provoke the debate needed to clarify meanings. Inevitably, pupils' perceptions remain unexamined if they passively agree to the arguments in order that work can proceed. So attempts to justify and explain, although genuine in intent, can fail to convey understanding to the pupils.

Check your progress

Notes:

a) Write your answers in the space given below.

b) Compare your answers with those given at the end of the unit.

2. Path smooth model deals with

   a. many concepts at a time

   b. one concept at a time

   c. No serious steps in problem solving

   d. a, b & c

   .....

5.3.3. An Alternative - the Challenging Model

The main features of the model are:

1. The teacher presents a challenging context or problem and gives pupils time to work on it and make conjectures about methods or results. Often the teacher will have an aspect of the syllabus in mind, but this may not be declared to pupils at this stage. An important word here is the challenge. The problem must be pitched at the right level, not too difficult, but more importantly, not too easy. The challenge may come from the complexity or the intriguing nature of the problem and the persistence needed to make progress with it, it may come from the variety of approaches which pupils bring to it, or from attempting to resolve the different perceptions which pupils have of a shared experience. A second important word is time. It is crucial to give sufficient time for pupils to get into the problem to recognise that it poses a challenge and that there may be a variety of approaches to it.

2. Out of pupils' working is established a variety of ways which help to deal with the situation. Here the role of the teacher is again crucial, initially, in drawing out pupils' ideas, so that they can be shared within groups or by the class as a whole. At some stage the teacher may wish to offer some ideas of her own.

3. Strategies which evolve are applied to a variety of problems - testing special cases, looking at related problems or extending the range of applications, developing some fluency in processes. Sometimes the syllabus requires the learning of more formal processes. The stimulus for this may be a harder mathematical problem and may require exposition by the teacher. However, the pupil will have the context of previous work to which more advanced techniques can be related.

4. A variety of techniques is used to help pupils to review their work, and to identify more clearly what they have learned, how it connects together and how it relates to other knowledge. Longer term failure is dealt with by ensuring that any return to the same subject matter encourages a different point of view and does not just go over the same ground in the same way. The model places a strong emphasis on the learner gaining new insights, and the time required for reflection is considered to be fully justified. Thus, at the heart of this model is the challenge to the learner. The teacher's function is not to remove all difficulties but to present the initial challenge and then to support the class in working on it. This may be a stumbling block if, as is often the case, pupils have different expectations of teachers and do not feel that they are being appropriately cared for. There seem to me to be three essential elements in developing the necessary supportive framework: to encourage collaborative work, to set more open tasks relating to global or key aspects of the syllabus, and to provide ways in which pupils can reflect on what they have done and relate aspects together. To achieve a necessary measure of teacher involvement, it is often preferable that the whole class should be working within the same topic. However, this does not preclude groups of pupils selecting their own topic of study from time to time, particularly once an effective way of working has been established. For all but the youngest pupils, where paired work is perhaps more feasible, it is possible to arrange for small groups of say four students to work collaboratively together. Each group may work on their own strategies to solve a common problem, on different aspects of a common topic or, sometimes, on different topics. Within this context the teacher can work in depth with particular groups, bring groups together to share ideas, and inject new ideas when required. Individual work will still occur, both as a contribution to the group effort and to meet individual needs. However, the greatest challenge to the teacher is to encourage good discussion within the groups and develop a climate in which pupils can see each other as a first resort for help and support. It helps if chosen topics are based on a major area of the syllabus, focus on central ideas, and extend over a lengthy period of time - perhaps even up to half a term. A substantial task can thus be presented, in which pupils help to: define the problem; develop ways of tackling it; generate examples to

test a theory or practise a method; predict and make generalisations; and explore further applications. Moving from exploratory work into new areas of knowledge requires specific strategies, such as sharing ideas about a carefully posed and challenging problem. Direct input by the teacher will sometimes be appropriate. In this way of working, a few key starting points are needed, sometimes supported with written sheets. A wide range of texts and reference books can be dipped into as required. Another essential feature is reviewing, which is the term used to describe various reflective activities, in which pupils step back from the immediate situation, and consider what they have done and how it relates to other aspects of their learning. Reflective activities can take the form of talking and writing about the processes pupils have gone through, making posters and reporting to the class, drawing up concept maps of a topic, and sharing attainment targets. Reviewing motivates and informs future learning activities and fosters general study skills.

Check your progress

Notes:

a) Write your answers in the space given below.

b) Compare your answers with those given at the end of the unit.

3. Challenging model insists on
   a. the difficulty level of the content and time
   b. teachers role
   c. gaining insights
   d. a, b & c

   .....

5.4. FORMATION AND APPLICATIONS OF MATHEMATICAL CONCEPTS

5.4.1 Vygotsky's Theory of Concept Formation

Although Vygotskian theory has been applied extensively in mathematics education, most of the research has focused on the mathematical activities of a group of learners or a dyad rather than the individual (Van der Veer and Valsiner, 1994). Furthermore it has been applied most frequently to primary school or high school learners (for example, van Oers, 1996; Radford, 2001) rather than to individuals at undergraduate level. Indeed, Van der Veer and Valsiner (1994) claim that the use of Vygotsky in the West has been highly selective. It is important to note that a focus on the individual does not contradict the fundamental Vygotskian notion that

"social relations or relations among people genetically underlie all higher functions and their relationships" (Vygotsky, 1981). After all, a situation consisting of a learner with a text is necessarily social; the textbook or exercises have been written by an expert also the text may have been prescribed by the lecturer with pedagogic intent. Thus a focus on the individual does not undermine the significance of the social. In order to understand Vygotsky's theory, one needs to understand how Vygotsky used the term 'word'. Vygotsky regarded a word as embodying a generalisation and hence a concept. As such, Vygotsky postulated that the child uses a word for communication purposes before that child has a fully developed understanding of that word. As a result of this use in communication, the meaning of that word (i.e., the concept) evolves for the child: Words take over the function of concepts and may serve as means of communication long before they reach the level of concepts characteristics of the fully developed thought (Uznadze, cited in Vygotsky, 1986). The use of a word or sign to refer to an object (real or virtual) prior to 'full' understanding resonates with the sense of how an undergraduate student makes a new mathematical object meaningful to herself. In practice, the student starts communicating with peers, with lecturers or the potential other using the signs of the new mathematical object (symbols and words) before she has full comprehension of the mathematical sign. It is this communication with signs that gives initial access to the new object. It is a functional use of the word, or any other sign, as a means of focusing one's attention, selecting distinctive features and analysing and synthesizing them, that plays a central role in concept formation (Vygotsky, 1986). Secondly but closely linked to the above notion, is Vygotsky's argument that the child does not spontaneously develop concepts independent of their meaning in the social world: He does not choose the meaning of his words. The meaning of the words is given to him in his conversations with adults (Vygotsky, 1986). That is, the meaning of a concept (as expressed by words or a mathematical sign) is 'imposed' upon the child and this meaning is not assimilated in a ready-made form. Rather it undergoes substantial development for the child as she uses the word or sign in her communication with more socialised others.

Thus the social world, with its already established definitions of different words, determines the way in which the child's generalisations need to develop. Analogously, one can argue that in mathematics, a student is expected to construct a concept whose use and meaning is compatible with its use in the mathematics community. To do this, that student needs to use the mathematical signs in communication with more socialised others (including the use of textbooks which embody the knowledge of more learned others). In this way, concept

construction becomes socially regulated.

Semiotic Mediation

Vygotsky (1978) regarded all higher human mental functions as products of mediated activity. The role of the mediator is played by a psychological tool or sign, such as words, graphs, algebra symbols, or a physical tool. These forms of mediation, which are themselves products of the socio-historical context, do not just facilitate activity; they define and shape inner processes. Thus Vygotsky saw action mediated by signs as the fundamental mechanism which links the external social world to internal human mental processes and he argued that it is by mastering semiotically mediated processes and categories in social interaction that human consciousness is formed in the individual (Wertsch and Stone, 1985).

Allied to this, concept formation, as discussed above, is only possible because the word or mathematical object can be expressed and communicated via a word or sign whose meaning is already established in the social world. In mathematics, the same mathematical signs mediate two processes: the development of a mathematical concept in the individual and that individual's interaction with the already codified and socially sanctioned mathematical world (Radford, 2000). In this way, the individual's mathematical knowledge is both cognitively and socially constituted.

This dual role of a mathematical sign by a learner before 'full' understanding is not well appreciated by the mathematics education community; indeed, its manifestations in the form of activities such as manipulations, imitations and associations are often regarded disparagingly by mathematics educators. That is, they regard such activities as 'meaningless' and without worth. In Vygotsky's theory, usages of the sign are a necessary part of concept formation. It manages to provide a link between certain types of mathematical activities (including those activities regarded pejoratively by many educators) and the formation of concepts.

Different Stages

Vygotsky further elaborated his theory by detailing the stages in the formation of a concept. He claimed that the formation of a concept entails different pre conceptual stages (heaps, complexes and potential concepts). During the syncretic heap stage, the child groups together objects or ideas which are objectively unrelated. This grouping takes place according to chance, circumstance or subjective impressions in the child's mind. In the mathematical domain, a student is using heap thinking if she associates one mathematical sign with another because of, say, the layout of the page. The syncretic heap stage gives way to the complex stage. In this stage, ideas are linked in the child's mind by associations or common attributes

which exist objectively between the ideas. Complex thinking is crucial to the formation of concepts in that it allows the learner to think in coherent terms and to communicate via words and symbols about a mental entity. And, as we have argued above, it is this communication with more knowledgeable others which enables the development of a personally meaningful concept whose use is congruent with its use by the wider mathematical community. Complexes corresponding to word meanings are not spontaneously developed by the child. The lines along which a complex develops are predetermined by the meaning a given word already has in the language of adults (Vygotsky, 1986). Furthermore, in complex thinking the learner begins to abstract or isolate different attributes of the ideas or objects, and the learner starts organizing ideas with particular properties into groups thus creating the basis for later more sophisticated generalizations. With complex thinking, the learner is not using logic; rather she is using some form of non-logical or experiential association. Thus complex thinking often manifests as bizarre or idiosyncratic usage of mathematical signs. For example, the learner is using complex thinking when she associates the properties of a 'new' mathematical sign with an 'old' mathematical sign with which she is familiar and which is epistemologically more accessible. As an illustration, on first encountering the derivative, f ¢ (x), of a function f(x), the learner may associate the properties of f¢ (x) with the properties of f(x). Accordingly, many learners assume or imply that since f(x) is continuous, so is f ¢ (x). Clearly this is not logical; indeed it is mathematically incorrect. Another example of activity guided by complex thinking is when the student seems to focus on a particular aspect of the mathematical expression and to associate these symbols or words with a new sign. For instance, when dealing with the greatest integer function x= greatest integer £ x, many students latch onto the word 'greatest' ignoring the condition £ x. They then link the word 'greatest' to the idea of 'greater than' and accordingly state that, say, 4.3= 5 (whereas of course, the answer should be 4).

The point here is not how the student uses the signs but rather that she uses the signs. Through this use, the student gains access to the 'new' mathematical object and are able to communicate (to better or worse effect) about it. Through social regulation or reflection (in tandem with the socially constituted definition and for an attenuated or extended time period) the learner will eventually come to use and understand the signs in ways that are congruent with official mathematics. Observations of undergraduate students over the years ties in very well with the idea that pre conceptual thinking is a necessary part of successful mathematics concept construction. Of course, the time spent using complex thinking may be very brief or very long, depending on the student, the particular mathematical object, the task, the context

and the social interventions. Vygotsky distinguished between five different types of complexes. For the purposes of this talk it is sufficient to elaborate on the pseudo concept, which is a construct which effectively bridges the divide between the individual and the social and between complex and concept.

Check your progress

Notes:

a) Write your answers in the space given below.

b) Compare your answers with those given at the end of the unit.

4. Vygotaky theory is applicable to

   a. Primary school students

   b. High school students

   c. Undergraduate students

   d. Primary and High school students

   .....

5.4.2 Concept Attainment Model

In 1956, psychologist Jerome Bruner published a book called "A Study of Thinking." Being a psychologist, Bruner was interested in cognitive processing–how people think, and how those tendencies might be used to inform teaching and learning processes. He developed a new way of introducing learners to new concepts called Concept Attainment.

Concept Attainment

It can be thought of as game of "find the rule." Concept Attainment is a "backwards conceptualizing" approach to making sense of new ideas. It is a teaching strategy characterized by "a pattern of decisions in the acquisition, retention, and utilization of information that serves to meet certain objectives" (Bruner et al 1956). Concept Attainment is a "close relative to inductive thinking (Joyce and Weil 1967), (and) focuses on the decision-making and categorization processes leading up to the creation and understanding of a concept." Neff also explains that there are several advantages to this approach, including learning "how to examine a concept from a number of perspectives, learning how to sort out relevant information", the benefit of seeing multiple examples of ideas, and maybe most importantly, moving beyond mere concept–definition association. This allows for the idea to be seen in its native context, and a more authentic and fuller definition to emerge.

Process of Concept Attainment

In the concept attainment process, new ideas are introduced–and defined by students–inductively through the "act(s) of categorization" (Bruner, Goodnow, and Austin 1956). Students see attributes, examples and non-examples, form theories, and then test those theories against the data given until they are able to name the idea.

This reverses the typical process of introducing an idea (e.g., gravity) by narrowly defining it (e.g., the force that attracts a body toward another physical body having mass). The Concept Attainment process requires learners to focus on attributes, categories, and relationships rather than simply mirroring an idea with a definition.

Benefits of Concept Attainment

Concept attainment is designed to clarify ideas and to introduce aspects of content. It engages students into formulating a concept through the use of illustrations, word cards or specimens called examples. Students who catch onto the idea before others are able to resolve the concept and then are invited to suggest their own examples, while other students are still trying to form the concept. For this reason, concept attainment is well suited to classroom use because all thinking abilities can be challenged throughout the activity. With experience, children become skilled at identifying relationships in the word cards or specimens. With carefully chosen examples, it is possible to use concept attainment to teach almost any concept in all subjects.

Check your progress

Notes:

a) Write your answers in the space given below.

b) Compare your answers with those given at the end of the unit.

5. Concept attainment model is
   a. related to inductive thinking
   b. enhancing new ideas
   c. a & b
   d. lacking in the skill development of students

   .....

5.4.3 Advance Organizer model

An **advance organizer** is a type of instructional preparation that links previously learned or known material to a new lesson. Usually the new material is at a more advanced level of the

same subject. Familiar terms and concepts are re-introduced and applied again, but at a higher level.

Applications

Advance organizers can be applied in different ways. For example:

- New material can be described using familiar terms
- Material can be introduced in the form of a story, using familiar terms
- Students can individually skim previously learned material before moving onto the new material
- Students can use graphic organizers to make visual connections between what they've learned previously and the new material.

Method

During the presentation of new material, a teacher should integrate the new while also making connections to the old, reminding students of the connections between the two. Key terms should be repeated. After the old material is reviewed and the connections to the new lesson have been made, students can work in groups to define or summarize key points, or draw comparisons between the old and the new.

Check your progress

Notes:

a) Write your answers in the space given below.

b) Compare your answers with those given at the end of the unit.

6. Advanced organiser model insists on
   a. reintroducing familiar concepts and terms
   b. ordinary and lower level of subjects
   c. a & b
   d. not linking with previous lessons

   .....

5.4.4 The Jurisprudential Inquiry Model

The model is somewhat complex and assumes that a number of teaching skills are understood, if not used by, the teacher. These include: cooperative learning strategies of Johnson, Grooker, Stutsman, Hultman, and Johnson (1985) and Slavin (1989); higher-order questioning skills; wait time; classroom organization and management skills. In addition, it helps to understand a constructivist approach to teaching and the need for student empowerment as both an approach to teaching and as an outcome of education. Also, the teacher must have enough content knowledge of the subject being taught so that he or she can concentrate on how to teach and not spend preparation time on what to teach. All of these characteristics must be blended with an understanding of how children learn and when to intercede for maximum learning.

The Jurisprudential STS Model of Teaching: Pedersen (1990) modified the original Joyce and Weil Jurisprudential Model (1986) to create a jurisprudential inquiry STS model of teaching that effectively lends itself to the study of science, technology, and societal issues in the classroom. The jurisprudential inquiry STS model approaches teaching issues by dividing a class into the issue viewpoints. Through the use of information-acquisition strategies and classmate interactions, students present their views to a class-selected board of arbiters. It is the board's responsibility to listen to the student arguments in a public hearing and render a decision on the issue.

The final phase of this and many other STS teaching strategies involve the creation and assessment of action plans. In many ways the actual action plans developed by students are just as important an outcome as the related science concepts they learned.

Six phases of the jurisprudential inquiry model applied to STS

Phase I: Orientation to the Issue

The initial step of this model introduces students to the selected issue. This occurs on the very first day that the topic is being studied. During this initial stage, the teacher must accomplish several tasks. They include:

1. Dividing the class into teams of two or three students. Each team will be assigned a side of the issue to represent in their respective group. The purpose

of the team is to cooperate in reading, researching, and interacting on the side of the issue that they have been assigned.

2. Then they are arranged into groups so that the number of teams in a group equals the number of sides to the issue. For example, a recycling issue may have two sides – recycling and non recycling. Therefore each group would have two teams of two (or three) members, a total of four (six) in the group.
3. Next the teacher should assign each team within a group one side of the issue to represent. It is important to do this randomly. Inevitably some students will be assigned to a side of an issue that they do not believe in, but this is perhaps desirable.
4. It is important to remember that the issue selected becomes the focus of the curriculum. The content becomes the support for the issue.

Phase II: Identifying and Defining the Issue

Students begin to use the content during the second phase of the model. The students, working in their cooperative teams, use the library and other resources to gather, clarify, and synthesize facts about the issue. The students begin to identify values and value conflicts and raise questions about opposing views. The following should be considered when entering Phase II.

1. Preparation for an adequate number of days in the library or for working with other resources. The teacher should be prepared to give guidance to both the students and resource people when necessary. For example, the teacher may need to address interview techniques, help students learn to read for fact versus opinion, or assist with questionnaire design. The teacher may also find it necessary to touch base with resource personnel such as librarians to ensure that students get the information they need.
2. Allowing time for the teams to be together to research, read, interview, survey, telephone, meet, discuss the issues and what they have found, and prepare each other for a public meeting.
3. Students can use encyclopaedias, magazines, journal articles, government publications, people, special interest groups, and a host of other resources. Probably the most overlooked resource will be the local or regional newspaper. It is important for the students to understand, when reading the

newspaper, the difference between fact and opinion. Students may assume that an editorial, because it is in the paper, is fact.

Phase III: Synthesizing the Research Information into Arguments

At least one day prior to the public meeting, the students should get back together as an intact class. At this point, the teacher should allow all of the teams representing the same side of the issue to get together to share information and prepare for the public discussion. It is during this time that the students need to plan a strategy for the public meeting. The following can be used as a guide for the students when in the large groups.

- Establish a stance based on factual information
- Point out the undesirable or desirable consequences of a position
- Clarify the value conflict with analogies
- Set priorities; assert priority of one value over another
- Identify factual assumptions and determine if they are relevant
- Determine the predicted consequences and examine their factual thoughts.

Phase IV: The Public Meeting

The fourth phase of the jurisprudential inquiry STS model involves the students in a mock public meeting. This meeting involves all students in presenting the different sides of the issue being studied. During the debate it is important that the students on the board of arbiters initiate and oversee the meeting. It is important also for the teacher to see that the following guidelines are followed.

- Maintain a vigorous intellectual climate where all views are respected.
- Avoid the direct evaluation of each other's opinions.
- See that issues are thoroughly explored.
- Respect the authority of the board.

Phase V: Clarification and Consensus

During this phase, students spend two days clarifying and arriving at a consensus on the issue. The first day is spent with the students still divided into the respective sides of the issue, the board, the newspaper crew, and the camera crew. During this time the students

clarify their best arguments in support of the side of the issue they represented. The board will be responsible for clarifying why they rendered their decision. The newspaper crew and camera crew will work on preparing their respective reports.

On the second day, students separate into their original groups. The groups were originally constructed so that all perspectives of the issue would be represented. The purpose of these groups is to come to a consensus on the issue. The students should use all information available to them in drawing their conclusions. This would include information from the debate, the research done, other groups, the newspaper and camera crews' perspective, and the board's recommendations.

The students' cooperative effort should represent the opinions of all the students in the groups. Their goal is to write those arguments that justify the original group's position on the issue.

Phase VI: Application

The final phase of this model is the most important phase. It is in this phase that the students take what they have learned and apply it to their surroundings. Students must be able to see the value in the science they have learned and see that, with this knowledge, they can have an impact.

The first step of this process is for each student to propose an overall action plan with resolutions. The key to this model of instruction is that students have opportunities to apply the investigation skills and action strategies to the community in which they live.

Teacher's Role

The teacher's role during this exercise is important. As the students are researching, discussing, and debating, the teacher should encourage the students to commit themselves to one side of the issue, but be supportive if they change their minds when confronted with new evidence, and encourage them to consider other points of view. At all times, the teacher should remain neutral on the issue, encourage differentiation of positions, and promote synthesis of the different positions presented to the class.

Summary

It is important to remember that STS issues are not things that a teacher can pull out of a book, they are not simply newspaper articles about issues in science, and they are not "discussing" an issue for ten minutes once a week. It is the integration of societal and technological issues that makes science content much more meaningful. The jurisprudential inquiry STS model can be used to accomplish that integration. Students must see the value of science. By using STS issues in this manner, students see how the issue impacts them and also how they impact the issue.

Check your progress

Notes:

a) Write your answers in the space given below.

b) Compare your answers with those given at the end of the unit.

7. The Jurisprudential model is

   a. encouraging students to see the value of science

   b. that selected issues becomes the focus of the curriculum

   c. a complex model

   d. a, b & c

   .....

5.5 CLASSROOM INTERACTION ANALYSIS (FLANDERS INTERACTION ANALYSIS CATEGORY SYSTEM) AND ITS IMPLICATIONS IN LEARNING MATHEMATICS

Flander's Interaction Analysis Category System (FIACS)

Flanders developed a system of interaction analysis to study what is happening in a classroom when a teacher teaches. It is known as Flanders Interaction Analysis Categories System (FIACS). Flanders and others developed this system at the University of Minnesota, U.S.A. between 1955 and 1960. Flanders classified total verbal behaviour into 10 categories. Verbal behaviour comprises teacher talk, student talk and silence or confusion.

There are ten categories mentioned in this analysis. They are

1. Teacher Talk – 7 categories
2. Pupil Talk – 2 categories
3. Silence or Confusion- 1 category

Thus, the first seven categories include teacher talk. Next two categories include pupil Talk. The last tenth category includes the small spans of silence or pause or confusion.

Teacher's Talk - 7 Categories

a) Indirect talk

b) Direct talk.

Category

1. Accepts Feelings
2. Praise or Encouragement
3. Accepts or Uses ideas of Pupils
4. Asking Questions
5. Lecture
6. Giving Directions
7. Criticizing or Justifying Authority

Pupil Talk -2 Categories

8. Pupil Talk Response Category
9. Pupil Talk Initiation

Neither Teacher Talk nor Pupil Talk -1 Category

Silence or Pause or Confusion -3 Category

Meaning of various categories

1. Teacher Talk (7 Categories)

A) Indirect Talk

In this method of analysis, the first four categories represent the teacher's indirect Influence.

Category 1: Accepts Feelings

- In this category, teacher accepts the feelings of the pupils.
- He feels himself that the pupils should not be punished for exhibiting his feelings.
- Feelings may be positive or negative.

Category 2: Praise or Encouragement

- Teacher praises or encourages student action or behaviour.
- When a student gives answer to the question asked by the teacher, the teacher gives positive reinforcement by saying words like good , very good, better, correct, excellent, carry on, etc.

Category 3: Accepts or Uses ideas of Pupils

- It is just like 1st category. But in this category, the pupils ideas are accepted only and not his feelings.

- If a pupil passes on some suggestions, then the teacher may repeat in nutshell in his own style or words.
- The teacher can say, „I understand what you mean etc. Or the teacher clarifies, builds or develops ideas or suggestions given by a student.

Category 4: Asking Questions

- Asking question about content or procedures, based on the teacher ideas and expecting an answer from the pupil.
- Sometimes, teacher asks the question but he carries on his lecture without receiving any answer. Such questions are not included in this category.

B) Direct Talk

Next 5th to 7th categories represent the teacher's direct influence.

Category 5: Lecturing /Lecture

- Giving facts or opinions about content or procedure expression of his own ideas, giving his own explanation or citing an authority other than a pupil.

Category 6: Giving Directions

- The teacher gives directions, commands or orders or initiation with which a pupil/student is expected to comply with
  - Open your books.
  - Stand up on the benches.
  - Solve 4th sum of exercise 5.3.

Category 7: Criticizing or Justifying Authority

- When the teacher asks the pupils not to interrupt with foolish questions, then this behaviour is included in this category.

2. Pupil Talk (2 Categories)

Category 8: Pupil Talk Response

- It includes the pupils talk in response to teacher's talk
- Teacher asks question, student gives answer to the question.

Category 9: Pupil Talk Initiation

- Talk by pupils that they initiate.
- Expressing own ideas; initiating a new topic; freedom to develop opinions and a line of thought like asking thoughtful questions; going beyond the existing structure.

3. Silence or Pause or Confusion (1 category)

Category 10: Silence or Pause or Confusion

- Pauses, short periods of silence and period of confusion in which communication cannot be understood by the observer.

Advantages of FIACS

1. It is an effective tool /instrument to measure the social-emotional climate in the classroom.
2. It is also used for in-service teachers.
3. It provides feedback to the pupil-teachers.
4. It is an objective and reliable method for observation of classroom teaching.
5. It is mostly teacher talk oriented.
6. It is used to compare the behaviour of teachers at different age levels, gender, subject etc.
7. It is much useful in team teaching and microteaching.

Check your progress

Notes:

a) Write your answers in the space given below.

b) Compare your answers with those given at the end of the unit.

8. FIACS is
   a. useful in team teaching and micro teaching
   b. mostly student talk oriented
   c. can not be used for in-service teachers
   d. not objective and reliable method

   .....

5.6 LET US SUM UP

This unit made an attempt to explain the different mathematics teaching models which is highly considered to bring significant outcome in mathematics education. Further suggestion of this unit is the different models and their applications in mathematics teaching. The FIACS is discussed well to concretize the concepts and use them effectively in mathematics teaching. So, teachers are expected to plan meticulously to select the apt model to make their class more effective.

5.7 UNIT END ACTIVITIES

1. Arrange a discussion with the students on Explicit Teacher Model.
2. Make an assignment on the advantages of Path Smoothing Model.
3. Make a chart on the main features of the Challenging Model.
4. Conduct a seminar on the Vygotsky's theory concept.
5. Bring out the significance of FIACS.

5.8 ANSWERS TO CHECK YOUR PROGRESS

1) d 2) b 3) d 4) d 5) c 6) a 7) d 8) a

5. 9 SUGGESTED READINGS

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UNIT VI

Techno-based Teaching and Evaluation in Mathematics

Structure

6.1 INTRODUCTION

Audio visual instruction simply means a supplementary device for waking learning objective real and effective. Experiences provide with the help of audio visual aids are generally interesting full of life and provide a clear vision leading to perfect understand ability and adaptability in life. Audio visual aids are not self-contained teaching devices. They are not in the field of learning to replace anything books teachers of audio visual aids can be found only when the separate entity is completely of audio visual aids can be found only then their separate is completely merged and they join hands with the existing techniques. They are good only because they make the learning. They are important because they make

experiences important by attaching importance to their nature existence and further use. They contribute towards clear consenting better understanding and permanent learning Audio visual material must be seen in their relationship to teaching as a whole and to the learning process as a whole, until the teacher understands the relationship between audio visual material and teaching learning process. Audio visual materials are produced, distributed and used as planned components of educational programs. It helps the process of learning that is motivation, classification and stimulation.

6.2 OBJECTIVES

At the end of this unit you will be able to:

Understand the meaning of Audio-Visual aids

Know the definitions of Audio-Visual aids

Understand the Importance and limitations of audio-visual aids

Understand the need for Information and Communication Technology in Mathematics Teaching

Know the various types of Evaluation

6.3 DEFINITIONS

1. **According to Kinder S. James**: Audio visual aids are any device which can be used to make the learning experience more concrete, more realistic and more dynamic.

2. **According to Burton**: Audio visual aids are those sensory objects or images which initiate or stimulate and reinforce learning.

3. **According to Carter.V.Good:** Audio visual aids are those aids which help in completing the triangular process of learning that is motivation, classification and stimulation.

4. **According to good's dictionary of education**: Audio visual aids are anything by means of which learning process may be encouraged or carried on through the sense of hearing or sense of sight.

5. **According to Edger Dale:** Audio visual aids are those devices by the use of which communication of ideas between persons and groups in various teaching and training situations is helped. These are also termed as multi-sensory materials.

6. **According to McKean and Roberts**: Audio visual aids are supplementary devices by which the teacher, through the utilization of more than one sensory channel is able to clarify, establish and correlate concepts, interpretations and appreciations.

7. **According to KP. Neeraja**: An audio visual aid is an instructional device in which the message can be heard as well as seen.

6.3.1 Psychology of Using Audio-Visual Aids

Psychology of learning brought the doctrine of interest into lime light and established that the child has got vital inherent interests and the education must discover and develop and use them for beneficial ends. To meet this end modern education provides happy cheerful and pleasant atmosphere in the school in a dignified way and on a high plane. School buildings curricular and extracurricular activities are planned today to keep the interest of pupils' not only alive but accelerated and to suit the varying interests of the children. Methods materials and techniques are useful and natural rather than academic and artificial. The belief today is that a worthy motive is an inducer and incite or an impeller and is always based on interest. Curiosity is the mother of all knowledge and serves as great stimulus to an immense amount of what otherwise be drudgery.

The concept of personal relevance of materials to the learner is a central one. It is proposed that individuals contribute to and importantly modify the information presented to them. Variability of reactions relates to ambiguity of information. The problem of individual variability is raised and related to the requirements of educational standards. Goal oriented striving which demands hard work and energy expenditure is proposed and contrasted with the permissive "pleasure principle" conception of learning. The requirements are stated for having materials organized while expecting reorganization by students. An attempt is made to broaden the widespread popular concept of "participation," and thus to meet a persisting criticism of many types of projected audio-visual aids.

6.3.2 Principles of using audio-visual aids

Audio visual aids should be centralized, under specialized direction and leadership in educational programs. An advisory committee consisting of representative from all areas of

curriculum should be appointed to assist in selection and coordination of Audio visual materials.

An education program should be flexible. Audio visual material should be carefully located to eliminate duplication, easy accessibility and convenient use.

Audio visual material should be available whenever and wherever they needed for effective utilization as an integral part of curriculum. Budget appropriations should be made regularly for Audio visual education programs. Periodic evaluation, to be done to assess the function of, utilization and expenditure of the program.

Some Principles for Use of A-V Aids

Thus far we have suggested that audio-visual aids are a valuable tool for the planner, and we have briefly defined audio-visual aids and the more important pieces of audio-visual equipment. Now, before going into the choice of a means for displaying the aids for a particular talk, we must discuss the selection of the aids themselves.

The illustration, both audio and visual, of a talk is similar to the illustration of a printed report. The process generally follows these steps:

1. There must be a goal or purpose for preparing the report (speech).
2. An outline of the finished product is prepared, to be used at this point as a guide to the research.

3. Research is completed, as necessary. If the research includes the compilation of data or map studies, these may be bases for illustrations.

4. The final report (speech) is written.

5. Illustrations are added to

a. Support statements.

b. Graphically depict key points.

c. Enhance the appearance of the report (speech).

d. Add a touch of humour.

e. Add emotional impact.

f. Condense and simplify statistical material.

In one sense an audio-visual presentation, with the audio presented "live" and the visual projected on a screen, is similar to an old-time vaudeville act with two men on the stage, the straight man and the so-called comedian. On some lines the straight man will move to stage center and project loudly, and on the next lines the comedian will stride over the footlights and give the punch line. With sharp, crisp dialogue and byplay, they hold their audience's interest. Of course the planner does not do a song and dance act when using audio-visual tools. But a certain amount of showmanship and enthusiasm, as well as pacing and timing, can make a presentation more effective. A visual aid carries the impact one time; then the planner steps forth to point out a key fact related to the illustration

6.3.3 Essential qualities of Audio-Visual Aids,

One of the basic conditions which audio visual materials are expected to perform is to help students visualize the various phenomena with which the subject deals.In order to achieve this function any audio visual material must possess the following characteristics

- It must be clear, clean, interesting and cheap.
- It should be of a suitable size eg. It must be large enough (bold) for the whole class or small for group work.
- It must adequate, accurate, giving up-to-date information
- Must be relevant to the topic being discussed
- It must not be over- crowded with details
- It must illustrate the specific point being taught
- Any audio visual aid must be realistic in terms of the pupils' ability to interpret aids
- It should be related to pupils' experience.
- It should motivate the learners and easily portable

The important features of audio visual aids are

- It helps in developing perception of learner.
- It aids in positive transfer of learning and training

- It facilitates in understanding and comprehension
- It provides reinforcement to the learner
- It increases the retention of the learner

Check your progress

Note : a) Choose the Correct Answer

b) Check your answers with the answers given at the end of the unit.

1. According to Edger Dale, Audio Visual aids are termed as

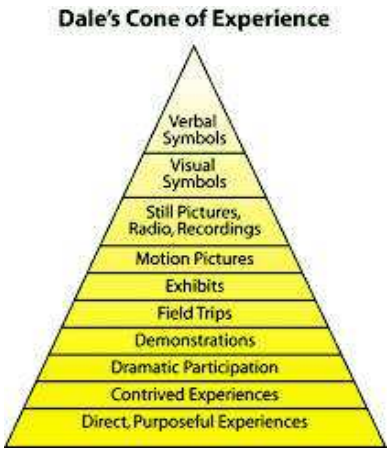
a) sense of sight b) sensory objects c) multi-sensory materials d) supplementary devices

2.Which one of the following is the most important features of audio visual aids

a) informative b) increase the retention c) interactive d)cheap and best

6.4 Dale's Cone of experience

Dale's Cone of Experience is a model that incorporates several theories related to instructional design and learning processes. During the 1960s, Edgar Dale theorized that learners retain more information by what they "do" as opposed to what is "heard", "read" or "observed". His research led to the development of the Cone of Experience. Today, this "learning by doing" has become known as "experiential learning" or "action learning". According to Dale's research, the least effective method at the top, involves learning from information presented through verbal symbols, i.e., listening to spoken words.



The most effective methods at the bottom, involves direct, purposeful learning experiences, such as hands-on or field experience. Direct purposeful experiences represent reality or the closet things to real, everyday life. The cone charts the average retention rate for various methods of teaching. The further we progress down the cone, the greater the learning and the more information is likely to be retained. It also suggests that when choosing an instructional method it is important to remember that involving students in the process strengthens knowledge retention. It reveals that "action-learning" techniques result in up to 90% retention. People learn best when they use perceptual learning styles. Perceptual learning styles are sensory based. More the possibility the sensory channels are interacting with a resource, the better chance that many students can learn from it. According to Dale, instructors should design instructional activities that build upon more real-life experiences. Dales' cone of experience is a tool to help instructors make decisions about resources and activities.

Check your progress

Note : a) Choose the Correct Answer

b) Check your answers with the answers given at the end of the unit.

3. According to Dale's research, the least effective method at the
   a)middle b) top c) bottom d) left
4. According to Dale's research, the most effective method at the
   a)middle b) top c) bottom d) left
5. The cone charts the average retention rate for various methods of teaching is
   a) 50% retention b) 70% retention c) 80% retention d) 90% retention
6. Perceptual learning styles are based on
   a)sensory b) visual c) audio d) audio-video

6.5 Classification of teaching aids

There are many aids available these days. We may classify these aids as follows

1) **Visual Aids**

The teaching aids which use the sense of vision for teaching/learning are called Visual aids. For example :- actual objects, models, pictures, charts, maps, flash cards, flannel board, bulletin board, chalkboard, overhead projector, slides etc. Out of these black board and chalk are the commonest ones.

2) **Audio Aids**

The teaching aids that involve the sense of hearing are called Audio aids. For example: - radio, tape recorder, gramophone etc.

3) **Audio - Visual Aids**

The teaching aids which involve the sense of vision as well as hearing are called Audio-Visual aids. For example: - television, film projector, film strips etc.

Characteristics of good audio visual aids

One of the basic conditions which audio visual materials are expected to perform is to help students visualize the various phenomena with which the subject deals.

- In order to achieve this function any audio visual material must possess the following characteristics
- It must be clear, clean, interesting and cheap.
- It should be of a suitable size eg. It must be large enough (bold) for the whole class or small for group work.
- It must adequate, accurate, giving up-to-date information
- Must be relevant to the topic being discussed
- It must not be over- crowded with details
- It must illustrate the specific point being taught
- Any audio visual aid must be realistic in terms of the pupils' ability to interpret aids
- It should be related to pupils' experience.

- It should motivate the learners and easily portable

The important features of audio visual aids are

- It helps in developing perception of learner.
- It aids in positive transfer of learning and training
- It facilitates in understanding and comprehension
- It provides reinforcement to the learner
- It increases the retention of the learner

6.6 Hardware and software approaches

The software approach owes its origin to the behavioural sciences and their applied aspects concerned psychology of learning. It originated from the pioneering efforts of skinner and other behaviourists. Software teaching technology directly related to the psychology of learning which comprises behavioural changes resulting from experience (Melton 1959). The software technology is sometimes referred to as instructional technology, teaching technology and behavioural technology. The Hardware technology has contributed more to behavioural sciences.

Significance of Hardware and Software Technology

- They cater to individual differences of students.
- Economy of time, energy and resources of teachers and students.
- Bring clarity and vividness of the subject matter.
- Proper use of hardware and software helps in motivating the students.
- Developing and sustaining the interests of the students.
- Make the subject matter easy to comprehensive.
- Make the subject matter interesting
- Make the teaching learning attractive inspirational and effective.
- Make the subject matter lively.
- Provide ample opportunities of student's participation.

Check your progress

Note : a) Choose the Correct Answer

b) Check your answers with the answers given at the end of the unit.

7. Choose the correct teaching aid in the example of Visual Aids

a)gramophone b) actual objects c) television d) film projector

8. Which of the following teaching aids is the incorrect example of Audio Aids

a) actual objectsb) gramophonec) radio, d)tape recorder

9. The software technology is referred to as

a) Hardware technology b) software technology c) instructional technology d) information technology.

10. The Hardware technology has contributed in the field of ----------

a) behavioural sciences. b) computer science c) instructional technology d) teaching technology

6.7 Preparation and use of software

Modern times have induced the teaching of mathematics through the use of software. General software is designed for many different applications. Teachers must examine the area of mathematics in which the software will be used and develop lessons that promote the type of learning on which they will focus. General software often can be used for a wide range of grade levels and mathematical subjects. Software designed to emphasize learning in a particular area of mathematics is an example of "specific" software. The focus with specific software is the learning of a distinct mathematical topic, such as fractions, reflections, polygons, order of operations, right triangles, proportions, ratios, the Pythagorean theorem, and so on. This software differs from the review and practice category in that the focus is on learning new content, not reviewing a specific mathematical concept. There are various software that can be used for teaching of mathematics in everyday classroom. Some of them are given below:

Soft ware used for teaching / learning Mathematics

• Graphic Calculators
• Dynamic graphing tools (Geogebra)
• Dynamic geometry tools
• Microsoft Excel / spreadsheet
• Microsoft Mathematics
• Geo Gebra
• Auto shape
• Mat lab

For example, the Geometer's Sketchpad (Jackiw, 1995) is an example of software designed for general use. This dynamic geometry program has gained respect for its potential to assist teachers implementing the NCTM standards by providing students with the possibility of testing conjectures about geometric shapes, relations, and transformations. A dynamic geometry program allows the user to construct, measure, and manipulate what is displayed on the screen, providing immediate feedback as the object changes size or shape.

There are many types of visual aids used in teaching. Following are some of the commonly used visuals:

- posters charts
- PowerPoint slides models
- pictures/photos dry erase boards
- overhead transparencies articles made
- equipment animals
- movie clips audio clips

Audio-visual aids are used to enhance the presentation in classroom teaching. They can be handouts, photos, white board, flip chart, OHP, power point slide show, microphone, music. There are a number of potential benefits of using the teaching aids in an educational setting. First, they help to support cognitive processes by reducing the memory load of a student and by encouraging awareness of the problem-solving process. Second, aids can share the cognitive load by reducing the time and a mode switching helps sustain motivation of the students. Third, the aids allow students to engage in mathematics, making learning

interesting. Fourth, aids support logical reasoning and hypothesis testing by allowing students to test conjectures easily.

6 .8 Importance and limitations of audio-visual aids

Importance of audio-visual aids

(i) Best Motivators

They are the best motivators. Students work with more interest and zeal. They are more attentive.

(ii) Fundamental to Verbal Instructions

They help to reduce verbalism which is a major weakness of our schools. They convey the same meaning as words mean. They give clear concepts and thus help to bring accuracy in learning.

(iii) Clear Images

Clear images are formed when we see, hear, touch, taste and smell as our experiences are direct, concrete and more or less permanent. Learning through the senses becomes the most natural and consequently the easiest.

(iv) Vicarious Experience

Everyone agrees to the fact that the firsthand experience is the best type of educative experience but such an experience cannot always be provided to the pupils so in some situations certain substitutes have to be provided. For this we find a large number of inaccessible objects and phenomenon. For example all the students in India cannot possibly be shown Taj Mahal etc. In all such cases audio-visual aids provide us the best substitutes.

(v) Variety

Audio-Visual aids provide variety and provide different tools in the hands of the teacher.

(vi) Freedom

The use of audio-visual aids provide various occasions for the pupil to move about, talk, laugh and comment upon. Under such an atmosphere the students work because they want to work and not because the teacher wants them to work.

(vii) Opportunities to Handle and Manipulate

The use of audio-visual aids provides immense opportunities to the pupils to see, handle and manipulate things.

Limitations of audio-visual aids

Inside of the increasing popularity that the audio-visual aids have gained in the educational system, there are certain problems to be faced and solved.

(i) Apathy of the Teacher

It has not yet been possible to convince the teacher that teaching with words alone is quite tedious, wasteful and ineffective.

(ii) Indifference of Students

The judicious use of teaching aids arouses interest but when used without a definite purpose they lose their significance and purpose.

(iii) Ineffectiveness of the Aids

Because of lack of proper planning and lethargy of teacher as also without proper preparation, correct presentation, appropriate application and essential follow up work, the aids have not proved their usefulness. A film like a good lesson has various steps-preparation, presentation, application and discussion.

(iv) Financial Hurdles

The Boards of audio-visual aids have been set up by central and state governments for chalking out interesting programmes for the popularisation of teaching aids but the lack of finances is not enabling them to do their best.

(v) Absence of Electricity

Most of the projectors cannot work without electric current and so the non-availability of electricity is creating a hurdle in the proper use of audio-visual aids.

(vi) Lack of Facilities for Training

More and more training colleges or specialized agencies should be opened to train teachers and workers in the use of audio-visual aids.

Check your progress

Note : a) Choose the Correct Answer

b) Check your answers with the answers given at the end of the unit.

11.Which one of the following Software used for teaching / learning Mathematics

a) operating system b) windows c) Dynamic geometry tools d) java

6.8.1 Radio

A radio is an effective audio aid device which is capable of providing valuable assistance to the teacher in the classroom by presenting worthwhile information and learning experience to a large number of students. Radio broadcasts are of two types

- General broadcast providing general information about the events and happenings assimilating knowledge about the world's culture and life.
- Educational broadcast specifically preferred and broadcast for serving the cause of education and classroom in the form radio lesson, lectures, etc.,

The use of radio for educational purposes began with the BBC's schools broadcasting services as far back as in 1924. The first school broadcast in India was commissioned in 1937, and regular broadcasts began in 1938 from All India Radio (AIR) in Bombay, Calcutta, Delhi and Madras. Subsequently, various educational radio projects over AIR have been carried out.

Systemic advantages and limitations

Besides improving the quality of teaching and learning, the strength of Interactive Radio Instruction (IRI) lies in the following systemic advantages:

• Equity: There is standardization of quality in the programme for all students in urban and even isolated rural areas.

• Access: Programmes can be accessed by formal elementary schools, other forms of learning centres, out-of-school children and youth, general "shadow" audiences.

• Cost-effectiveness: IRI is much less expensive than other options, as it can go to scale to reach lakhs of students and their teachers. It is important to note that in the CLR's radio projects for teaching English, it was not classroom teachers' competence in subject matter but their professional commitment to students that determined the significant gains in learning.

Sustainability

IRI's global experience in sustainability reveals that where radio projects have been externally funded, only about half continue to be operational after funding ceases, and this in spite of unambiguous learning gains. Hence it is clear that improved quality of teaching and learning does not necessarily ensure sustainability of the radio pedagogy. As is the case with all initially successful educational innovations within our state systems, sustainability of IRI programmes in India will ultimately be governed by structural, management, financial and political factors.

How to utilize radio broadcasting in the classroom

The educational broadcasting services offered by the AIR and other radio channels may render valuable assistance in the classroom instructional programmes for the desired outcomes. It needs a careful effort on the part of the teachers.

- The teacher must acquaint himself with the schedules and programmes of these broadcasts through the relevant available literature.
- The teacher must carefully think and plan the integration of the scheduled broadcasting programmme with classroom teaching.
- The teacher must try to prepare students as adequately and possible educationally as well as psychologically to properly get the knowledge and experiences imparted through a radio broadcast.

6.8.2 Tape recorder

It is an effective recording device that calls for the use of auditory senses to convey educational message to the learners. It mainly consists of three parts

- a micro phone or over sound inputs,
- amplifier and
- the reproducer

The tape recorder has two functions in the operation of an A-V program: to rehearse a presentation; and to record "live" interviews.

A tape recorder is an excellent device to use for rehearsing a talk, especially when using overhead transparencies, slides or a 35 mm. filmstrip. By replaying a tape, the planner becomes aware of how he sounds and can decide where he'll want greater or less emphasis.

The teacher may take a tape recorder out in the field and tape "live" interviews to learn people's opinions about a current issue. Later on, the taped interviews can be used when projecting the visuals, along with photographs of the person speaking and of the subject of his comments. It involves two process recording and reproducing of the sound. Also, the teacher will usually need a recorder with two speeds. A relatively fast speed is used for quality recording, such as background music. The slower speed can be used for interviews or other sounds with lower quality demands permitting longer playing time on one tape.

6.8.3 Television

Television is the most potential instrument in educating masses and thereby narrowing down the gap of progress between the developing and developed countries in the world. For a country like India which has vast and inaccessible areas different climatic conditions large and ever growing population television can be used as an important central media in providing formal and non formal education to the masses. It can also in bringing about social cultural changes bearing on art, music drama and literature. It is through television that stimulating and though provoking views of renowned statesmen, scientist, educationist, artist and teachers can be shared by all. Television helps in enforcing a public understanding of social, political and scientific advancement of a country.

India has also started to use television in education for improving the quality of education at all levels to expand educational facilities particularly in rural and backward areas for normal and non formal systems and to make education interesting to a learner and thereby reduce wastage.

6.8.4 LCD Projection

LCD stands for Liquid Crystal Display are super thin displays that are used in laptop computer screens and flat panel monitors. Instructors supplement their lecturer material with power point presentation shown with and LCD projectors and computer. The teacher also projects videos in the class helps to assist large group teaching. They are becoming the center pieces of class room technology hubs. The directly engaged students and add impact to each lesson.

The implementation of LCD projectors in mathematics classrooms will meet four main objectives:

1. Enhances teaching methodologies and makes lessons meaningful to each student.

2. Increase learning time, enabling students to reach mastery level mathematics.

3. Connect mathematics curriculum to other subjects and real-world applications.

CHECK YOUR PROGRESS

Note : a) Choose the Correct Answer

b) Check your answers with the answers given at the end of the unit.

12. The first school broadcast in India was commissioned in

a) 1935 b) 1940 c)1945 d) 1937

13. ---------- is the use of auditory senses to convey educational message to the learners.

a) radio b)Tape recorder c) TV d) LCD Projection

14) LCD stands for

a)Light Crystal Display b) Liquid Crystal Device c) Liquid Crystal Display d)Liquid Colourl Display

6.9 Educational Broadcasts

6.9.1 Radio and TV

The foundation of Indian broadcasting lies in the country's network of radio and television stations that contribute the bulk of the telecast programmes. Specifically, the satellite based network with high and low power transmitters have been located all over the country and more than 40 production centres form part of one of the largest television systems in the world. The structure of AKASHVANI (All India Radio) and DOORDARSHAN INDIA (Indian television) is presently two-tier, with national and regional stations. With increased capacity on the latest INSAT (Indian Satellite system) satellites, there are a variety of services offered from national network and metro services to services in various languages. The Indian broadcaster has, since its inception, been an active partner in educational broadcasting. Both the broadcasting organisations (Akashvani or All India Radio and Doordarshan or Indian television) and other governmental agencies have been involved in the production of educational programmes, with transmission, however, remaining within the exclusive control of the former. Doordarshan started as an educational experiment in 1959. The aim was to provide information to viewers with the purpose of influencing attitudes. The first educational experiment was with higher secondary schools in Delhi covering such subjects as Physics, Chemistry, Hindi, Current Affairs, and Geography. Doordarshan's role in education really increased substantially from 1975 when the Satellite Instructional Television Experiment (SITE) was conducted. SITE was a year-long multipurpose communication project designed to study the effectiveness of television as a medium for education and information. A major focus of the SITE experiment was on school education and teacher training, especially for teachers in geographically dispersed areas. Broadly educational in character, programmes produced and broadcast during that one-year experiment addressed a wide range of issues from developmental to specific teacher training.

6.10 Information and Communication Technology in Mathematics Teaching

ICT (Information and Communication Technology) has great potential for teaching and learning process at all levels. The use of ICT has enriched the teaching learning process with the help of computer. It has brought a great change, innovativeness, and creativity in teachers in teaching learning process. Mathematics and computer are both important in today's life as they open the gate of ample opportunities in this modern world. Mathematics is widely used in computers both in hardware and software. Computer helps in improving the knowledge of mathematics. Computer helps in making classroom teaching lively. Computer can play vital role in learning process as it can work with the imagination of students. Any concept in mathematics can be explained with the help of pictures and this visual image can help in understanding the concept at ease. In paper pencil method student can get bored easily and can find it difficult to practice the sum again and again.

6.10.1 CAI

CAI (Computer Assisted Instruction) refers to any use of computers that interacts with students in any way in the educational process. As a change and increases the curiosity of students and they can learn interestingly without any difficulty. Also whatever is learnt through computer aided instructions, the contents can be retained for longer time as they use more senses of the students.

Characteristics of CAI

 Practice: CAI enables the students to practice as many times as they like so this will enable them to achieve the required competencies. Students come from different background it is a heterogeneous group so their understanding level differs from student to student so a single teacher cannot cater such heterogeneous group so there is a need of right learning tool and a supporting environment. Practice makes a man perfect. Many psychologists like Thorndike support the usefulness of practice in learning.

 Immediate feedback: CAI enables the students to see the correct answer immediately as soon as they answer a particular question so that they can correct themselves. If the answer is correct then they will get immense happiness and added confidence. If the answer is wrong they can correct themselves immediately. In traditional classroom teaching, teacher gives students homework for practice. The child comes to know of any mistake when the teacher checks the homework and corrects the mistake. Normally teachers do not provide the correct answer during checking, so child knows that his answer is wrong but does not know the correct answer. If the teacher does sometimes provide the correct answer, the child may not

pay due attention to the corrected answer and may consider it as a part of his work is to complete the homework and would proceed with the next homework.

 Self-Evaluation: CAI enables the students to find their strengths and weakness and student can overcome his weakness before proceeding further.

 Reinforcement: CAI reward students immediately whenever they answer the question correctly immediate reinforcement gives immense pleasure as indicated by many psychologists.

 Immediate Evaluation: As soon as each concept is completed students should answer questions related to that particular concept this enables immediate evaluation.

Check your progress

Note : a) Choose the Correct Answer

b) Check your answers with the answers given at the end of the unit.

15) Doordarshan started as an educational experiment in

a)1958 b) 1956 c) 1957 d)1959

16) CAI stands for

a)Computer Assisted Instruction b) Computer Application Instruction
c) Computer Assisted Instrument d) Common Assisted Instruction

6.10.2 ICAI -Intelligent Computer-Assisted Instruction

Intelligent computer-assisted instruction (ICAI, also known as intelligent tutoring systems or ITSs) grew out of generative computer-assisted instruction. Programs that generated problems and tasks in arithmetic and vocabulary learning eventually were designed to select problems at a difficulty level appropriate for individual students (Suppes, 1980). These adaptive systems (i.e., adapting problems to the student's learning level) were based on summaries of a student's performance on earlier tasks, however, rather than on representations of the student's knowledge of the subject matter (Sleeman& Brown 1982). The truly intelligent systems that followed were able to present problems based on models of

the student's knowledge, to solve problems themselves, and to diagnose and explain student capabilities.

Historically, ICAI systems have been developed in more mathematically oriented domains arithmetic, algebra, programming and have been more experimental in nature than has conventional CAI. Although ICAI is an area of active research projects, ICAI programs in the schools are not widespread. ICAI tends to call for more meaningful interactions than traditional CAI and tends to deal with more complex subject matter. ICAI's focus on modeling student knowledge lends itself to applications in teaching advanced thinking skills. ICAI has not been used extensively with disadvantaged students (traditional targets for basic skills instruction).

One intelligent tutoring system, *Geometry Tutor*, provides students with instruction in planning and problem solving to prove theorems in geometry (Office of Technology Assessment 1988). *Geometry Tutor* comprises an expert system containing knowledge of how to construct geometry proofs, a tutor to teach students strategies and to identify their errors, and an interface to let students communicate with the computer. *Geometry Tutor* monitors students as they try to prove theorems, instructing and guiding them throughout the problem-solving process (Anderson et al. 1985). Schofield, Evans-Rhodes, and Huber (1989) studied the implementation of *Geometry Tutor* in a public high school and found changes in the behavior of teachers and students using this system: teachers spent more time with students having problems, collaborated more with students, and based more of a student's grade on effort; students increased their level of effort and were more involved in the academic tasks. Thus, ICAI can be implemented in ways that support the kind of learning that education reformers advocate. Although most of these applications control instructional content, they can be used within a broader instructional framework that stresses joint work with the automated tutor.

6.10.3 Intelligent Tutoring System,

Intelligent tutoring systems (ITSs) have been shown to lead to impressive improvement in student learning in a range of domains, using a variety of different approaches. This is a non-expert overview of Intelligent Tutoring Systems (ITSs), a way in which Artificial Intelligence (AI) techniques are being applied to education.

Intelligent tutoring systems (ITSs) have been researched in AI now for several decades. With the enormous development and increasing availability of the Internet, the application of web-based learning systems becomes more likely and realistic and research for intelligent features receives more attention than before. As a result, a number of new ITS have been developed over the last five years, among them Active Math, is a web-based, adaptive learning environment for mathematics. These systems strive for improving long-distance learning, for complementing traditional classroom teaching, and for supporting individual and life-long learning. Web-based systems are available on central servers and allow a user to learn in their own environment and whenever it is appropriate for them. Intelligent tutoring systems are a great field of application for AI techniques.

6.10.4 e-learning

e- Learning is a broad term that covers teaching, learning and the enabling educational environment. It can use a range of pedagogical approaches and electronically supported technologies. Rosenberg (2001) tried to define the term e- learning in the following words

"e learning refers to the use of internet technologies to deliver a broad array of solutions that enhance knowledge and performance". In a broader view 'e learning is an innovative technique or a form of information and communication technology used in providing learning experiences to the students on-line through use of internet services and web technology of the computers on the same lines as witnessed by us in the form of e-mail, e-banking, e booking and e- commerce in our day to day life.

Modes and Styles of e- learning

The essential condition for calling a particular learning as e- learning lies in it characteristics of delivering the instructional contents through advanced electronic means like computers, multimedia and mobile ICT Appliances. While fulfilling this condition, various e-learning situations may be seen to adopt any of the following delivery modes and styles.

- Support learning

  E learning can play a mere supporting role to the teaching learning activities organized in the class. As a result, a teacher may make its use for his better teaching and a learner for his needed learning.

- Blended learning

  In this mode, attempts are made for making use of a combination of traditional and ICT enhanced e- learning practices. The programmes and activities are so planned and executed as to present a happy combination of both traditional classroom teaching practices and e-learning based instruction.

- Complete e learning

  In this mode of learning the traditional classroom teaching learning is totally replaced by the virtual classroom teaching learning. There is no existence of classrooms schools and teaching learning environment as happens in the traditional set up of school education.

6.10.5 Web based learning

Web-based instruction has evolved from any number of computer-based instructional methods, often referred to as Computer-Assisted Instruction (CAI), Computer-aided Instruction (CAI), Computer-Managed Instruction (CMI), Internet-Based Instruction (IBI), or Web-Based Instruction (WBI), but collectively called Computer-Based Education (CBE). As McCormack and Jones (1998) wrote "It means we can use the Web as a repository, students can access to retrieve any information that would be useful to them. Not only can you use the Web to help distribute information – we can also place the information in a form that goes beyond text and takes advantage of the media that will help students understand better and to which they can relate more easily." The emergence of the World Wide Web as a pipeline for learning will have a profound effect on the manner in which our students learn and we teach. The convergence - speeded by the Internet and by the growth of company intranets and extranets - is having a revolutionary impact on both the nature of training and the skills that trainers will need to do their jobs in the next century.

There are a number of reasons why a teacher might choose to use Web-Based Instruction, including :enhancing student learning, spending more time with students working in small groups or one-on-one reducing repetitive teaching tasks reducing paper flow and management, and providing improved instructional materials. (Mathew &Dohery, 2000). According to Ells (1998) the Web offers educational possibilities including: simplified creation, distribution and maintenance of educational materials; student-centered learning;

multiple channels for educational participation; content reinforcement; easy access to current information; and multimedia presentation of content. Owston (1997) provides an explicit reason of using the web: "One of the primary advantages of web use is that it appeals very much to the way our students now prefer to learn. They play, are entertained by, and learn with the computer. They tend to be more visual learners than previous generations because their world is reach in visual stimuli. They also thrive on interacting with the device. So it is fitting that we design learning materials and opportunities that capitalize on what we know about how our students prefer to learn."

Learners are responsible for their learning process and results have the freedom to move from their environment to anywhere all over the world have a choice of content, time, resources, feedback, and a variety of media for expressing their understanding can explore existing resources and information according to their needs and interests can construct their own knowledge by engaging students' thinking skills can learn through exploring the foundations, justifications, decisions and value of a fact, principle, skill, or concept knowledge have a choice whether actively participate in learning activities or just observe them in the background meet their own specific needs in self-paced and self assessing environment.

Check your progress

Note : a) Choose the Correct Answer

b) Check your answers with the answers given at the end of the unit.

17. Which one of the following is the example of intelligent tutoring system

a) Geo Gebra b) Auto shape c) Mat lab d) Geometry Tutor

18. Combination of traditional classroom teaching and ICT enhanced e- learning practices are called

a) Support learning b)Blended learning c) e-Learning d) Online learning

6.11 Evaluation

Evaluation to support or justify the activities of a mathematics support centre will need to consider the services provided from the viewpoints of the different stakeholders. For

example, students may avail themselves of mathematics support to gain understanding during their course and/or knowledge and confidence for examinations and future employment. The mathematics support centre will be interested in the success of their support, the marketing of their services, the availability of support, the resources they use or provide, staffing and methods of delivery. The governing institution may be seeking to justify funding, establish direct academic impact, and assess the effect of mathematics support on the retention of students.

6.11.1 Construction of the Achievement Test

The purposes of classroom achievement tests are

• measure an individual's achievement of course objectives

• assess the group's performance

• evaluate the test and the items

• evaluate and improve instruction and the curriculum

Achievement test results should accurately measure individual differences or achievement at a certain pre-specified mastery level and should always foster learning. To accomplish these purposes, a test must be valid and reliable. Validity is addressed when a test plan is formulated to accurately represent the course content and depth of learning achieved in a course. Test results must be reliable or repeatable to be confident that a student's score is a true reflection of an examinee's achievement. When a test is constructed which closely adheres to the test plan and other guidelines presented in this manual, the likelihood of gaining repeatable test results that accurately reflect achievement of the course content is improved.Achievement tests are either norm-referenced or criterion-referenced. Norm referenced tests emphasize individual differences, how students compare with each other; criterion-referenced tests highlight how examinees' performance compares to a specific standard or level of mastery, logically or empirically determined.

6.11.2 Comparison between objective and subjective tests:

A test consisting of, factual questions requiring extremely short answers that can be quickly, unambiguously scored by anyone with an answer key, thus, minimizing subjective judgments by both, the person taking the test and the person scoring it. On the other hand, a subjective test is evaluated by giving an opinion. It can be compared with an objective test, which has right or wrong answer and so can be marked objectively. Subjective test are more

challenging and expensive to prepare, administer and evaluate correctly, but they can be more valid,

The techniques used in objective tests are multiple – choice items (MCI), True / false items, matching items, transformation sentences, re-arrangement items and fill the blanks or gap filling. On the other hand, the techniques used in subjective tests include: essay writing, composition writing, letter writing, reading aloud, completion type and answer these type questions. To answer an objective test, the testee has to select his answers from two, three, four or even more alternatives which has only one correct answer. Besides, to answer an subjective test, the testee has to plan and write his own answer by using his own words and expressions. Furthermore, objective tests need much time and effort to write the questions because the examiner has to provide the answers as well as the question so that objective test requires more careful preparations than other types of test. But in subjective test the examiner needs to write few questions without answers. In objective tests, it seems that kind is .more reliable because it gives a stable scoring. But in subjective test, it seems, it is not reliable because it doesn't give a stable scoring. Objective tests are used to test structures, vocabulary, comprehension, and sound discrimination. On the other hand, subjective tests are used to test ideas, culture, coherence and creativity. Objective tests encourage guessing and it is difficult to write simple to answer , easy to score , suit for a large number of testees , and this type of test can be scored by a machine. Besides, subjective test doesn't encourage guessing easy to write, difficult to score and suit for a small number of testee . This type of test can't be scored by a machine. Objective test can be used to test specific area of language, while, subjective test can be used to evaluate overall achievements. Furthermore, objective tests require recognition more than production but subjective tests require production as well as recognition. An objective test is a type of discrete point test, but subjective test is a type of an integrative point test .Objective test is a type of close – ended atomistic, a system – referenced and it is an applicative test and replicative test. On the other hand, subjective test is a type open – ended test, a holistic and replicative and it isn't applicative. Objective test depends on students' knowledge. It is a valid test in which the student's can answer in a short time than a subjective test. But subjective test depends on student's experience. It is less valid test and students need more time to answer than objective type test.

A Comparison of Essay and Multiple Choice Tests

	Essay	Multiple Choice
Recommended Uses	1. When measuring the highest cognitive levels (synthesis and evaluation levels of Bloom's Taxonomy – Appendix A). 2. When a response needs to be created. 3. When evaluating writing ability.	1. When measuring achievement at the knowledge, comprehension, application and analysis cognitive levels.
Advantages	1. Relatively short amount of time required to construct the items. 2. Allows for creativity, originality and composition.	1. Objective scoring. (Once "correct" answers are decided). 2. Evaluation of validity is possible by comparing the test to the table of item specifications. 3. Evaluation of reliability is possible. 4. Thorough sampling of course content is possible. 5. Item analysis resulting from test scores can reveal particular problems in the exam and/or in the instruction or learning.
Disadvantages	1. Objective scoring is questionable, and more difficult. 2. No generally acceptable criteria for demonstrating the validity and reliability of test. 3. Course sampling is limited. 4. Time consuming to evaluate responses.	1. Time consuming to construct. 2. Difficult to construct items at the highest cognitive levels. 3. Faculty must have some training or knowledge in test construction and item analysis techniques to write valid and reliable test.

6.11.3 Blueprint

Test Construction

Constructing a test to evaluate achievement of objectives is a process. These evaluation strategies are decided much in advance i.e. at Design phase. The actual tests are developed at development phase of an Instructional Design.

In order to prepare an achievement test, one has to prepare a Blue Print consisting of three aspects:

1. Content areas
2. Objectives
3. Types of Questions.

Weightage for each of this aspect is decided by the Instructional Designer that is the teacher. The blue print is three dimensional. The Blue Print is presented in

Weightage to Content

Content Areas	Marks	Weigthage in %
1	10	20
2	15	30
3	10	20
4	15	30
Total	50	100

Weightage to Objectives

Objectives	Knowledge	Comprehe-nsion	Application	Synthesis	Evaluation	Total
Marks	5	10	20	7.5	7.5	50
%	10	20	40	15	15	100

Weightage to Types of Questions

Types of Questions	Marks	Weightage in %
Objective	30	60
Short Answer	5	10
Essay	15	30
Total	50	100

Blue Print for Test Development

Unit:

Content Areas	Objectives																		Total Marks
	Knowledge			Comprehension			Application			Analysis			Synthesis			Evaluation			
	O	E	SA	O	E	SA	O	E	SA	O	E	SA	O	E	SA	O	E	SA	

1	2			1.5			3									3.5		10
2				3			2		5					5				15
3				5				5										10
4	3			.5			5							2.5			4	15
Total	5	-	-	10		-	10	5	5	-		-	-	7.5	-	-	7.5	-	
	5 (10%)			10 (20%)			20 (40%)			-			7.5 (15%)			7.5 (15%)		50

O : Objective Type of Test 50%
E : Essay Type Test 40%
SA : Short Answer Type Test 10%

Test items are then prepared as per the table. For example, you will need to frame test items for 5 marks on content number 1 and 4 for Knowledge level objective. Test items are developed and then they are arranged in a test format.

CHECK YOUR PROGRESS

Note : a) Choose the Correct Answer

b) Check your answers with the answers given at the end of the unit

19. Which one of the following is not an aspect of Blue Print consisting

a) Content areas b) Objectives c) subjective d)Types of Questions

6.11.4 CAE

The method of making good use of computers in the education process is called "Computer Assisted Education (CAE)." Students learn their deficiencies and performance through mutual interaction, control their learning by getting feedback, and become more interested in classes with the help of graphics, sounds and animations (Rushby, 1989; Uşun, 2000). Aşkar (1991) stated that computers have an undeniable role in realizing the top level targets. Similarly, according to Keser (1988) one of the most distinctive features of computers in the education-treatment process is that it focuses on the students.

Computer Assisted Mathematics Education (CAME)

Mathematics education using cognitive devices dependent on computers is called "Computer-Assisted Mathematics Education (CAME)." Displaying abstract mathematical concepts and the ability to make them concrete is the most remarkable use of CAME (Baki, 1996; Özdemir&Tabuk, 2004). One can say that the most efficient way is to make the best use of computers while raising individuals with top level cognitive talents (Altun, Uysal, &Ünal, 1999). Dis-proportionality between teachers-student ratios and an increased importance on individual diversity direct people to make use of educational computers (Uşun, 2000). Computers and software are the biggest supporters of education and must be used to increase the curiosity of students as well as help them understand mathematics easily (Heddens& Speer, 1997; İçel, 2011). The two main important forms included in the software are "Computer Algebra Systems (CAS)" and "Dynamic Geometry Software (DGS)" (Şataf, 2010).

6.11.5 On-line tests

The internet provides an effective avenue for testing students on knowledge and attitudes. Researchers report that test conducted over the internet yield similar results to standard paper and pencil test in a traditional classroom leading to the conclusion that online test can be valid and reliable as any other kind of exam (rice,2003). Evaluation of the online test was based on two criteria: functionality and usability. In terms of functionality, evaluation was meant to get the students' view of the feedback provided by the system, while in terms of usability, the evaluation sought to ensure that the system not only functions as expected by the users but is also usable .The main objective of the online test is to identify the role of feedback provided by an online test in a learner centred paradigm. Additionally, other objectives for providing such an online test are to: (i) offer practicing questions to students, as a preparation for their final examination, (ii) provide students with the experience of using a CAA (Computer Assisted Assessment**)** system as part of an e-learning environment, (iii) investigate the effectiveness of CAA in e-learning and (iv) undertake a thorough evaluation of CAA.

Just as in traditional education test ad quizzes in the online environment play an important part in measuring course effectiveness and student learning. The instructor should view online test as effective learning aids and use a variety of measures in assigning grades. Class

assignments and exams should emphasize higher level cognitive functions such as the development of portfolios, projects and creative synthesis in addition to traditional quizzes and tests. Online assessment is an important part of the evolving educational teaching opportunities provided by the World Wide Web

Check your progress

Note : a) Choose the Correct Answer

b) Check your answers with the answers given at the end of the unit

20. CAA stands for

a)Computer Assisted Alignment b) Common Assisted Assessment c) Compact Assisted Assessment d) Computer Assisted Assessment

21. Online assessment is provided by

a)WWW b) WBI c) CAI d) CAME

6.12 LET US SUM UP

In this unit we have discussed the Audio-Visual aids definition, psychology, principles, essential qualities of audio-visual aids and Dale's Cone of experience. We have seen theClassification of teaching aids, Hardware and software approaches and Importance and limitations of audio-visual aids.We also learnt Educational Broadcasts and Information Communication Technology in Mathematics Teaching and Evaluation

6.13 UNIT END ACTIVITIES

1. What is the role of psychology in using audio visual aids?

2. Give a brief account of Dale's Cone of Experience in teaching?

3. Give the significance of hardware and software approaches to education?

4. What are the benefits of ICT based education?

5. What is Web Based learning?

6. Prepare a blue print for any mathematics lesson?

6.14 ANSWERS TO CHECK YOUR PROGRESS

1. c 2.b 3.b 4.c 5.d 6.a 7.b 8.a 9.c 10. a 11. c 12.d 13. b 14.c

15. d 16.a 17.d 18.b 19.c 20.d 21. a

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UNIT VII

Mathematics Teacher and Strengthening Mathematics Education

Structure

7.1 INTRODUCTION

A mathematics teacher of today is expected to possesses certain skills and qualities pertaining to the subject. Academic qualities and qualifications matter a lot in mathematics teaching. Mathematics teacher has to update the maths knowledge of the learners through mathematics club activities, mathematics fairs, field trips, Olympiad and celebrating mathematics events. All these topics are dealt in this chapter.

7.2 OBJECTIVES

At the end of this unit the learners will be able to

- Understand the qualities of a good mathematics teacher
- Know about the need of in service training
- Comprehend the concept of professional organisation
- Apply different strategies

7.3 MATHEMATICS TEACHER

Math teachers educate students at all levels, from elementary school through high school. In general, aspiring math teachers can take one of several pathways toward licensing through either undergraduate or graduate schooling. Math teachers help students to make a successful transition to college and prepare them for careers in high demand fields related to science, technology and engineering.

7.4 QUALITIES OF GOOD MATHEMATICS TEACHER

1. Knowledge of Maths
2. Alternative strategies of solve mathematics problems
3. Facilitating approach
4. Good leadership
5. Care and concern
6. Understanding of information, communication
7. Interactive, Hands on
8. Engaging, able to make course interesting and fun
9. Experienced
10. Gives a lot of problems to practice with
11. Helpful, insightful, explains things well and goes over things extra times
12. Can teach a topic in different ways to help better understand something
13. Organized, smart, Enthusiasm
14. Able to fully answer questions & visibly demonstrate answer; able to make learning fun
15. Patience, intelligence
16. Explains new material in detail

17. Goes at a good pace

7.5 ACADEMIC AND PROFESSIONAL QUALIFICATIONS OF A MATHEMATICS TEACHER IN INDIA

Level	Minimum academic and Professional qualifications
I <u>Elementary</u> a. Primary b. Upper Primary (Middle school section)	i. Senior Secondary School certificate or Intermediate or its equivalent ; and ii. Diploma or certificate in basic teachers' training of a duration of not less than two years. **OR** Bachelor of Elementary Education (B.El.Ed.) i. Senior Secondary School certificate or Intermediate or its equivalent ; and ii. Diploma or certificate in elementary teachers training of a duration of not less than two years. **OR** Bachelor of Elementary Education (B.El.Ed.) **OR** Graduate with Bachelor of Education (B.Ed.) or its equivalent.
II <u>Secondary/High School</u>	Graduate with Bachelor of Education (B.Ed.) or its equivalent. **OR** Four years' integrated B.Sc., B.Ed. or an equivalent course.
III <u>Senior Secondary/PUC/Intermediate</u>	Master's Degree in the relevant subject with Bachelor of Education (B.Ed.) or its equivalent. **OR** Two years' integrated M.Sc.Ed. Course or an equivalent course.

7.6 MEMBERSHIP OF PROFESSIONAL ORGANIZATIONS

There are professional organizations in every field. While each and every organization is different. Especially if one is young and just starting out in career, many professional organizations offer scholarships for college members, and mentors for those in the interning or entry-level position. They can also offer insight into how the industry works and how to navigate it, as well a professional development courses. For students and young

professionals, the membership dues are often lowered substantially. Here are some benefits to join a professional organization:

Jobs

Many professional organizations help their members find jobs, or at the least, offer up job listings that other members may be offering.

Mentoring

Mentoring is the cornerstone of many professional organizations when it comes to working with younger members. Never get in the room with someone at the top of the field, for a very long time. But professional organizations have the ability to pare with someone much more experienced.

Professional Development

Many organizations offer professional development via courses, workshops, publications, and information on their website shared only with members. They also keep members up to date on industry trends and how to deal with them. Some organizations offer news and print coverage of their annual conferences, run by students—which is an excellent opportunity to gain experience.

Networking

Most organizations have an annual conference. This is an opportunity to mix and mingle with others in the field in both professional and leisure settings. There is also often a job fair where we can make contact and stay up to date with the very people who hire – even if they're not hiring right now. In fact, some people find recruiters follow their career and stay updated.

Scholarships

For the youngest of members (high school and college), scholarships may be the primary reason to join a professional organization. Many offer scholarships to the new members studying to enter the field.

Check Your Progress

Notes:

a) Write your answers in the space given below.

b) Compare your answers with those given at the end of the unit.

1. A good Mathematics teacher is one who

   a. gives only a lot of problems to practice with

   b. remains helpful, insightful, explains things well and goes over things extra times

c. follows the same method always .

d. encouraging convergent thinking.

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7.7 MATHEMATICS CLUB

The Mathematics club plays an important role in creating interest in mathematics in schools. This helps the students in having an idea of the practical utility of mathematics in addition to creating their interest in Mathematics. It can serve a number of purposes.

Importance of the club

1. Mathematics Club is useful in arousing and maintaining interest in Mathematics.
2. Gifted students get an opportunity to satisfy their needs and interests by actively participating in the activities of mathematics clubs.
3. It is helpful in making proper utilization of leisure time.
4. The students get an opportunity of mathematical hobbies, recreational mathematics, mathematical projects, mathematical games, mathematical discussions and debates, and mathematical innovations.
5. It provides an opportunity to read mathematical literature.
6. It provides an opportunity of leadership, cooperation, joint responsibility, active participation and organizing programmes.

Organization of the club

A Mathematics Club will be a great help in enlivening the teaching of Mathematics. Such a club should be run by the students under the guidance of the teacher. Mathematics Club is an organization of the students, by the students, for the students. For proper running of a club the most important thing is the preparation of a draft constitution of the club. For efficient and successful working of Mathematics club an expert body has suggested the following.

1) Patron 2) Sponsor/In-charge 3) Staff Advisors 4) Associate Staff Advisors. The club may have an elected/ nominated executive committee amongst the students i.e. 1) President 2) Vice president 3) Secretary 4) Treasurer.

Activities of the club

1. Arranging lecturers by renowned Mathematics Teachers or Scholars.

2. Celebrating days and events pertaining to the history of Mathematics or men of Mathematics.
3. Organizing Mathematical competitions.
4. Organizing recreational activities in Mathematics.
5. Preparing Mathematical aids and illustrations.
6. Organizing Mathematical exhibitions or fairs.
7. Mathematical articles for the school magazine.
8. Organizing seminars and career courses relating to Mathematics.

Check your progress

Notes:

a) Write your answers in the space given below.

b) Compare your answers with those given at the end of the unit.

2. What do you mean by mathematics club?

a. arousing and maintaining interest in Mathematics.

b. opportunity to read mathematical literature.

c. making proper utilization of leisure time.

d. a, b & c

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7.8 MATHEMATICS FAIRS

With a view to encourage, popularize and inculcate scientific temper among the children of the country, NCERT organizes national level science exhibition every year where children showcase their talents in science and mathematics and their applications in different areas related with our everyday life.

The first Science Exhibition was jointly organized under the banner of the National Science Exhibition for Children in 1971, by the NCERT and the University Grants Commission (UGC) at Delhi. The subsequent National Science Exhibitions for Children have been organized by NCERT alone. From 1972 to 1978, the Jawaharlal Nehru Memorial Fund collaborated with the NCERT in its efforts to popularise Science Exhibitions by jointly sponsoring the National and State Level Science Exhibitions.

In 1988 with the birth centenary celebration of Jawaharlal Nehru, the National Science Exhibition was renamed as the 'Jawaharlal Nehru National Science Exhibition for Children'. This exhibition is now renamed as Jawaharlal Nehru National Science, Mathematics and Environment Exhibition (JNNSMEE) for Children.

In order to ensure the widest possible participation and involvement of students and teachers in the programme, NCERT organises exhibition in two phases. In the first phase, exhibitions are held in each and every state and union territory from the district, to the state level. This first phase is known as State Level Science, Mathematics and Environment Exhibition (SLSMEE) for Children. All participating states, union territories and other educational organisations like CBSE (for its affiliated independent public schools), Kendriya Vidyalaya Sangathan, Navodaya Vidyalaya Samiti, DAE Central Schools and Demonstration Multipurpose Schools of NCERT forward their selected entries to NCERT for consideration for participation in the National Exhibition – the second phase of NCERT's organizing Science, Mathematics and Environment Exhibitions. The exhibits for display in this national exhibition are selected at NCERT on the basis of a notified criterion.

Objectives of Exhibition

- To provide a forum for children to pursue their natural curiosity and inventiveness to quench their thirst for creativity
- To make children feel that science is all around us and we can gain knowledge as well as solve many problems also by relating the learning process to the physical and social environment.
- To lay emphasis on the development of science and technology as a major instrument for achieving goals of self-reliance and socio-economic and socio-ecological development;
- To highlight the role of science and technology for producing good quality and environmental friendly materials for the use of society;
- To encourage children to visualize future of the nation and help them become sensitive and responsible citizens
- To analyze how science has developed and is affected by many diverse individuals, cultures, societies and environment
- To develop critical thinking about global issues to maintain healthy and sustainable societies in today's environment
- To apply mathematics and information technology to visualise and solve problems pertaining to everyday life etc.

- To appreciate the role of science in meeting the challenges of life such as climate change, opening new avenues in the area of agriculture, fertiliser, food processing, biotechnology, green energy, disaster management, information and communication technology, astronomy, transport, games and sports etc.
- To create awareness about environmental issues and concerns and inspiring children to devise innovative ideas towards their mitigation.

The organisation of these exhibitions envisages that children and teachers would try to analyse all aspects of human endeavour with a view to identify where and how the new researches and developments in science and technology can bring and sustain progress of society leading to improvement for the challenges of life. The organisation of science, mathematics and environment exhibitions also provide opportunities to all participating students, teachers and visitors to get acquainted with different kind of equipment, devices and techniques. This exercise enables the students and teachers to generate scientific ideas for addressing various problems of the society and environment.

Right from its inception, each exhibition has focused on a specific theme. In order to facilitate the preparation of exhibits and models for display and the organisation of state level exhibitions, a set of sub-themes is also provided. NCERT has also been providing printed Guidelines for the Preparation of Exhibits and Models, and for Organising Exhibitions to all states/UTs and other educational organizations. The importance of each sub-theme in the context of the main theme and a number of suggestive ideas for development of exhibits are also given in these Guidelines. These Guidelines are also uploaded on the NCERT website www.ncert.nic.in. In order to encourage the efforts of NCERT in the popularisation of science, a catalytic grant is also provided to each and every State and Union Territories.

During the exhibition, the participating students and teachers not only display their scientific talents through their models and exhibits, but also get an opportunity to listen to some of the eminent scientists and scholars of the region in which the exhibition is organized. Additionally, they would be able to interact with one another and share their views and, in the process, also share the diverse cultures of our country.

Check your progress

Notes:

a) Write your answers in the space given below.

b) Compare your answers with those given at the end of the unit.

3. National Science Exhibition for Children was conducted for the first time

a. 1971 b. 1972 c. 1973 d. 1974

4. Objectives of mathematics exhibition was

a. to provide a forum for children to quench their thirst

b. to emphasis on the development of science technology

c. a & b

d. to make time pass

3. .....

4. .....

7.9 FIELD TRIP

Field trips are a time-honoured tradition in most schools. The students' love them field trips give them a chance to get out of the classroom and experience something new. There are advantages and disadvantages of field trips.

Enhances the Curriculum

One of the biggest advantages to field trips is that they allow students to have a real-world experience. This experience should clearly illustrate and enhance information taught by the curriculum.

New Learning Environment

Field trips also allow the students to learn outside of the classroom. This is slightly different from the first advantage. While the first advantage of field trips is to supplement the curriculum, the second advantage is that field trips offer the opportunity to teach the students something new. A field trip to a local flight museum that features space-flight simulators is going to teach students a lot about rockets that cannot be nearly as effectively taught in a classroom.

Team Building

A final advantage of field trips is that they are a way to bring the students closer together. Many field trips combine educational content with team-building activities, such as working together to clean a stream that has been polluted. In fact, it is often a good idea to go on a field trip early in the school year to help create a bond between the students.

Planning

A disadvantage of field trips is that they take an incredible amount of planning. You must figure out transportation issues, chaperons (including background checks), food and alternate

plans in the event of inclement weather, if the trip is to a location outdoors. You must make sure that every child has a signed permission form, that you have emergency contact and information available on each student (including allergies) and that all fees have been paid in advance.

Liability

Field trips bring up a wide array of legal issues, most regarding liability. If a student gets injured on a nature hike, is the school liable to answer. Parents may be nervous about the safety of their children. Other liabilities include expose issues. For example, even a "children's" theatre performance may contain material or scenes that some parents might object to.

Check your progress

Notes:

a) Write your answers in the space given below.

b) Compare your answers with those given at the end of the unit.

5. Field trip is

a. wasting money and time

b. to make enjoyment

c. a & b

d. to enrich learning experiences

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7. 10 MATHEMATICS OLYMPIAD

The Mathematics Olympiad activity was undertaken by National Board for Higher Mathematics (NBHM) from 1986 onwards and is currently run in collaboration with the Homi Bhabha Centre for Science Education, Mumbai. One main purpose of this activity is to support mathematical talent among high school students in the country. NBHM has taken on the responsibility for selecting and training the Indian team for participation in the International Mathematical Olympiad every year. While, NBHM coordinates and supports Mathematics Olympiad contests all over the country, regional bodies, mostly voluntary, play an important role at different stages. For the purpose of administering Mathematics Olympiad contests, the country has been divided in 16 regions. A regional coordinator is responsible for

conducting these tests in each region. The names of the regions and their respective regional coordinators are given at the end. The Mathematics Olympiad Programme leading to participation in the International Mathematical Olympiad consists of the following stages:

Stage 1: Regional Mathematical Olympiad (RMO) is held in each region normally between September and the first Sunday of December each year. The regional coordinator ensures that at least one centre is provided in each district of the region. All high school students up to class XII are eligible to appear for RMO. RMO is a 3-hour written test containing about 6 to 7 problems. Each regional coordinator has the freedom to prepare his/her own question paper or to obtain the question paper from NBHM. The regions opting for the NBHM question paper hold this contest on the 1st Sunday of December. On the basis of the performance in RMO, a certain number of students from each region are selected to appear for the second stage. Regional coordinators charge nominal fees to meet the expenses for organizing the contests.

Stage 2: Indian National Mathematical Olympiad (INMO) is held on the first Sunday of February each year at various Centres in different regions. Only students selected on the basis of RMO from different regions are eligible to appear for INMO. INMO is a 4-hour written test. The question paper is set centrally and is common throughout the country. The top 30-35 performers in INMO receive a certificate of merit.

Stage 3: International Mathematical Olympiad Training Camp (IMOTC).

The INMO certificate awardees are invited to a month long training camp (junior batch) conducted in May-June, each year. In addition, INMO awardees of the previous year that have satisfactorily gone through postal tuition throughout the year are invited again for a second round of training (senior batch).

Stage 4: The team selected at the end of the camp International Mathematical Olympiad (IMO), a "leader" and a "deputy leader," represent India at the IMO that is normally held in July in a different member country of IMO each year. The leader and deputy leader are chosen by NBHM from among mathematics teachers/researchers involved in the Mathematics Olympiad activity. IMO consists of two written tests held on two days with a gap of at least one day. Each test is of four-and-a-half-hours duration. Travel to IMO venue and return takes about two weeks. India has been participating in IMO since 1989. Students of the Indian team who receive gold, silver and bronze medals at IMO receive a cash prize of Rs. 5,000/-, Rs. 4,000/- and Rs. 3,000/- respectively, from NBHM during the following year at a formal ceremony at the end of the training camp. The Ministry of Human Resource Development (MHRD) finances international travel of the eight-member Indian delegation

connected with international participation. NBHM finances the entire in-country programme and takes care of other expenditure Students aiming for selection for participation in IMO should note that RMO is the first essential step for the programme. To appear for RMO, students should get in touch with the RMO co-ordinator of their region well in advance, for enrolment and payment of a nominal fee, Syllabus for Mathematics Olympiads. The syllabus for Mathematics Olympiads (regional, national and international) is pre-degree college mathematics. The areas covered are number systems, arithmetic of integers, geometry, quadratic equations and expressions, trigonometry, co-ordinate geometry, systems of linear equations, permutations and combinations, factorisation of polynomials, inequalities, elementary combinatorics, probability theory, number theory, infinite series, complex numbers and elementary graph theory. The syllabus does not include calculus and statistics. The typical areas for problems are: number theory, geometry, algebra and combinatorics. The syllabus is in a sense spread over class IX to class XII levels, but the problems under each topic are of an exceptionally high level in difficulty and sophistication. The difficulty level increases from RMO to INMO to IMO.

Check your progress

Notes:

a) Write your answers in the space given below.

b) Compare your answers with those given at the end of the unit.

6. Mathematics Olympiad activity was undertaken from 1986 by

a. National Board for Higher Mathematics (NBHM)

b. Ministry of Human Resource Development (MHRD)

c. University Grand Commission (UGC)

d. Higher Education

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7.11 MATHEMATICS LIBRARY

In any scheme of education, mathematics library plays a key role. Class room teaching has its limitations. It is difficult for teachers to go beyond the prescribed text book. Class room teachings may leave gaps and doubts. A good library provides opportunities for leaving the

gaps. The curious students get facilities for quenching their first thirst of knowledge through library. A well organized library is a source of attraction for its students. A mathematics library is the birth place of future mathematicians. It inspires, stimulates and equips them to follow the footprints of great mathematicians.

A mathematics library, besides being a source of learning and inspiration to its students, also serves the interest and needs of teachers. Knowledge has no boundaries. A teacher has to keep himself abreast of the latest knowledge and skills in his subject. He has to learn most effective methods and devices for teaching. A good library in this sense serves the role of a burning lamp. It sets burning the ambitions of learning more and more in teachers and inspires the students to imitate the ideals of their teachers.

In our schools laboratories are generally established for science subjects. Therefore for a number of persons the idea of setting mathematics laboratory in the school sounds quiet unusual and unpractical. Laboratory is a place which serves two fold purposes. Firstly it provides safe and proper place for placing all the essential material and equipments concerning the learning activities in a subject. Secondly it gives proper facilities and opportunities for essential practical work and lively learning experiences. Apart from this, setting of mathematics library will prove useful to a mathematics teacher in many different ways. The mathematics knowledge which cannot be translated into practice is a useless burden and therefore students of mathematics should be given proper opportunities for the integration of theory with practice.

Need and Importance of Mathematics Library

Having realized the need and importance of library in teaching of mathematics it is now to be thought whether to have a separate mathematics library or not. Generally in schools, there happens to be a general library where all sorts of general books and books related to different subjects and activities are placed in different almirahs at different places. On big table or tables, newspapers, magazines, periodicals and journals are placed. This place also serves as a reading room.

There should be a period for library reading in the time table for enabling the students of every section and class to have an easy access to such library. The teacher may take the help of monitor or some interested student of the class in the management of the affairs. The establishment of mathematics library in separate room or as part of general library may be supported on the following grounds.

1. The separate arrangement brings efficiency in the organization.
2. Mathematics teacher remains in touch with the volumes and literature available in library.

3. It gives a sense of separate identity and inculcates interest in the subject mathematics.
4. The student gets better facilities for reading the books and literature.
5. It helps in the activities of mathematics club.
6. It may help in nurturing gifted and potentials students in mathematics.

Therefore, in every school attempts should be made to have a mathematical library with the cooperation of authorities and the students.

A mathematics laboratory

A mathematics laboratory may contain the following types of material and equipments:

1. Different types of pictures and charts: Pictures and charts make the learning of mathematics interesting and useful. A mathematics laboratory should contain different types of charts and pictures concerning various topics and sub-topics of mathematics. A few pictures and photographs of mathematicians may also be hung on the walls of the laboratory to make it as mathematical as possible.
2. Models: In mathematics education models prove a very effective source of teaching and learning.
3. Weighing and measuring instruments: These are two important aspects of mathematics. A mathematics laboratory should, therefore, have all the essential equipments for weighing and measuring purposes like different types of balances, weights, measuring tapes and graduated cylinders.
4. Drawing instruments: For drawing and sketching of various figures and diagrams there should be drawing instruments in mathematics laboratory.
5. The useful material concerning other subjects: modern teaching follows the principle of integration and correlation. In mathematics text concepts and problems are sometimes very much linked with the experience areas of other subjects.
6. Surveying instruments: Surveying is an important phenomenon concerning mathematics. For surveying purposes besides various types of measuring tapes the following types of special instruments should be kept in a mathematics laboratory.
    - Angle mirror: It is used for laying out right angles in the field.
    - Hypsometer and clinometers: Used in combination, the apparatus a simple device for measuring distance and heights of objects.

- Sextant: It is a sophisticated instrument for measuring the angular distance. It is used to find out angles of elevation and depression.
- Plane table: It is used for elementary mapping and surveying.
- Level: It is used in levelling the surfaces by finding differences in elevation.
- Transit: It is used in the measurement of angular distance and leveling.

7. Other useful materials: The useful concrete material like beads, balls, sticks, match boxes, pebbles, seeds, didactic apparatus, different types of coins, different types of wooden or card board pieces etc. may be kept in mathematics library.
8. Some other modern equipments: Under this category the following types of instruments may be kept in the mathematics laboratory:
   - Proportional Dividers: This apparatus is based on the principle of proportionality in similar triangles and used for enlarging or reducing the pictures, maps or diagrams.
   - Slide Rule: In principle it consists of two or more logarithmic scales sliding on each other.
   - Calculating Machines: It is a sophisticated device for making the computation works a joy. It can also do all sorts of calculations in no time with great precision and accuracy.

It should not be taken that the list of materials and equipments for mathematics laboratory ends completely with the above discussion. It is an ever ending task. The needs and requirements of learning experiences are always flexible. A resourceful teacher should not always look for the finances but try to encourage his students for the improvising and self collection. Moreover, he should not confine the practical experiences in the mathematics to the mathematical laboratory. For a teacher of mathematics the world outside the walls of the class room in an open laboratory where he can find ample opportunities for his students to experiment and taste the fruits of learning in mathematics .

Advantages

Some of the advantages of a mathematics laboratory may summarise as follows:

- It will help in creating interest of the students in the learning of mathematicians.
- It will help in making use of all the progressive methods like inductive, analytic, laboratory, heuristic and project methods in the teaching and learning of mathematics.
- It will help in the inculcation of scientific, problem solving and heuristic attitude among the students.
- The theoretical concepts may be easily clarified through practical demonstration. In this way the laboratory would definitely save the time and energy of the teachers as well as students.
- It will help in training the students for the practical application of mathematical facts and principles in their life.
- It will help in satisfying the creative and constructive urges of the students.

Check your progress

Notes:

a) Write your answers in the space given below.

b) Compare your answers with those given at the end of the unit.

7. Mathematics laboratory

a. creates disinterest in learning

b. inculcates scientific and problem solving attitude

c. not effective for students in mathematics learning

d. b & c

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7.12 MATHEMATICAL INSTITUTES AND ORGANIZATIONS

Professional organizations are available for almost any career field. Students may join while enrolled in school or after graduation. However, fees are greatly reduced for students who are still in college. In addition to providing information about your chosen field, professional organizations enhance your professional development and provide endless networking

opportunities. Associations may also provide monetary returns such as tuition assistance through private grants and fellowships.

Thanks to ever-growing digital technologies, information abounds. But sometimes sifting through the tons of information available can be mind-boggling, not to mention time consuming. Professional associations publish journals, newsletters, and websites with invaluable information on up-to-date issues and developments in your specific field of interest. Professional associations frequently also coordinate professional development conferences replete with industry related trade shows and facilitated networking opportunities.

Further, prospective employers seek out individuals whose field knowledge is not solely dependent on college studies; therefore, association memberships are excellent supplements for a resume. Memberships convey to an employer that they are dedicated to the field of study. Membership could also open doors of opportunity as they provide with greater exposure to the job market - many organizations provide "members only" job listings in their publications.

Recalling the adage "knowledge is power," even membership in professional associations tangential to the particular field may be beneficial.

Prominent professional associations available are listed below.

- American Institute of Mathematics (AIM)
- American Mathematical Society (AMS)
- American Statistical Association (ASA)
- Association for Symbolic Logic (ASL)
- Association for Women in Mathematics (AWM)
- Canadian Mathematical Society (CMS)
- Center for Discrete Mathematics and Theoretical Computer Science (DIMACS)
- Centre de Recerca Matemàtica (CRM)
- Centre de Recherches Mathématiques (CRM)
- Centre International de Recontres Mathématiques (C.I.R.M. - Luminy)
- Clay Mathematics Institute (CMI)
- Cornell Theory Center (CTC)
- Courant Institute of Mathematical Sciences (CIMS)
- The Erwin Schrödinger International Institute for Mathematical Physics (ESI)
- Fields Institute for Research in Mathematical Sciences

- The Geometry Center (at UIUC)
- Institut de Mathématiques de Luminy (Luminy)
- Institut de Recherche Mathématique Avancée (IRMA)
- Institut des Hautes Etudes Scientifiques (IHES)
- Institut Fourier (Grenoble)
- Institute for Advanced Study (IAS)
- Institute for Mathematics and its Applications (IMA)
- Instituto Nacional de Matemática Pura e Aplicada (IMPA)
- Institute of Mathematical Statistics (IMS)
- Institute for Pure and Applied Mathematics (IPAM)
- Indian Statistical Institute (ISI)
- Mathematical Association of America (MAA)
- Mathematical Biosciences Institute
- Mathematical Institute, Tohoku University
- Mathematics and Education Reform Forum (MER)
- The Mathematical Institute, Oxford
- MIT Media Lab
- Mathematisches Forschungsinstitut Oberwolfach (Oberwolfach)
- Max Planck Institute for Mathematics
- Institut Mittag-Leffler
- Mathematical Science Research Institute (MSRI)
- Isaac Newton Institute for Mathematical Sciences
- The Pacific Institute for the Mathematical Sciences
- Research Institute for Mathematical Sciences, Kyoto (RIMS)
- Sociedad Matemática Mexicana
- Sociedade Brasileira de Matemática
- Steklov Institute of Mathematics, St. Petersburg
- Tata Institute of Fundamental Research
- Alfréd Rényi Institute of Mathematics
- Statistical and Applied Mathematical Sciences Institute (SAMSI)
- Society for Industrial and Applied Mathematics (SIAM)

7.13 FUNCTIONS AND ORGANIZATIONAL OBJECTIVES

Organizational objectives are short-term and medium-term goals that an organization seeks to accomplish. An organization's objectives will play a large part in developing organizational polices and determining the allocation of organizational resources. Achievement of objectives helps an organization reach its overall strategic goals.

Key Concepts

Setting objectives can involve many factors. One can set a single objective for the organization or multiple objectives. We can set target deadlines for the accomplishment of objectives. Other critical factors include who controls, the decisions that will affect objective achievement. The decision-makers must be committed to the objectives.

7.14 CELEBRATION OF MATHEMATICS RELATED EVENTS

The calendar year has plenty of opportunities to celebrate and get excited about math.

1. Pi Day **(3/14):**
2. Fibonacci Day **(11/23):**
3. Sonia Kovalevsky Mathematics Day**:**
4. Math 2.0 Day **(7/8)**
5. World Math Day **(3/1).**
6. Math Storytelling Day **(9/25)**

Check your progress

Notes:

b) Write your answers in the space given below.

c) Compare your answers with those given at the end of the unit.

8. World math day is celebrated in

a. March 1st b. May 1st c. June 1st d. July 1st

7.15 LET US SUM UP

This unit tries to attempt clearly for providing students the qualities of a maths teacher that serves as base for a teacher. The need and importance of professional organisations, mathematics club and fairs to be conducted for the improvement of the learners are highlighted. Mathematical field trips and its advantages are discussed in this unit. The significance of mathematical events, mathematics lab and library explained.

7.14 UNIT END ACTIVITIES

1. Ask the students to prepare a chart on the qualities of a good mathematics teacher.
2. Make the students aware of the qualifications of the mathematics teacher.
3. Discuss the need of the in service education.
4. Share the experience of the membership of professional organization and encourage them to join in it.
5. Form a mathematics club and provide opportunity to the students.
6. Arrange a field trip to the students.
7. Give assignments to the students to work in the library in mathematics teaching.
8. Celebrate maths days at your class and school.

7.15 ANSWERS TO CHECK YOUR PROGRESS

1. b 2. d 3. a 4. c 5. d 6. a 7. b 8. a

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