TAMIL NADU TEACHERS EDUCATION UNIVERSITY

Chennai-600 097

Course Material for B.Ed. (First Year)

(2016-2017)

Course 7(a): Pedagogy of Mathematics (Part –I Methodology)

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Unit I **Aims and objectives of teaching Mathematics**

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Unit – I: Aims and Objectives of Teaching Mathematics

Objectives:

After the completion of the unit, the learners will be able to:

1. explain the nature of Mathematics.
2. examine the scope of Mathematics.
3. identify the aims and objectives of teaching Mathematics.
4. appreciate the values of Mathematics.
5. sensitize the needs of teaching Mathematics.

Introduction

The world of today, which learns more on science and technology, demands more mathematical knowledge on the part of more people. And the world of tomorrow will make still greater demands on a person to be "well educated" in the technological society of today, and as such they should have some degree of mathematical literacy. Though mathematics has been with us for more than 5000 years, the subject has never been made as lively as it is today. The pace of mathematical discovery and invention has accelerated amazingly during the last few decades. It has been said that mathematics is the only branch of learning in which theories of two thousand years old are still valid.

Mathematics - Meaning and Definitions

The dictionary meaning of mathematics is that 'it is either the science of number and space or the science of quantity, measurement and spatial relations. It is a systematized, organize and exact branch of science. It deals with quantitative facts, relationships as well as with problems involving space and form. It is a logical study of shape, arrangement, and quantity. Mathematics is defined in different ways by different authors. Let us examine a few of them.

Comte defined mathematics as "The science of indirect measurement"

According to ***Kant*** "Mathematics is the indispensable instrument of all physical researches."

Gauss stated "Mathematics is the queen of sciences and arithmetic is the queen of all mathematics".

Roger Bacon said "Mathematics is the gateway and key to all sciences".

According to ***Lindsay***, "Mathematics is the language of physical sciences and certainly no more marvelous language was created by the mind of man"

Locke stated, "Mathematics is a way to settle in the mind a habit of reasoning".

According to ***Marshal H. Stone***, "Mathematics is the study of abstract system built of abstract elements. These elements are not described in concrete fashion".

According to ***Bertrand Russell,*** "Mathematics may be defined as the subject in which we never know what we are talking about nor whether what we are saying true".

Benjamin Peirce emphasized that, "Mathematics is the science that draws necessary conclusions".

A more comprehensive definition of mathematics was given by Courant and Robin when they defined mathematics in the following way "Mathematics is an expression of the human mind which reflects the active will, the contemplative reason and the desire for aesthetic perfection. Its basic elements are logic and intuition, analysis and construction, generality and individuality".

Nature of Mathematics

The nature of mathematics is made explicit by discussing it under the following heads:

1. Mathematics: a science of discovery.
2. Mathematics: an intellectual game
3. Mathematics: the art of drawing conclusions
4. Mathematics: a tool subject.
5. Mathematics: a system of logical processes
6. Mathematics: an intuitive method.

1.***Mathematics – A Science of Discovery***

Mathematics is the discovery of relationships and the expression of those relationships in symbolic form- in words, in numbers, in letters, by diagrams or by graphs. According to *A.N. Whitehead* (1912) "Every child should experience the joy of discovery".

The children must not only have opportunities for making their own discoveries of mathematical ideas, but they must also have the practice necessary to achieve accuracy in their calculations. Today it is discovery techniques, which are making spectacular progress. They are being applied in two fields: in pure number relationships and in everyday problems involving such things as money, weights and measures.

2. Mathematics – An Intellectual Game

Mathematics can be treated as an intellectual game with its own rules and without any relation to external criteria. From this viewpoint, mathematics is mainly a matter of puzzles, paradoxes, and problem solving – a sort of healthy mental exercise.

3. Mathematics – The Art of Drawing Conclusions

One of the important functions of the school is to familiarize children with a mode of thought which helps them in drawing right conclusions and inferences. According to J. W.A. Young a subject for this purpose should have three characteristics:

- That its conclusions are certain. At first, at least, it is essential that the learner should know whether or not he has drawn the correct conclusion.
- That it permits the learner to begin with simple and very easy conclusions to pass in well graded sequence to very difficult ones, as the earlier ones are mastered.
- That the type of conclusions exemplified in the introductory subject be found in the other subjects also, and in human interactions, in general.

These characteristics are present in mathematics to a larger extent than in any other available subject.

4. Mathematics – As a Tool Subject

Mathematics is a tool subject. In earlier days it is expressed as the handmaiden to the sciences. Nowadays it is useful to other disciplines, but it is dependent upon none of them. With its new found freedom, mathematics established its own goals to pursue. Its mentors of the past – engineering, physical science and commerce – now became no more than its peers.

Mathematics has its integrity, its beauty, its structure and many other features that relate to mathematics as an end in itself. However, many conceive mathematics as a very useful means to other ends, a powerful and incisive tool of wide applicability.

5. Mathematics – A System of Logical Process

Polya suggested that Mathematics actually has two faces. One face is a 'systematic deductive science'. This has resulted in presenting mathematics as an axiomatic body of definitions, undefined terms, axioms and theorems. Mario Pieri stated "Mathematics is a hypothetico-deductive system". This statement means that mathematics is a system of logical processes whereby conclusions are deduced from certain fundamental assumptions and definitions that have been hypothesized.

Polya described the second face of mathematics by saying 'Mathematics in the making appears as an experimental, inductive science". It is based on the principle that if a relationship holds good for some particular cases, it holds good for any similar case and hence the relationship can be generalized. Such a process is called inductive reasoning. For example, the student generalizes that the 'sum of the angles in a triangle is180^0' after having observed this property in a number of triangles.

6. Mathematics – An Intuitive Method

Intuition implies the act of grasping the meaning or significance or structure of a problem without explicit reliance on the analytic apparatus of one's craft. It is intuitive mode that yields hypothesis quickly. It is a form of mathematical activity which depends on the confidence in the applicability of the process rather than upon the importance of right answers all the time.

Intuition when applied to mathematics involves the concretization of an idea not yet stated in the form of some sort of operations for example. When Mathematics is taught in a very formal way by stating the logical rules, and algorithm, we remove his confidences in his ability to perform mathematical processes. Teachers quite often provide formal proof in place of direct intuition. For example, to check the conjecture, 8x is equivalent to 3x+ 5x, a formal rigorous statement as the following,

Scope of Mathematics

Mathematics is all pervasive. So the demarcation of it scope is a difficult task,if not impossible. It is a science of all the sciences and provides basis to all the disciplines. According to this definition, two main aspects or categories of Maths are 'Basic Mathematics' and 'Applied Mathematics.'

(i) Basic Mathematics or Pure Mathematics

The Theoretical aspect of Mathematics is termed as basic Mathematics or Pure Mathematics. It involves systematic and deductive reasoning. It treats only theories and principles without regard to this application to concrete things. It is developed on an abstract self – contained basis without any regard to possible practical applications that may follow.

The following are sub branches of Pure Mathematics.

Algebra

It includes Arithmetic, Elementary and Multivariate Algebra, Linear Multivariate Algebra, Algebraic Structure etc.

Geometry

It includes Euclidean geometry, Projection, Analytical geometry, Trigonometry, Combinatorial geometry, differential and Algebraic Geometry etc.

Modern Mathematics

It consists of following topics.

(i) Set theory –Origin and definition, fundamental set concepts, postulates of axiomatic set theory, etc.

(ii) Topology – General topology, Topological groups, Differential topology, Algebraic topology.

(iii) Algebraic System- Groups, Rings, Field, Vector Spaces.

Analysis

It includes Real and Complex analysis, Functional Analysis, Differential Equation, Fourier, Theory of Probability, Vector and Tensor.

(ii) Applied Mathematics

Applied Mathematicsis the application of pure Mathematics in developing the various means to score the human and humanity. It considers those part of Mathematical theories that have certain direct or practical application to objects in the material world.

The following are sub branches of applied Mathematics

(a) Calculatory Science – It includes numeral notations, calculating aspects of algebra, calculating use of tables and graphs, geometrical aids, mathematical models, analogic, computation, digital computations etc.
(b) Statistics- Basic principles,Estimation, Hypothesis testing structure etc.
(c) Numerical analysis.
(d) Mathematical theory of optimization
(e) Automation theory
(f) Information theory
(g) Mathematical aspects of physical theories.

Aims of teaching Mathematics

Aims of teaching Mathematics are to be framed in the light of the educational values of the subject. Value is the spring-board of aim. We know that mathematics has wide applications in our daily life. It has great cultural and disciplinary values. Thus we may mention the aims of teaching mathematics as under:

1. To enable the students to solve mathematical problems of daily life. We have to select the content and methods of teaching so that the students are able to make use of their learning of mathematics in daily life.

2. To enable the students to understand the contribution of mathematics to the development of culture and civilisation.

3. To develop thinking and reasoning power of the students.

4. To prepare a sound foundation needed for various vocations. Mathematics is needed in various professions such as those of engineers, bankers, scientists, accountants, statisticians etc.

5. To prepare the child for further learning in mathematics and the related fields. School mathematics should also aim at preparing him for higher learning in mathematics.

6. To develop in the child desirable habits and attitudes like habit of hard work, self-reliance, concentration and discovery.

7. To give the child an insight into the relationship of different topics and branches of the subject.

8. To enable the child to understand popular literature. He should be so prepared that he finds no handicap in understanding mathematical terms and concepts used in various journals, magazines, newspapers etc.

9. To teach the child the art of economic and creative living.

10. To develop in the child rational and scientific attitude towards life.

Objectives of teaching Mathematics

Aims of teaching mathematics are genially scope whereas objectives of the subject are specific goals leading ultimately to the general aims of the subject. The objectives of teaching mathematics in school can be described as under:

(1) Knowledge Objectives

Through mathematics, a pupil

- learns mathematical language, for example, mathematical symbols, formulae figures, diagrams, definitions etc.
- understands and uses mathematical concepts like concept o area, volume, number, direction etc.
- learns the fundamental mathematical ideas, processes, rules and relationships.
- understands the historical background of various topics an contribution of mathematicians.
- understands the significance and use of the units of measurement]

(2) *Skill Objectives*

Mathematics develops the following skills:

- The child learns to express thoughts clearly and accurately.
- He learns to perform calculations orally.
- He develops the ability to organise and interpret the given data
- He learns to reach accurate conclusions by accurate and logic reasoning.
- He develops speed and accuracy in solving problems.

- He develops the skill to draw accurate geometrical figures,
- He develops the ability to use mathematical apparatus and tools skillfully.

(3) ***Appreciation Objectives***

The child learns to appreciate:

- The contribution of mathematics to the development of various subjects and occupations.
- The role played by mathematics in modern life.
- The mathematical type of thought which serves as model for scientific thinking in other fields.
- The rigour and power of mathematical processes and accrue of results.
- The cultural value of mathematics.
- The value of mathematics as leisure time activity.

(4) ***Attitude Objectives***

Mathematics helps in the development of following attitudes:

- The child develops the attitude of systematically pursuing a task to completion.
- He develops heuristic attitude.
- He tries to make independent discoveries.
- He develops the habit of logical reasoning.
- He is brief and precise in expressing statements and results,
- He develops the habit of verification.
- He develops power concentration and independent thinking.
- He develops habit of self-reliance.

Need and significance of teaching Mathematics

The need to understand and be able to use mathematics in everyday life and in the workplace has never been greater and will continue to increase.

Mathematics for Life: Knowing mathematics can be personally satisfying and empowering. The underpinnings of everyday life are increasingly mathematical and technological. For instance, making purchasing decisions, choosing insurance or health plans, and voting knowledgeably all call for quantitative sophistication.

Mathematics as a part of Cultural Heritage: Mathematics is one of the greatest cultural and Intellectual achievements of human-kind, and citizens should develop an appreciation and Understanding of that achievement, including its aesthetic and even recreational aspects.

***Mathematicsfor the Workplace*:** Just as the level of mathematics needed for intelligent citizenship has increased dramatically, so too has the level of mathematical thinking and problem solving needed in the workplace, in professional areas ranging from health care to graphic design.

Mathematics for the Scientific and Technical Community. Although all careers require a foundation of mathematical knowledge, some are mathematics intensive. More students must pursue an educational path that will prepare them for lifelong work as mathematicians, statisticians, engineers, and scientists. In this changing world, those who understand and can do mathematics will have significantly enhanced opportunities and options for shaping their futures. Mathematical competence opens doors to productive futures. A lack of mathematical competence keeps those doors closed. Generally it is an assumption that mathematics is only for the select few. On the contrary, everyone needs to understand mathematics. All students should have the opportunity and the support necessary to learn significant mathematics with depth and understanding. There is no conflict between equity and excellence. Principles and Standards call for a common foundation of mathematics to be learned by all students. This approach, however, does not imply that all students are alike. Students exhibit different talents, abilities, achievements, needs, and interests in mathematics. A society in which only a few have the mathematical knowledge needed to fill crucial economic, political, and scientific roles is not consistent with the values of a just democratic system or its economic needs.

Values of teaching Mathematics

The main values of mathematics are Practical or utilitarian value, Disciplinary value, Cultural value. Aim will be based on the educational values of the subject. One can prepare a long list of goals of teaching mathematics. These aims pertain to the entire school stage. Apart from enabling the student to acquire essential mathematical knowledge, skills, interests and attitude, the teaching of mathematics has to help them in many ways. Aims of teaching mathematics are as follows

Utilitarian aim: Mathematics will be taught primarily for its practical values and aims. The students will be given mathematical knowledge and skills needed in his day-to-day life and enabled to make use of that knowledge and skill. This aim makes the study of mathematics functional and purposeful and establishes relation between the subject and practical life.

Disciplinary aim: The subject has also to be taught for its disciplinary and intellectual values. It has to aim at providing training to the mind of the learner and developing intellectual habits in him. Cultural aim: This aim helps the learner to understand the contribution of mathematics in the development of civilization and cultural.It has enabled him to understand the role of mathematics in fine arts and in beautifying human life.

Adjustment aim: It is help the learner to develop a healthy, purposeful, productive, exploratory and controlling adjustment with environment.

Social aim: It is to help the learner to imbibe essential social virtues. Moral aim: It enables the learners to imbibe the attribute of morality.

Aesthetic aim: It is to develop their aesthetic sensibilities, meet their varying interest and help them in the proper utilization of their leisure time. International aim: To develop in them international outlook and understanding.

Vocational aim: It is to prepare them for technical and other vocations where mathematics is applied.

Inter-disciplinary aim: To give them insight into the application of mathematics in other subjects.

Self-education aim: It is to help them to become independent in learning.

Educational preparation aim: It is to prepare them for higher education in science, engineering, technology, etc.

Development of powers aim: It pertains to the development of powers of thinking, reasoning, concentration, expression, discovery, etc.

Harmonious development aim: Overall aim of teaching all the subjects including mathematics is to ensure all-round and harmonious development of the personality of the child.

Conclusion:

Mathematics may be thought of as a highly disciplined mode of thinking. The teachers should help students to appreciate the structure and pattern which underlie mechanical and computational skills. Many situations can be broken down by analyzing them into interrelated constituent problems which can be explored by well-known mathematical techniques. Wherever there is structure, relationship, regularity, systematic variation, there is mathematics. To recognize this, one needs some knowledge of mathematical skills and formulae, but above all one needs imagination, appreciation of order, structure and pattern, combined with a flexible, roving interest to live in the changing, challenging and exciting world around us.

Questions for Discussion and Reflection

1. Explain the aims and objectives of teaching Mathematics.
2. Discuss the values of teaching Mathematics.
3. Analyse the scope of Mathematics.
4. Describe the nature of Mathematics.
5. Bring out the needs for Mathematics in our daily life.

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Unit – II: Planning for Instruction

Objectives

After the completion of the unit, the learners will be able to:

1. explain the steps involved in the lesson plan.
2. design a unit plan for Mathematics.
3. formulate instructional objectives based on the domains.
4. construct test items for formative evaluation.
5. discuss the different types of test items.

Introduction

Planning means making decisions about what information to present, how to present the information, and how to communicate realistic expectations to students. If all students in a class were at the same instructional level and if the goals and objectives of schooling were clearly prescribed and the same for all students, then instruction would consist of doing the same things with all students, in the right order, at the right time. But all students are not alike, and the goals and objectives of instruction are not the same for all students. This is why planning is such an important part of instruction.

Steps in planning a Lesson

A lesson plan is the instructor's road map of what students need to learn and how it will be done effectively during the class time. Before planning the lesson, it is needed to identify the learning objectives and then design appropriate learning activities and develop strategies to obtain feedback on student learning. The following point helps in planning a lesson.

Herbartian formal steps for lesson planning are as follows

1. Preparation
2. Presentation
3. Association and comparison,
4. Generalization
5. Application
6. Recapitulation

(i) Preparation

In this state simply a ground is prepared. Student is made ready to learn something new. Nothing new is total to the child. Child's previous knowledge is tested in such a way that interest may stimulate for learning something new in the mind of the child. This should be done by linking their previous knowledge with the new learning material.

(ii) Presentation

Before coming to the second step, aims of the lesson are made clear to the students. The methods and techniques employed are related to the subject matter. Material is presented to the students in an orderly manner with suitable examples, taking in account the understanding power of the child. Proper question answer technique is employed to develop the subject matter with mutual participation of the teacher and taught. Proper illustrations and aids are used according to the needs.

(iv) Association

In this step new ideas and knowledge is compared with the known similar facts to arrive at proper generalization, to establish principle or to derive definition. It is the most important step in the process of lesson planning.

(iv)Generalization

In this step by considering the above generalized facts, principles and definitions with the help of association and compression, students themselves draw out the conclusions in this step, if sometimes students are unable to have proper conclusion and generalization of the learning material, teacher should help to correct the result.

(v)Application

After establishing new formula or principle, practical implication of the material are given to the students, related to their everyday life, to have actual verification of the derived formula or principle. This helps to make the learnt material more clear and understandable.

(vi) Recapitulation

In this step assessment of teaching and learning material is done. By putting objective type questions to the students at the end of teaching. If need arise corrections are made. Finally home work is assigned to the students related to the subject matter taught.

Setting lesson goals

1. Subject matter in the lesson plan should be according to the time for teaching at the disposal of the teacher
2. Provision of homework related to the subject matter taught should be there.
3. It should provide maximum participation of the child in the teaching and learning process.
4. In the lesson plan there should be proper provision of the teaching aids and good illustrations.
5. In the lesson plan there should be proper provision of recapitulation to have view of evaluation of the subject matter taught to the students.
6. In the lesson plan there should be provision of summary of whole subject matter.
7. Lesson plan should be child centered.
8. Example quoted to teach and explain the subject matter should be related to the everyday life of the child
9. Method, procedure and techniques applied for teaching should be according to the age and the mental level of the students.
10. Subject matter arranged in the lesson plan should be related to the previous knowledge of the child.
11. Selection and organization of the subject matter should be to the point and systematics.
12. It should be written clearly and vividly.

Designing a Unit Plan

Different meaning has been assigned to the term unit. They are 1. The lesson of the day 2. As a Chapter in a text book etc. Syllabus contains many topics/ units such as Mensuration, Algebra, Triangles trigonometry, Statistics etc.

Definitions of Unit Plan

According to Morrison, H.C. – "A Unit is a comprehensive and significant aspect of the environment of an organized science and art".

According to Preston – "A Unit is as large a block of elated subjects' matters as can be overviewed by the learner."

According to wisely – " The unit is an organized body of information and experience designed to effect significant outcome for the learner"

Unit Planning

A unit plan involves planning a teaching a unit, teaching methods,evaluation of teaching activities, diagnosing and remedial steps all together is called unit planning.

S.NO	Sub Division of content	No. of Period required	Teaching Method	Resource Materials	Evaluation

Designing a Lesson Plan

Planning of a lesson is animportant equipment of a teacher in a school or in a college. A lesson plan is strictly individual; it is indeed the creation of the teacher who plans out lesson plan. A plan is a work or is involving much imagination and study. The plan is an unfolding of the teacher's soul; it contains the life-blood of the teacher. Lesson plan is a kind of discipline, which has to be learnt in the training college.

R.L. Stevenson sates the importance of lesson plan as, "To every teacher I would say, always plan out your lesson beforehand but do not be slave to it"

Ryburn also said, "To Teach we must use experience already gained as starting point of work". Hence the lesson plan reflects the intelligence, ability, capacity, resourcefulness

and personality of the teacher. Lesson planning provides awareness to the structure and content with which teacher is involved in the direction to achieve the objectives.

Bloom's Taxonomy of educational objectives

Benjamin bloom, has been extremely influential in clarifying and organizing educational thought regarding the classification of objectives, his original work being carried out during the 1950's. Bloom and his co-workers contended that objectives are attainable in three distinct areas, or domains, to which they assigned suitably impressive jargon names: the cognitive domain, affective domain and psychomotor domain.

The cognitive domain

This contains objectives which are related to the acquisition and application of knowledge and understanding, and probably includes the great majority of educational and training objectives. An example of such an objective might be: "The student should be able to calculate all the dimensions of a triangle given the lengths of two sides and the size of the angle between them". Bloom and his co-workers also divided the cognitive domain into six distinct levels, each level building on those below and representing a progressively higher level of cognitive activity. Their hierarchy of the cognitive domain is as follows.

Level 6: Evaluation: Making judgments/critical comparisons on the basis of agreed Criteria.

Level 5: Synthesis: Bringing elements together to form a new, coherent whole.

Level 4: Analysis: Breaking a system down into its constituent elements.

Level 3: Application: Applying procedures/systems/rules in specific situations.

Level 2: Comprehension: Understanding and interpreting information

Level 1: Knowledge : Recalling information

The affective domain

This contains objectives that are concerned with attitudes and feelings which are brought about as a result of some educational or training process. An example of such objectives might be:"The trainees' lecturer should exercise empathy when counselling students".The affective domain was also divided into a number of distinct, hierarchical levels; this work was carried out by Bloom.

Level 5: Characterization: integrating one's beliefs, ideas and attitudes into a total, all-embracing philosophy.

Level 4: Organization: Making adjustments or decisions from among several alternatives.

Level 3: Valuing: Committing oneself to taking up an attitudinal position.

Level 2: Responding: Showing active interest in something.

Level 1: Receiving: Developing an awareness of something.

The Psychomotor domain

This contains objectives that deal with the development of manipulative or physical skills-things like measuring setting up and using equipment, using tools, drawing graphs, and so on. An example of such an objective might be: "The student should be able to assemble and use the distillation apparatus provided".

Level 4: Speech behavior: sound production and projections sound/gesture coordination

Level 3: Non-Verbal Communication: Facial expressions gestures, bodily movements.

Level 2: Finely-Coordinated Movement: Movements of hand and fingers, hand and eye, eye and foot, etc.

Level 1: Gross body Movements: Movements of arms, shoulders, trunk, feet and legs

Format of an Objective-based Lesson Plan

The following format may be used to prepare an objective-based lesson plan.

Objective-based Lesson Plan format

Name of the Student-teacher : subject : Date :

Class /Section and Section : Unit :

Name of the school : Topic :

Instructional Objectives : The student -teacher

1. Acquires knowledge of
    a. Understands
2. Applies the scientific knowledge
3. Develops skills
4. Develops interest
5. Develops attitude
6. Appreciates

A. Specifications : the student
1. Recalls
2. Recognizes
3. Differentiates
4. Cites example
5. Enjoys

B. Instructional Resources

Required :

Previous Knowledge of Learners:

Content/Concept	Specification of Behavioural Objectives	Learning Experiences (Teacher/Learner activities)	Evaluation

Follow up Activities(if any):

Signature of the Guide Signature of the Student-Teacher

MODEL LESSON PLAN

Name of the student teacher : XXX **Subject:** Mathematics

Class/section and session : IX **Unit** : Mensuration

Name of the school : XXX **Topic** : Surface area and Volume of the cube

Instructional objectives: The pupil

1. identifies the different mathematical shapes.
2. recalls the formulae on area and volume of the cube
3. explains the relationship between the area and the volume of the cube.
4. computes the problems with speed and accuracy.
5. formulates the problems on their own.

Instructional resources:

1. Model of a cube
2. Solid objects
3. Pictures depicting cube

Previous knowledge of learners

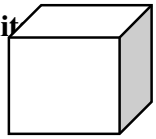
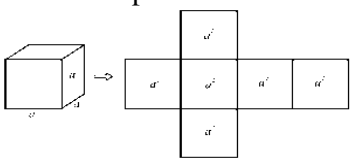
The Teacher asks the below questions to check the previous knowledge of the students.

1. How many sides are there in a cube?

2. Name some of the cube shape objects.

3. What is the area of the square?

Concept/Content	Specification of behavioural objectives	Learning Experiences(Teacher/Learner activities)	Evaluation
Lateral Surface Area (LSA) of the cube. The Lateral Surface Area of a cube is the area of all the sides of the cube excluding area of its base and top.	Defines Discusses	The teacher defines the Lateral Surface Area of the cube. Students discuss the definition in pairs.	Define LSA of the cube.
Model of the cube.	Recognises	Students handle the model of the cube and recognize its LSA.	
Formula for LSA of the cube=$4a^2$sq. units	Explains Writes	The teacher explains the steps involved in the deriving the formula. = 4x area of each sides = $4a^2$square units Where 'a' is the side of the cube. Students write the formula for LSA of the cube in their notebook.	Write the formula for LSA of the cube.
Find the LSA of the cube if the side is 5 cm? Given a=5 cm The LSA of the cube $=4a^2$ $=4x5^2$ $=4x25$ $=100\ cm^2$	Reads Identifies Substitutes Calculates	The teacher reads the problem. Students identify the value of 'a' in the given problem. The teacher substitutes the value of the 'a' blackboard. Students calculate the LSA of the cube in their notebook.	Identify the value of 'a' in the given problem. Calculate LSA of the cube if the side is 6 cm.
Total Surface Area (TSA) of the cube. The Total Surface Area of a cube is the area of all the sides of the cube including its base and top.	Defines Discuss	The teacher defines the Total Surface Area of the cube. Students discuss the definition in pairs and copied in their note book.	Define TSA of the cube.

Concept/Content	Specification of behavioural objectives	Learning Experiences(Teacher/Learner activities)	Evaluation
Formula for TSA of the cube= $6a^2$sq. unit 	demonstrates	The teacher demonstrates the TSA of the cube by unfolding the cube shape box  The students unfold the given cube shaped box.	Count the number of sides in the given cube.
	Explains	The teacher explains the formula for TSA of the cube. = The sum of the areas of all the six equal faces of the cube. = 6 X a^2 =$6a^2$sq. units.	Write the formula for TSA of the cube.
	Writes	Students write the formula for TSA of the cube in their notebook.	
Find the TSA of the cube if the side of the cube is 7 cm? Given: a=7, The TSA of the Cube=$6a^2$ =$6x7^2$ =6x49 =294 cm^2	Simplifies	Students do the simplification on the black board.	
	Summarises	The teacher summarises the steps involved in the derivation.	Simplify the given problem.

Concept/Content	Specification of behavioural objectives	Learning Experiences(Teacher/Learner activities)	Evaluation
Comparison of LSA and TSA of the cube.	Compares	The teacher compares the LSA and TSA of the cube by explaining its sides. LSA = 4 a^2sq. units TSA = 6a^2 sq. units	Compare LSA and TSA of the cube.
Volume of the cube: The number of unit cubes required to fill the entire cube. Real cube shape objects	Defines Writes demonstrates	The teacher defines the volume of the cube. Students write the volume of the cube in their notebook. The teacher demonstrates the volume of the cube by using real cube shaped objects. Students demonstrate the volume of the cube by using real cube shaped objects.	Define the volume of the cube.
Find the volume of the cube if the side of the cube is 6 cm? The volume of the cube is a^3 = aXaXa Given a=6 =6x6x6 =216cm^3	Selects appropriate formula. Computes	Student writes the appropriate formula in the blackboard. The teacher helps the students to compute the problem.	

Home work:

1. Find the Lateral Surface Area (LSA), Total Surface Area (TSA) and volume of the Cube having their sides as 8 cm.
2. If the Total Surface Area of a cube is 1014 cm^2, find the length of its side

Signature of the Pre - service teacher **Signature of the supervisor**

Types of test – Items

1. Multiple-Choice Tests
2. True-False Tests
3. Matching Tests
4. Essay Tests
5. Short-Answer Tests
6. Problem sets
7. Oral exams

Multiple-Choice Tests:

Multiple-choice items can be used to measure both simple knowledge and complex concepts. Since multiple-choice questions the students can give the answer very quickly and correct. Use of this items when the student gave the correct answer a question that student have clear idea about the question. In addition, the items can be easily and reliably scored. However, good multiple-choice questions are difficult to write.

True-false Tests

True-false tests are less reliable than other types of exams. However, these items are appropriate for occasional use. Some faculty who use true-false questions add an "explain" column in which students write one or two sentences justifying their response.

Matching Tests

The matching format is an effective way to test students' recognition of the relationships between words and definitions, events and dates, categories and examples, and so on.

Essay Tests

Essay tests or assignments enable you to judge students' abilities to recognize, interpret material, and express themselves in their own words. Research indicate that students study more efficiently for essay-type examinations than for selection tests: students preparing for essay tests focus on broad issues, general concepts, and interrelationships rather than on specifics details and this studying results in somewhat better student performance regardless of the type of exam they are given(McKeachie,1986)

Essay also given you an opportunity to comment on students' progress, the quality of their thinking, the depth of their understanding, and the difficulties they may be having. However, because essay tests pose only a few questions, their content validity may be low. In addition, the reliability of essay tests is compromised by subjectivity or inconsistencies in grading.

Short-Answer Tests:

Depending on your objectives, short-answer questions can call for one two sentences or a long paragraph. Short-answer tests are easier to write, though they take longer to score, than multiple-choice tests.They also give you some opportunity to see how well students can express their thoughts, thought they are not as useful as longer essay responses for this purpose.

Problem sets

In courses in mathematics and the sciences, your tests can include problem sets. As a rule of thumb, allow students ten minutes to solve a problem you can do in two minutes.

Oral Exams

Oral exams are sometimes used for undergraduates in foreign language classes. In other classes they are usually seen as too time- consuming, too anxiety provoking for students, and too difficult to score unless the instructor tape-records the answers.

Constructing test-items for formative evaluation in class

General steps

1. Identify and define the learning outcomes to be measured
2. Prepare test specifications
3. Construct relevant test items
4. Review and edit the items
5. Arrange the items in the test
6. Prepare directions

Step 1*: *Identify and define learning objectives

1. State the general objectives.
2. Develop 5 to 15 general objectives.

3. Begin each general objective with one of the six cognitive domain headings of Bloom's Taxonomy
4. State the specific objectives.
5. For each G.O., develop 3-5 specific objectives.
6. Begin each S.O with an action verb.

Step 2: Preparing Test specifications

1. Select the specific outcomes to be tested
2. Outline the subject matter by listing topic and subtopic areas in the lesson plan
3. Make a two-way table of specifications

Step 3: Construct Relevant Test Items and Consider:

1. Selecting the type of test items to use
2. Selecting type items (e.g, multiple choice, true-false, matching, interpretive exercises)
3. Supply type items(e.g, short answer, essay(restricted response), essay (extended response)
4. Matching items to Specific Objectives
5. For each S.O., write one or more related items, Parts of an Item:
    i. Stem-the question or incomplete sentence.
    ii. Alternatives-the choices
    iii. Distractors-the incorrect choices

Step 4: Review and edit the items

1. Does each test item measure an important learning-outcome included in the table of specifications?
2. Is each item type appropriate for the particular learning outcome to be measured?
3. Does each item present a clearly formulated task?
4. Is the item stated in simple, clear language?
5. Is the item free from extraneous clues?
6. Is the difficulty of the item appropriate for the students to be tested?
7. Is each test item independent and are the items, as a group, free from overlapping?
8. Do the items to be included in the test provide adequate coverage of the table of specifications?

Step 5: Arrange the items in the test

1. The items should be arranged so that all items of the same type are grouped together.
2. The items should be arranged in order of increasing difficulty.

3. For some purposes, it may be desirable to group together items which measure the same learning outcomes or the same subject-matter content.

Step 6: Prepare directions

1. Purpose of the test.
2. Time allowed to complete the test.
3. How to record the answers.
4. Whether to guess when in doubt about the answer.

Conclusion

The planning aspects of teaching is so important that it alone can determine the failure or success of teacher. It is the planning of lessons that take into account the interaction between student and teacher that determines the success of the learning experience. Teachers who spend more time in preparation will spend less time in trying to keep their students on the learning track.

Questions for Discussion and Reflection

1. Explain Bloom's Taxonomy of Educational Objectives with suitable examples.
2. Prepare a model Lesson Plan for any one of the topic in 9th standard Mathematics Text book.
3. Briefly explain the significance of Lesson Plan in teaching Mathematics.
4. Critically analyse the structure and steps involved in the four fold Lesson Plan.
5. Explain the types of test-items and construct test-items for formative evaluation in class room environment.

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Unit – III: Practicing the teaching skills in Mathematics

Objectives:

After the completion of the unit, the learners will be able to:

1. To obtain knowledge on the meaning of teaching.
2. To understand the teaching skills.
3. To analyse the major steps in teaching a mini-lesson.
4. To explore, observe and feedback on integration of teaching steps in mini-teaching

Introduction

An educational institution performs a significant function of providing learning experiences to lead their students from the darkness of ignorance to the light of knowledge. The key personnel in the institutions who play an important role to bring about this transformation are teachers. As stated by NCTE (1998) in Quality Concerns in Secondary Teacher Education, –The teacher is the most important element in any educational program. It is the teacher who is mainly responsible for implementation of the educational process at any stage. This shows that it is imperative to invest in the preparation of teachers, so that the future of a nation is secure. The importance of competent teachers to the nation‘s school system can in no way be overemphasized.

Meaning of Teaching

Teaching includes all the activities of providing education to other. The person who provides education is called teacher. The teacher uses different method for giving best knowledge to his students. He tries his best to make understand students. His duty is to encourage students to learn the subjects. Teaching means interaction of teacher and students. They participate for their mutual benefits. Both have their own objective and target is to achieve them.

Understanding major teaching skills

Teaching skills would include providing training and practice in the different techniques, approaches and strategies that would help the teachers to plan and impart instruction, provide appropriate reinforcement and conduct effective assessment. It includes effective classroom management skills, preparation and use of instructional materials and communication skills.

1. Skill of Introducing

This is an important skill required for a teacher. Well begun is half done is a saying which indicates the importance of introducing a lesson. It is the duty of a teacher to bring the students into the classroom mentally. The skill is intended for making effectiveness in introducing of the content. This is always done at the start of a class. Here teacher gives a brief introduction about the lesson in order to pre-dispose the pupil's mind to it.

There are many ways to present an introduction. Here are a few:

1. Asking questions to get the students thinking about the topic of the lesson.
2. Showing pictures that relate to the lesson topic.
3. Telling a story to show the importance of the topic.
4. Bringing in real objects related to the lesson.

2. Skill of Explaining

Teaching is not primarily telling. It's helping other people learn. That means the focus is on the learners, not the teacher. People learn best through experiencing something themselves, so when you are striving to teach something, you are constantly trying to Get into the shoes of the learners so that you can better understand where they are and what they need

from you to learn the subject understudy. Explaining can be defined as an activity to bring about an understanding of a concept, principle etc. it is an activity to fill the gap in someone's understanding.

In classroom the teacher explains ideas and concepts. It is the most commonly used skill and is the essence of instruction. Explanation is a key skill. Generally, the skill of explanation is complex Explanation is to explain or to give understanding to another person. It leads from the known to the unknown, it bridges the gap between a person's knowledge or experience and new phenomena, and it may also aim to show the interdependence of phenomena in a general sable manner. It assists the learner to assimilate and accommodate new data or experience.

In a classroom, an explanation is a set of interrelated statements made by the teacher related to a phenomenon, an idea, etc. in order to bring about or increase understanding in the pupils about it. The teacher should practice more and more of desirable behaviours like using explaining links using beginning and concluding statements and testing pupil understands behaviours like making irrelevant statements, lacking in continuity, using inappropriate vocabulary, lacking in fluency, and using vague words and phrases as far as possible.

A class is not homogeneous group. Some pupils are intelligent some have normal intelligence, some are mature and others are immature. But the teacher has to impart knowledge to all. To present the subject matter in the simplified form before the pupils and making it acquirable is called the skill of explanation. It is necessary in all the subjects. In its absence the presentation of the subject matter is not possible. In the skill of explanation, such words are used in the statements by which the statements exhibit the clarity of their meanings.

The explanation serves two purposes: (1) to introduce the subject by giving some background about its usefulness and application; and (2) to describe the subject in a simple, complete, and tantalizing way. The explanation should create a desire to become proficient in the subject under study

The components of skill of explaining involved

1. Clarity
2. Continuity

3. Relevance to content using beginning and concluding statements
4. Covering essential points
5. Simple
6. Relevant and interesting examples appropriate media
7. Use of inducts, deductive approach, it can be functional, causal or sequential

Characteristics of effective explanation

1. *Coordination in Statements*: Coordination in the statements used during the explanation is very essential; otherwise there will be all hotch- potch.
2. *Relevant Statements*: While presenting the subject matter, the concerned statements should be relevant.
3. *Fluency in Language:* The teacher should use fluent language so that the pupils may listen and understand his thoughts.
4. *Connecting Link:* The use of words, idioms or connecting links such as 'therefore' as a result of etc. is essential to link the different thought or statements.
5. *Clear Beginning Statement*: Before starting any explanation, the teacher should make the pupils aware of what he is to teach on that day through a clear beginning statement.
6. *Use of proper Words*: The teacher should use proper words for explaining an object or an event otherwise he would be in a state of confusion

3. Skill of Questioning

Successful teaching highly dependent on questioning technique employed in the teaching sessions. Questioning is an important teaching skill that a teacher must learn. The teacher should learn to ask suitable, appropriate and meaningful questions. Questioning is definitely a skill. We can very easily answer a question but it is too difficult to ask a question.

A question is any sentence which has an interrogative form or function. In classroom settings, teacher questions are defined as instructional cues or stimuli that convey to students the content elements to be learned and directions for what they are to do and how they are to

do it. Questioning promotes involvement, initiates thinking, creates motivation and enhances learning.

Effective questioning is a real compliment to the instructional skills. It shows the ability to understand the student's real needs. It shows that for meaning that's deeper than the spoken message. Effective questioning is a powerful, learned skill.

For students, questioning strategies help to categorize and anticipate exam questions, allowing for more effective preparation. The strategies are also useful for study groups, focusing efforts and allowing members to test each other. They improve the student's ability to clarify, reorganize, and accurately explain new information. Questioning also aids in self-assessment and self-monitoring.

Basis of Questioning skill

Questioning skills refer to one's ability to formulate and respond to questions about situations, objects, concepts, and ideas. Questions may derive from oneself or from other people.

There are two levels of questions:

1. **Low-level questions refer** to questions that require one to recall information that has been registered in memory. Low-level questions operate on the level of knowledge, drawing from one's knowledge base of a subject.
2. **The High-level questions** encompass questions that require one to process information rather than simply recall it. High-level questions operate on one's ability to comprehend, apply, analyze, synthesize, and evaluate information.

Questioning techniques

Good questions are essential to effective communication between: the teacher and the student: the teacher who lack the skill to effectively question their student create disinterest and boredom on the part of the student. They also ignore a fine opportunity to open communication lines for determining the effectiveness of the lesson. Good questions expand on central thoughts, develops the subject, and not on minor, nice-to-know points. Let us look at some rules for asking questions.

• Distribute questions at random. Do not always ask the same student or those sitting in a particular area. Ask questions of the entire class to promote thinking in all students and get them involved.

•Acknowledge all answers to ensure incorrect or vague answers are clarified.

•Don't use catch or trick questions. Students will not participate and you could possibly lose them if they feel humiliated.

•Allow enough time for the student to think about and give an answer. Do not waste time waiting if the student clearly does not know the answer, but do not cut the student off before ample time is given for the complete though process or answer period.

•Begin questions with the words that require thoughtful answers, such as, "Why, When, How, What," etc. Stay away from questions that can be answered with a simple yes or no. This will help stimulate and even guide students thinking.

•Avoid frequent group or choral responses. This method provides answers that are often unintelligible and errors that are hard to pick up.

•Do not waste time "pumping" a student. If the trainee does not know the answer, either offer an explanation or ask the question of another student.

4. Skill of closure

This skill is useful for a teacher to close his teaching properly. The teacher is to summarise all the teaching during the period and provide opportunities for the students to correlate the learnt matter with the past and future knowledge. This is to be done by statements or by asking questions.

5.Skill of Reinforcement

This skill is the most important one than other teaching skills. Reinforcement, the term implies the use of the technique for influencing behaviour of individuals in desired direction. The concept of reinforcement is based on the hedonistic principles, which envisages that all individuals tend to repeat the pleasant experiences and avoid unpleasant

ones. The skill is being used to utilize good behaviours of the learners and to avoid the undesirable behaviours of the learners. The teacher would like the student's desirable behaviours and criterion responses to be retained and undesirable behaviours to be eliminated. For reinforcing student's desirable behaviours and criterion responses he uses positive verbal and non-verbal reinforcers. These reinforcers not only strengthen the student's desirable behaviours but also develop confidence in them.

Besides, they enhance their positive self-concept. Absence of positive reinforcers for student's desirable behaviours may erode their confidence and lead to poor self-image. Positive reinforcements encourage students to participate actively in classroom interactions. It stimulates them to achieve more, thereby, creating a sense of achievement. Skilled use of reinforcers helps a teacher to promote student's learning. The skill of reinforcement refers to the effective use of reinforcers. It, can therefore be defined as 'the effective use of reinforcers to modify student's behaviour in the desired direction".

6. Skill of varying the stimulus

Varying the stimulus is described as a deliberate change in the behaviours of the teacher in order to sustain the attention of the learners throughout the lesson. The variation in the stimulus helps in avoiding monotony and in generating interest among the students which in turn makes learning effective.

Learning in the classroom depends, to a large extent, on the attention of the students on the learning task. It is therefore, essential for the teacher to secure and sustain student's attention for making his teaching effective. Continuous use of the same stimulus or activity for longer period induces inattention. The inattention is caused in two ways: one is continued focus of the students on the same stimulus for a long time restricts his postural mobility which leads to fatigue. Next is the continued use of the same stimulus for longer duration introduces the element of monotony, which brings in dullness. This will be further aggravated because of the short span of student's attention. Their attention tends to shift from one stimulus to another frequently. They find it difficult to attend to one stimulus for more than a few minutes. The problem of inattention is a challenge to the teacher, unless he is in a position to secure and sustain student's attention. It is therefore, essential for the teacher to secure and sustain student's attention towards the topic of the lesson.

One of the significant ways to secure and sustain students' attention is to introduce the elements of variation in teaching. The variation can be introduced in several ways depending upon the teaching activity. Appropriate variation in different dimensions can help a teacher to secure and sustain students' attention. The set of teacher behaviours that tend to secure and sustain student's attention in teaching learning situation in the classroom constitutes the skill of varying the stimulus.

Some of the components of varying the stimulus are as follows:

1. Movement
2. Gestures
3. Change in voice
4. Focusing
5. Change in interaction pattern
6. Pausing
7. Student's physical participation
8. Aural visual switching

7. Non – verbal cues

Non-verbal communication has been defined as communication without words. They are usually made with the help of the movements of the eye, hand, head, body, and facial expressions. Facial expression will lead to encourage pupil to participate actively in learning situations. Positive non-verbal cues include smiling, nodding the head, a delighted laugh, patting on the shoulder, asking the students to clap. The students can be asked to clap their hands for correct answers given by a student.

Disapproval without suing words has the effect on negative reinforcement. Negative non-verbal cues include staring, looking angry, shaking the head, beating, caning, bruising, raising the eyebrows, tapping foot impatiently and walking around etc.

8. Fluency in communication

Communication in general is a process of sending and receiving messages that enables humans to share knowledge, attitude, and skills. Communication is a series of

experiences of hearing, seeing, smelling, tasting, and touching / feeling. Although we usually identify communication with speech, communication is composed of two dimension: verbal and non-verbal. Both verbal and non-verbal plays a significant role in teaching learning process. Verbal communication is divided into Intra verbal: intonation of word and sound and extra verbal: implication of words and phrases, semantics.

The teacher uses knowledge of effective verbal and nonverbal communication techniques as well as instructional media and technology to foster active inquiry, collaboration, and supportive interaction in the classroom.

Understanding Major Steps in teaching a Mini-Lesson

Instructional Procedures and Activities: Provide a detailed discussion of the mini lesson (15-20 min) using the following headings:

Motivation

This step is considered to be the preparatory step, wherein the teacher is trying to prepare the minds of the students ready to receive the subject matter. Hence, this step identifies the mental readiness of the students. The teacher will be able to check the students' entering behavior before he starts teaching the lesson. Thus testing students' previous knowledge develops interest in the minds of students and helps to maintain curiosity of the students.

Presentation

It is the key step and only through which the actual process of teaching is going to take place. Here the aims of the lesson should be stated clearly and the heading shold be written on the blackboard. We have to provide situation for both the teacher and the students to participate in the process of teaching and learning. Our ultimate aim of the presentation is to make the concepts understandable to the students. Therefore, use of simple language is recommended. Appropriate and specific examples and illustrations of the concepts will make the understanding better. The interest of the students on the subject matter should be maintained continuously by the way of asking questions from time to time in this stage. Use of instructional aids like charts, audiovisuals, specimen etc in an appropriate manner is strongly recommended during presentation.

Interaction

Interaction in the classroom will be done by speaking, sharing opinion, listening to others and establishing a mutual consent. Students in the learning process support when they are done by interacting directly with the object of learning and communicating in groups and also provide the ability of gaining mastery over the subject.

Reflection

Students will be given opportunity to express their ideas, experiences and opinions. Students will be cooperative, respect the opinions of others, responsible, honest on information receiving and able to give decisions.

Summing-up

This stage is meant for the teachers to know whether the students have grasped and understood the concepts taught or not. This can be achieved by reviewing the lesson and by giving assignments to the students. Only through this step achieving closure is possible.

MINI-LESSON

- It is a teaching training technique for learning teaching skills.
- It employs real teaching situation for developing skills and helps to get deeper knowledge regarding the art of teaching.
- A mini lesson is a basic precursor to a bigger or broader topic. It is a short lesson that can be taught in just a few minutes, but it can benefit the students in lessons to come.
- For instance, you may teach a basic topic like fact versus opinion by sharing a variety of statements and having students tell you if the statement is fact or opinion.
- This practice may take only 20 minutes, but teaches a valuable lesson to the students and sets the foundation for further discussion of writing styles or reading concepts.

MINI LESSON

Name of the student teacher : ----------

Subject: MATHEMATICS

Topic : WORK

Focus : Scalar, Vector Quantity

Date :

Time : 10 - 10.20 AM

OBJECTIVES

1. Acquires knowledge of the scientific meaning of work.
2. Understands the knowledge of the use of scalar product to represent quantity of work done.
3. Develops an understanding of activities where work is done and not done.
4. Application of knowledge in day-to -day activities of life.

MATERIALS

1. Chart illustrating different activities
2. Hammer
3. Saw
4. Rubber band
5. Pinwheel
6. Attached to string
7. Magnet

CONTENT OUTLINE

1. Meaning of work
2. Scalar product to represent quantity of work
3. Description of where work is done and not done
4. Procedure to find how scalar product is used to define work
5. Identification of work in day-to-day life

TEACHING SKILLS

1. Skill of Introduction
2. Skill of Explaining
3. Skill of Questioning
4. Skill of Stimulus Variation
5. Skill of Closure

INSTRUCTIONAL PROCEDURES AND ACTIVITIES:

- **MOTIVATION (Skill of Introduction – use of previous knowledge)**

  The teacher asks the students questions related to their knowledge of the meaning of work to their knowledge of the meaning of work, as follows:

  1. What do you know about work?
  2. Do you work every day?
  3. Would you call every activity 'work'?
  4. How would you define work?
  5. In science, when we use the term 'work' what do you mean?

- **PRESENTATION**

  The teacher announces the topic as "work done as a scalar product" and writes it on the black board. **(Skill of Explaining – Cognitive link)**

  1. Work is done by a force or against the direction of a force when the point of application of the force moves in or against the direction of the loree.
  2. Forces such as muscles, objects lifted, objects stretched, wind, water, laminar objects.
  3. The teacher uses aids like a lifted hammer or saw, a stretched rubber band that lifts weights, a pinwheel, magnet etc,.. to demonstrate these**3** forces**. (skill of Explaining – uses of Illustrations)**
  4. Could you name some of the forces man has at his disposal to overcome friction, gravity, inertia?
  5. Objects, magnets, electric current ***(Recalls)***
  6. The teacher writes on the board scalar product.

7. Students as you all know that work involves force and distance. These both are vectors but work is a scalar. How is this possible? **(Skill of Questioning – Relevancy)**

8. The teacher expresses scalar product of **2** vectors : As the scalar quantity that we find when we multiply the magnitude of one vector by the component of a second vector along the direction of the first.

9. The scalar product gives the quantity of work alone. It is the product of the magnitude of force and the component of distance parallel with force. ***(Recognizes)***

- **INTERACTION: (Skill of Questioning – Specificity)**
  1. When will the scalar product be zero?
  2. When will it be maximum?
  3. What will happen if Ø =180 ^{0}?
  4. What am I doing? Is the work done here positive or negative?
     i. The teacher points out by lifting an object form floor to table. Here the produce is positive since the vectors re in same direction.
     ii. When the two factors are in opposite direction product is negative.
  5. When is "no work" done?
     i. The teacher whirls a ball around to demonstrate no work.

- **REFLECTION: (Skill of Stimulus Variation – Audiovisual Switching)**

The teacher now shows the chart illustrating different activities and asks pupils to identify cases where positive work, negative work and no work is done.

- **SUMMING UP: (Skill of Closure – Consolidation of major points)**
  1. Work is done when a force is exerted or overcome over a distance.
  2. When we multiply the magnitude of one vector by the component of a second vector along the direction of the first.
  3. When an object is lifted vectors in the same direction work positive.
  4. The two factors are in opposite directions product is negative.

Observation and Feedback on the practice of Integration of teaching skills

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.

The teaching skills developed through training are to be observed by the peers/ teacher educators. Immediate feedback may be given to the student-teachers individually using the feedback forms.

Distribute a copy of both Assessment formats (skills & steps) to the pre-service teachers (peers)

INTEGRATING THE STEPS IN MINI TEACHING (Assessment by Peers/Teacher Education)				
TEACHING STEPS	AVERAGE (SCORE 1)	GOOD (SCORE 2)	VERY GOOD (SCORE 3)	TOTAL
Motivation				
Presentation				
Interaction				
Reflection				
Summing Up				

Range of scores:5-15

OVERALL ASSESSMENT OF TEA CHING STEPS

AVERAGE ____ GOOD ____ VERY GOOD_____

Interpretation of scores
Average : 5
Good : 6-10
Very Good :11-15

Observation and Feedback on Integration of teaching steps in Mini-Teaching

INTEGRATING SKILLS IN MINI TEACHING (Assessment by Peers/Teacher Educators)				
Teaching skills	AVERAGE (SCORE 1)	GOOD (SCORE 2)	VERY GOOD (SCORE 3)	TOTAL
Introducing				
Explaining				
Questioning				

Varying the stimulus				
Non verbal cues				
Reinforcement				
Closure				
Fluency in Communication				

Range of scores:8-24

OVERALL ASSESSMENT OF TEACHING STEPS

AVERAGE ____ GOOD ____ VERY GOOD_____

Interpretation of scores

Average : 8

Good : 9-16

Very Good :17-24

Conclusion

Today as never before, meeting our society's challenges demands educational excellence. Reinvigorating the economy, achieving energy independence with alternative technologies and green jobs, and strengthening our health care system require a skilled populace that is ready for the critical challenges we face. There is widespread consensus, however, that our education systems are failing to adequately prepare all students with the essential 21st century knowledge and skills necessary to succeed in life, career and citizenship.

Questions for Discussion and Reflection

1. Briefly explain the major steps in teaching a mini lesson.
2. Write a mini-lesson with multiple teaching skill for class IX in the Mathematics subject.
3. Explain the mini lesson format.
4. Critically analyse the skill of varying the stimulus.
5. Explain the skill of explaining with its skill components.

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Unit - IV Methods of Teaching Mathematics

Objectives:

After the completion of the unit, the learners will be able to:

1. explain the various methods of teaching Mathematics.
2. identify the different teacher centered methods of teaching.
3. analyse the recent trends in teaching and learning Mathematics.
4. adopt the small group interactive learning methods.
5. discuss the various learner centered methods .

Introduction

Different methods of teaching mathematics have been proposed by different educators. Knowledge of these methods may help in working out a teaching-learning strategy. It is not an educational sound for a teacher to commit himself to any particular method. A teacher should adopt an approach considering the nature of the children, their interests and maturity and the resources available. The merits and demerits of various method listed.

A teacher has to make uses of various kind of methods, devices and techniques in teaching. It is not appropriate for a teacher to commit to one particular method. A teacher should adopt a teaching approach after considering the nature of the children, their interests and maturity and the resources available. Every method has certain merits and few demerits and it's the work of a teacher to decide which method is best for the students.

Teacher – centered Methods:

1. Lecture Method
2. Analytic Method
3. Synthetic Method
4. Inductive Method

5. Deductive Method
6. Demonstration Method
7. Team Teaching

(1) Lecture method

The lecture method is the most widely used form of presentation. Every teacher has to know how to develop and present a lecture. They also must understand the scopes and limitations of this method.Lectures are used to introduce new topics, summarizing ideas, showing relationships between theory and practice, reemphasizing main points, etc. This method is adaptable to many different settings (small or large groups).

- It may be used to introduce a unit or a complete course.
- Finally, lectures can be effectively combined with other teaching methods to add meaning and direction. The lecture teaching is favorable for most teachers because it allows some active participation by the students. The success of the teaching lecture depends upon the teacher's ability to communicate effectively with the class. However in this method the feedback is not very obvious and thus the teacher must develop a keen perception for subtle responses from the class-facial expressions, manner of taking notes and apparent interest or disinterest in the lesson. The successful teacher will be able to interpret the meaning of these reactions and adjust the lesson accordingly.

Preparing the Teaching Lecture:

1. Planning
2. Rehearsing
3. Delivering a lecture
4. Use of notes

Planning:

The following four steps are followed in the planning phase of preparation:

- Establishing the objective and desired outcomes;
- Researching the subject;
- Organizing the material; and
- Planning productive classroom activities.

Rehearsing:

After completing the preliminary planning and writing of the lesson plan, the teacher should rehearse the lecture to build self-confidence. It helps to smooth out to use notes, visual aids, and other instructional devices.

Delivering a lecture

In the teaching lecture, simple rather than complex words should be used whenever possible. The teacher should not use substandard English. If the subject matter includes technical terms, the teacher should clearly define each one so that no student is in doubt about its meaning. Whenever possible, the teacher should use specific words rather than general words.

Another way the teacher can add life to the lecture is to vary his or her tone of voice and pace of speaking. In addition, using sentences of different length also helps. To ensure clarity and variety, the teacher should normally use sentences of short and medium length.

For a teacher notes are must because they help to keep the lecture on track. The teacher should use them modestly and should make no effort to hide them from the students. Notes may be written legibly or typed, and they should be placed where they can be consulted easily.

Advantages of the Lecture method

1. Gives chance for the teacher to expose students through all kinds of material.
2. Allows the teacher to precisely determine the aims, content, organization, pace and direction of a presentation.
3. Can be used to arouse interest in a subject.
4. Can complement and clarify text material.
5. Complements certain individual learning preferences.
6. Facilitates large-class communication.

Disadvantages of the Lecture Method

1. Places students in a passive rather than an active role, which hinders learning.
2. Encourages one-way communication; therefore, the lecturer must make a conscious effort to become aware of student problems and student understanding of content without verbal feedback.
3. Requires a considerable amount of time for unguided student outside of the classroom to enable understanding and long-term retention of content.
4. Requires the teacher to have effective speaking skills.

(2) Analytic method

The word ‘analytic’ is derived from the word ‘analysis’, which means ‘breaking up’ or resolving a thing into its constituent elements. This method is based on analysis and, therefore, in this method we break up the problem in hand into its constituent parts so that it

ultimately gets connected with something obvious, or already known. Therefore, it is the process of unfolding of the problem or of conducting its operations to know his hidden aspects. In this process we start with what is to be finding out (unknown) and then think of further steps and possibilities which may connect with the known and find out the desired result. Hence in this method we proceed from unknown to known, from abstract to concrete and from complex to simple. In analytic method, the argument is that "To prove that B is true if A is true, it is sufficient to prove that A is true "

The following example illustrate how analytic method can applied

Example

If prove that .To prove this using analytic method, begin from the unknown.

The unknown is

A is true

B is true, and C is true But in analysis we say C is true if B is true;

B is true if A is true; But A is true therefore C is true

Merits of Analytic Method

1. It leaves no doubts in the minds of the students as every step is justified.
2. It is a psychological method.
3. It facilitates clear understanding of the subject matter as every step is derived by the student himself.
4. It helps in developing the spirit of enquiry and discovery among the students.
5. It develops self-confidence in the students as they tackle the problems confidently and intelligently.
6. It develops thinking and reasoning power among the students.

Demerits of Analytic Method

1. It is a lengthy, time consuming method and therefore not economical.
2. It is difficult to acquire efficiency and speed.
3. This method may not be suitable for all topics of mathematics.
4. Information is not presented in a well-organized manner.

(3) Synthetic method

'Synthetic' is derived from the word 'synthesis'. Synthesis is the complement of analysis. To synthesis is to combine the constituent elements to produce something new. In this method we start with something already known and connect it with the unknown part of

the statement. Therefore, in this method one proceeds from known to unknown. It is the process of combining known bits of information to reach the point where unknown information becomes obvious and true. In synthetic method the reasoning is as follows "Since A is true, B is true".

The following example illustrates the use of synthetic method.

Example

If prove that

In synthetic method, one has to begin with the known i.e. and reach the unknown i.e. .

Proof:

From (known) Adding on both sides we get (unknown).Thus beginning with the known, the unknown is reached. But why is added is not explained.

In synthetic method the reasoning is as follows

A is true.

B is true and

C is true.

Merits of synthetic Method

1. It is short and elegant
2. It facilitates speed and efficiency
3. It is more effective for slow learners.

Demerits of synthetic Method

1. It leaves many doubts in the minds of the learner and offers no explanation for them.
2. It does not provide full understanding.
3. It makes the student passive listeners and encourages rote memorization.

Difference between Analytic and Synthetic Method

S.No	**Analytic Method**	**Synthetic Method**
1	This method is logical	This method is psychological
2	It is short, concise and elegant	It is lengthy, laborious and time consuming
3	It is a method for the presentation of discovered facts	It is a method for discovery and demands thought. The analytics approach in exploratory procedure.
4	It is a method for the learner	It is a method for the discoverer /

		teacher how to attack an original exercise
5	Once forgotten it is not easy to recall	It can be rediscover
6	The teacher is not in touch with class	The teacher carries the class with them
7	This method is moves from unknown to known	This method moves from known to unknown

(4) Inductive method

Making of Mathematics is experimental and inductive. Induction is that form of reasoning in which a general law is derived from a study of particular objects or specific processes. The child can use measurement, manipulator or constructive activities, patterns etc. To discover a relationship which he shell himself, later, formulate in symbolic form as a law or rule. The law, the rule or definition formulated by the child is the summation of all the particular or individual instances. In all inductions, the generalization that is evolved is regarded as a tentative conclusion.

Example 1: Ask pupils to draw a number of triangles. Ask them to measure the three angles of each triangle and find their sum. They will find that the sum of the three angles of all triangles is 180.

Example 2: Ask pupils to find the sum of two odd numbers like 3+5=8, 5+7=12, 9+11=20, etc. They will find that the sum of two odd numbers is an even number.

Merits of Inductive method

1) This method is psychological. The student feels interested in experiments, experiences and discoveries.
2) This method fosters independence and self-confidence among the pupil which proves very useful in later life.
3) In this method, children discover the solution themselves. Hence it develops and encourages initiative and creative thinking.
4) All that is learnt using inductive method is remembered easily as it is self-acquired.
5) In this method, the pupils observe and analysis particular objects of similar and different nature and try to arrive at general truth.

6) Inductive method takes into consideration all the maximums of good teaching. The process of induction calls for perception, reasoning, judgment and generalization.

(5) Deductive method

1) Like the inductive method, the first step is the clear understanding of the problem.
2) It may involve the study of a particular thing and phenomenon.
3) Principles and generalizations are reviewed to find the one which may be applicable to find a solution.
4) In this step the rule, principle or generalization is applied to a problem and inference is formulated that the problem fallsunder such rule, principle or generalization.
5) Verification of the inference is done by applying it to a case. If it solves the problemthen it is accepted otherwise the procedure is repeated to find the correct one.

Merits of deductive method

1) Deductive method is short and time-saving. It takes little time to solve the problem by predetermined formulae.
2) In the deductive method, the teacher's work is very much simplified. Teacher gives a rule and asks the pupils to verify it by application to several concrete examples. For example, students are told that the area of rectangle = Length x Breadth. Then a few sums are solved before the students. The students apply these formulae to solve these problems and they memorize it for future use.
3) This method is very useful for small children because with small children we generally use story or telling method.
4) This method glorifies memory, as the students have to memorize a considerable number of formulae and definitions.
5) This method is adequate and advantageous during practice and revision stage.

Difference between Inductive Method and Deductive Method

S.No	Inductive Method	Deductive Method
1	Proceeds from particular to general, concrete to abstract.	Proceeds from the general to the particular, the abstract to the concrete.
2	It takes care of the needs and interests of children. It is a developmental process.	Facts are thrust upon the child. The principle of growth is not considered.
3	It encourages 'discovery' and stimulates Thinking	The authority decides or gives the formula and encourages memorization

4	The generalization or rule is formulated by the child therefore they remembers it with ease.	The rule is given to the child. He does not appreciate its nature and it is to forget it easily.
5	How and why of the process is made clear through reasoning.	The process is taken from granted and accepted without Reasoning
6	It starts from observation and direct Experience and ends in developing a Rule in abstract form.	Does not encourage learning by doing; it starts with a rule and provides for practice and applications.
7	It encourages child participation and group work	It demands individual learning and treats the child as a passive recipient.

(6) Demonstration Method

Defining demonstration of learning is complicated by the fact that educators use many different terms when referring to the general concept, and the terms may or may not be used synonymously from place to place. For example, the terms capstone exhibition, culminating exhibition, learning exhibition, exhibition of learning, performance exhibition, senior exhibition, or student exhibition may be used, in addition to capstone, capstone experience, capstone project, learning demonstration, performance demonstration, and many others. Educators may also create any number of homegrown terms for demonstrations of learning—far too many to catalog here.

Teachers not only use demonstrate specific learning concepts within the classroom, they can also participate in demonstration classrooms to help improve their own teaching strategies, which may or may not be demonstrative in nature. Although the literature is limited, studies show that the effects of demonstration classroom teachers includes a change of perspective in relating to students, more reflection in the teachers' own classroom strategies, and more personal responsibility for student learning.

Advantages of demonstration method

1. It helps in involving various sense to make learning permanent.
2. Through teacher behaviour is autocratic, he invites the cooperation of pupils in teaching learning process.
3. It develops interest in the learners and motivates them for their active participation
4. Any simple or complex sill becomes easy to understand.

Disadvantages of demonstration method

1. It can be used only for skill subject.

2. Only attention of the learners is invited towards the activity demonstrated. They are free to discuss about it.
3. Due to poor economic conditions of the government schools there is scarcity of audio Visual aids and equipment and the teacher are not so creative to produce handmade modes for demonstration.
4. There is a general lack of sincerity and diligence among teachers who which to
5. Complete the syllabus or syllabi at the earliest without putting sincere efforts.

(7) Team teaching

Team teaching involves a group of instructors working purposefully, regularly, and cooperatively to help a group of students of any age learn. Teachers together set goals for a course, design a syllabus, prepare individual lesson plans, teach students, and evaluate the results. They share insights, argue with one another, and perhaps even challenge students to decide which approach is better.

Teams can be single-discipline, inter disciplinary, or school-within-a-school teams that meet with a common set of students over an extended period of time. New teachers may be paired with veteran teachers. Innovations are encouraged, and modifications in class size, location, and time are permitted. Different personalities, voices, values, and approaches spark interest, keep attention, and prevent boredom.

The team-teaching approach allows for more interaction between teachers and students. Faculty evaluate students on their achievement of the learning goals; students evaluate faculty members on their teaching proficiency. Emphasis is on student and faculty growth, balancing initiative and shared responsibility, specialization and broadening horizons, the clear and interesting presentation of content and student development, democratic participation and common expectations, and cognitive, affective, and behavioural outcomes. This combination of analysis, synthesis, critical thinking, and practical applications can be done on all levels of education, from kindergarten through graduate school.

Working as a team, teachers model respect for differences, inter dependence, and conflict-resolution skills. Team members together set the course goals and content, select common materials such as texts and films, and develop tests and final examinations for all

students. They set the sequence of topics and supplemental materials. They also give their own interpretations of the materials and use their own teaching styles. The greater the agreement on common objectives and interests, the more likely that teaching will be interdependent and coordinated.

Teaching periods can be scheduled side by side or consecutively. For example, teachers of two similar classes may team up during the same or adjacent periods so that each teacher may focus on that phase of the course that he or she can best handle. Students can sometimes meet all together, sometimes in small groups supervised by individual teachers or teaching assistants, or they can work singly or together on projects in the library, laboratory, or fieldwork. Teachers can be at different sites, linked by video-conferencing, satellites, or the Internet.

Breaking out of the taken-for-granted single-subject, single-course, single-teacher pattern encourages other innovations and experiments. For example, students can be split along or across lines of sex, age, culture, or other interests, then recombined to stimulate reflection. Remedial programs and honours sections provide other attractive opportunities to make available appropriate and effective curricula for students with special needs or interests. They can address different study skills and learning techniques. Team teaching can also offset the danger of imposing ideas, values, and mindsets on minorities or less powerful ethnic groups. Teachers of different backgrounds can culturally enrich one another and students.

Advantages of Team Teaching

All the Students do not learn at the same rate. Periods of equal length are not appropriate for all learning situations. Educators are no longer dealing primarily with top-down transmission of the tried and true by the mature and experienced teacher to the young, immature, and inexperienced pupil in the single-subject classroom. Schools are moving toward the inclusion of another whole dimension of learning. The lateral transmission to every sentient member of society of what has just been discovered, invented, created, manufactured, or marketed. For this, team members with different areas of expertise are invaluable.

Of course, team teaching is not the only answer to all problems plaguing teachers, students, and administrators. It requires planning, skilled management, willingness to risk change and even failure, humility, open-mindedness, imagination, and creativity. But the

results are worth it.

Teamwork improves the quality of teaching as various experts approach the same topic from different angles: theory and practice, past and present, different genders or ethnic backgrounds. Teacher strengths are combined and weaknesses are remedied. Poor teachers can be observed, critiqued, and improved by the other team members in a nonthreatening, supportive context. The evaluation done by a team of teachers will be more insightful and balanced than the introspection and self-evaluation of an individual teacher.

Disadvantages of Team teaching

Team teaching is not always successful. Some teachers are rigid personality types or may be wedded to a single method. Some simply dislike the other teachers on the team. Some do not want to risk humiliation and discouragement at possible failures. Some fear they will be expected to do more work for the same salary. Others are unwilling to share the spotlight or their pet ideas or to lose total control.

Team teaching makes more demands on time and energy. Members must arrange mutually agreeable times for planning and evaluation. Discussions can be draining and group decisions take longer. Rethinking the courses to accommodate the team-teaching method is often inconvenient.

Opposition may also come from students, parents, and administrators who may resist change of any sort. Some students flourish in a highly structured environment that favours repetition. Some are confused by conflicting opinions. Too much variety may hinder habit formation.

Salaries may have to reflect the additional responsibilities undertaken by team members. Team leaders may need some form of bonus. Such costs could be met by enlarging some class sizes. Non-professional staff members could take over some responsibilities.

Learner Centered Methods

Learner-centered methods are those methods are those methods where the focus of attraction is learners than teachers. It is through the involvement of learners the method develops. The recent psychological approaches in the classrooms give more importance to learner centered methods than teach centered methods.

(i) Project Method

Project method owes its origin to the pragmatic school of philosophy. It was propounded by W H. Kilpatrick and was perfected by J. A.Stevenson. The method consists

of building a comprehensive unit around an activity which may be carried out in the school or outside. The essence of this method is to carry out a useful task in a group in which all the students work co-operatively. Learning by doing and learning by living are the two basic principles involved and children learn through association, co-operation and activity.

Definition

- "A project is a unit of whole-hearted purposeful activity carried on preferably in its natural setting". Kilpatrick
- "A project is a problematic and carried to completion in its natural setting" - Stevenson.
- "A project is a bit of real life that has been imparted in to the school" - Ballard.

Principles of the Project Method

1. The principle of freedom.
2. The principle of reality.
3. The principle of activity.
4. The principle of experience.
5. The principle of utility.
6. The principle of interest.
7. The principle of sociability

Major steps of the Project Method

1. Providing a situation
2. Choosing and purposing
3. Planning
4. Carrying out the project (executing)
5. Evaluating
6. Recording

Kinds of Project

1. Producer type: Here the emphasis is directed towards the actual construction of a material object or article.
2. Consumer type: Here the objective is to obtain either direct or vicarious experience such as reading and learning stories or listening to music etc.
3. Problems Type: Here the purpose is to solve a problem involving the intellectual process such as determining the e/m ratio of an election.
4. Drill type: Here the purpose is to attain efficiency in some activity. E.g. swimming,

driving etc.

Merits of Project method

1. The method is in accordance with psychological laws of learning
   i. Law of readiness - pupil are ready to learn creating interest, purpose and life like situation.
   ii. Law of exercise - by practice we learn things, self-activity on the part of students create experience in later life.
   iii. Law of effect - child should be satisfied and feel happy in what he is learning.
2. It promotes co-operation and group interaction.
3. It gives training in a democratic way of learning and living.
4. There is no place for rote memorization.
5. Provides dignity of labor and develop respect and taste for all types of work.

Demerits of Project Method

1. Project absorbs large amount of time and can be used as a part of science work only.
2. Many aspect of curriculum will not yield to project work.
3. Larger projects in the hands of an inexperienced and unskillful teacher lead to boredom.
4. Text book written on this lines are not available.
5. The method is highly expensive as pupil has to purchase lot of item, travel and do outdoor work.

(2) Peer Tutoring

- Peer tutoring is a flexible, peer-mediated strategy that involves students serving as academic tutors and tutees. Typically, a higher performing student is paired with a lower performing student to review critical academic or behavioral concepts.
- It is a widely-researched practice across ages, grade levels, and subject areas
- The intervention allows students to receive one-to-one assistance
- Students have increased opportunities to respond in smaller groups
- It promotes academic and social development for both the tutor and tutee
- Student engagement and time on task increases
- Peer tutoring increases self-confidence and self-efficacy
- The strategy is supported by a strong research base

Types of Peer Tutoring

Classwide Peer Tutoring (CWPT) –Class wide peer tutoring involves dividing the entire class into groups of two to five students with differing ability levels. Students then act as tutors, tutees, or both tutors and tutees. In CWPT, student pairings are fluid and may be based on achievement levels or student compatibility.

Cross-age Peer Tutoring (CPT) - Older students are paired with younger students to teach or review a skill. The positions of tutor and tutee do not change. The older student serves as the tutor and the younger student is the tutee. The older student and younger student can have similar or differing skill levels, with the relationship being one of a cooperative or expert interaction. Tutors serve to model appropriate behavior, ask questions, and encourage better study habits. This arrangement is also beneficial for students with disabilities as they may serve as tutors for younger students.

Peer Assisted Learning Strategies (PALS)- It involves a teacher pairing students who need additional instruction or help with a peer who can assist. Groups are flexible and change often across a variety of subject areas or skills. Cue cards, small pieces of cardstock upon which are printed a list of tutoring steps, may be provided to help students remember PALS steps. All students have the opportunity to function as a tutor or tutee at differing times. Students are typically paired with other students who are at the same skill level, without a large discrepancy between abilities.

Reciprocal Peer Tutoring (RPT): Two or more students alternate between acting as the tutor and tutee during each session, with equitable time in each role. Often, higher performing students are paired with lower performing students. RPT utilizes a structured format that encourages teaching material, monitoring answers, and evaluating and encouraging peers. Both group and individual rewards may be earned to motivate and maximize learning.

Same-age Peer Tutoring: Peers who are within one or two years of age are paired to review key concepts. Students may have similar ability levels or a more advanced student can be paired with a less advanced student. Students who have similar abilities should have an equal understanding of the content material and concepts. When pairing students with differing levels, the roles of tutor and tutee may be alternated, allowing the lower performing student to quiz the higher performing student. Answers should be provided to the student who is lower achieving when acting as a tutor in order to assist with any deficits in content knowledge.

(3) Individual activities

The social aspect of activities is just as important as the creative, leisure and learning aspects. Mentors make great efforts to help people join small friendly groups to share experience and skills and support each other in maintaining the group in the long-term. Some participants are housebound. In these circumstances, mentors encourage activities that people can pursue individually at home. Sometimes, arrangements may be made for an external artist or 'provider' to visit the person for a while. Wherever possible, the participant is introduced to others who might share their interests, by phone or letter or visiting. Some people prefer to pursue interests on their own.

(4) Experiential learning

The word experiential essentially means that learning and development are achieved through personally determined experience and involvement, rather than on received teaching or training, typically in group, by observation, listening, study of theory or hypothesis, or some other transfer of skills or knowledge. The expression 'hands-on' is commonly used to describe types of learning and teaching which are to a lesser or greater extent forms of experiential learning.

The expression 'chalk-and-talk' (the teacher writes on a board and speaks while learners listen and look and try to absorb facts) refers to a style of teaching or training which contains no experiential learning aspect whatsoever.

Experiential learning, especially used at the beginning of a person's new phase of learning, can help to provide a positive emotional platform which will respond positively and confidently to future learning, even for areas of learning which initially would have been considered uncomfortable or unnecessary.

Experiential learning also brings into play the concept of multiple intelligences - the fact that people should not be limited by the 'three Rs' and a method of teaching based primarily on reading and writing.

Experiential learning is a way to break out of the received conditioned training and teaching practices which so constrain people's development in schools and work.

(5) Problem Solving method

The method is defined as a planned attack upon a difficulty for the purpose of finding a solution. It is also defined as the process of raising a problem in the minds of the pupils in such a way as to stimulate purposeful reflective thinking for arriving at a rational solution. In

this method the person uses his ability to analyze a problem which confronts him in order to arrive a solution.

Steps in problem solving method

1. Sensing the problem
2. Interpreting, defining and delimiting the problem.
3. Collecting relevant data
4. Organizing and evaluating the data
5. Formulating tentative solution
6. Drawing conclusion and making generalization
7. Application of generalization to new situation

Small group/ whole class interactive learning

Small group teaching has become more popular as a means of encouraging student learning. While beneficial the tutor needs a different set of skills for those used in lecturing, and more pertinently, small group work is an often luxury many lecturers cannot afford. A further consideration with small group teaching is the subjective perspective of what constitutes a small group. A lecturer used to taking 400 students in a lecture would define 50 students as a small group, while a lecturer used to a group of 50 students would define 5-10 students as a small group. In a discussion, where participation is assessed some students may not speak up in a group that begins to be get bigger than 10 participants and in addition tutors would find it hard to assess participation by individual students in groups with numbers greater than this.

(1) Student Seminar

A seminar is a form of academic instruction, either at an academic institution or offered by a commercial or professional organization. It has the function of bringing together small groups for recurring meetings, focusing each time on some particular subject, in which everyone resent is requested to actively participate. This is often accomplished through an ongoing Socratic dialogue with a seminar leader or instructor, or through a more formal presentation of research. It is essentially a place where assigned readings are discussed, questions can be raised and debates can be conducted. Student seminars are the open presentations done by the students before their peers and teachers. The word seminar is derived from the Latin word seminarian, meaning “seed plot”.

Some Tips for Seminar Preparation

1. Choose a topic: Choose a topic which will sustain your interest and will allow you

to exhibit enthusiasm during your presentation.

2. Keep your Audience in Mind: The primary objective in giving a talk should be to communicate an interesting idea to students who attend the seminar. This means that the talk should be delivered in a way that students in attendance understand what you are saying, so be mindful of their background.
3. Tell a story/ anecdote: Begin with solid motivation for your problem and plenty of illuminating examples. Only after your audience understands what your topic is and why they should care about it should you spend time working carefully through the relevant science.
4. Keep timing in mind: Choose a topic that you can motivate and explicate comfortably in this window of time.

Scoring Indicators for Evaluation of seminar

1. Ability to Collect Data: Sufficient, Relevant, Accuracy of facts.
2. Ability to Prepare seminar Paper: Introduction, Content Organization, Conclusion.
3. Presentation: Communication, Competence, Fluency, Spontaneity.
4. Understanding the Subject: Involvement in the Discussion, Responding suitably.

(2) Group discussions

Active learning can be implemented by organizing the class into small groups of students who can work together, foster their own learning strategy and create an atmosphere in which information sharing can takes place. Instructional techniques involving group controlled learning experiences provide room for the learners self-development and active participation in the teaching learning process. A discussion is a teaching technique that involves exchange of ideas with active learning and participation by all concerned. Discussion is an active process of teacher-pupil involvement in the classroom environment. This allows a student present its own perspective about something freely. Four basic concepts are to be considered for initiating small group discussion

- Process - the interactions that takes place within the group
- Roles - each group member's specific responsibilities within the group
- Leadership - the capacity to guide and direct others in a group setting.
- Cohesion - group members support for one another

Different Types of Small Group Discussions

(3) Mixed ability grouping

It refers to grouping together students of different abilities. Usually this kind of

grouping occurs when the group consists of students with different ages with one or two years span. The term "mixed aged grouping" or "heterogeneous grouping" is used for this case but we prefer to use the more general term of "mixed ability grouping" since the basic criterion for grouping is ability and not necessarily age. In mixed ability groups there are some students that are more mature and experienced than other ones and thus they have more advanced ability to acquire knowledge. The main aim of setting up mixed ability groups is not to produce homogeneity of ability in a group as this is the case in ability grouping, but to increase interaction across students with different abilities.

In other words the purpose of mixed ability grouping is for children to benefit by their intellectual and social interaction with other students of their group that have different social behavior and ability to learn. The former reveals the main difference of mixed ability grouping with ability grouping. While grouping children with same ability the goal is to achieve homogeneity of the group and homogenize instruction for students of the group on basis different of grades or ages but based on ability.

(4) Maths through games and puzzles

Mathematical games are 'activities' which:

- involve a challenge, usually against one or more opponents; a
- are governed by a set of rules and have a clear underlying structure;
- normally have a distinct finishing point;
- have specific mathematical cognitive objectives.

Benefits of Using Games

The advantages of using games in a mathematical programme have been summarised in an article by Davies (1995) who researched the literature available at the time.

- Meaningful situations - for the application of mathematical skills are created by games
- Motivation - children freely choose to participate and enjoy playing
- Positive attitude - Games provide opportunities for building self-concept and developing positive attitudes towards mathematics, through reducing the fear of failure and error;
- Increased learning - in comparison to more formal activities, greater learning can occur through games due to the increased interaction between children, opportunities to test intuitive ideas and problem solving strategies
- Different levels - Games can allow children to operate at different levels of thinking

and to learn from each other. In a group of children playing a game, one child might be encountering a concept for the first time, another may be developing his/her understanding of the concept, a third consolidating previously learned concepts

- Assessment - children's thinking often becomes apparent through the actions and decisions they make during a game, so the teacher has the opportunity to carry out diagnosis and assessment of learning in a non-threatening situation
- Home and school - Games provide 'hands-on' interactive tasks for both school and home
- Independence - Children can work independently of the teacher. The rules of the game and the children's motivation usually keep them on task.

Recent trends in Teaching and Learning Mathematics

1. Constructivist learning
2. Problem based learning
3. Brain based learning
4. Collaborative learning
5. Flipped learning
6. Blended learning
7. e-learning trends
8. Video conferencing

(1)Constructivist learning

Constructivism is a learning theory that has its foundation in philosophy and anthropology as well as psychology. The constructivist approach to education attempts to shift education from a teacher-dominated focus to a student-centered one. The role of the teacher focuses on assisting students in developing new insights. Students are taught to assimilate experience, knowledge and insights with what they already know and from this they need to construct new meanings. Constructivist learning is based on students' active participation in problem solving and critical thinking regarding a learning activity which they find relevant and engaging. They are "constructing" their own knowledge by testing ideas and approaches base on their prior knowledge and experience, applying these to new situations and integrating the new knowledge gained with pre-existing intellectual constructs.

In the constructivist theory the emphasis is placed on the learner or the student rather than the teacher of the instructor. It is the learner who interacts with objects and events and thereby gains an understanding of the features held by such objects or events. The learner

constructs her own conceptualizations and solutions to problems. Learner autonomy and initiative is accepted and encouraged. Exploring or experiencing the physical surroundings, experiential education is a key method of constructivism. To the constructivists, the act of teaching is the process of helping learners creates knowledge. In constructivist thinking learning is also affected by the context, beliefs and attitude of the learner.

There are many different schools of thought within this theory, all of which fall within the same basic assumption about learning. The main two are: Cognitive constructivism (e.g., Theory of Piaget) and Social constructivism (e.g., Theory of L.S. Vygotsky).

Cognitive Constructivism

Cognitive constructivism is generally attributed to Jean Piaget, who articulated mechanisms by which knowledge is internalized by learners. The process of accumulating the knowledge are through accommodation and assimilation, individuals construct new knowledge from their experiences.

It is important to note that constructivism is not a particular pedagogy. In fact, constructivism is a theory describing how learning happens, regardless of whether learners are using their experiences to understand a lecture of following the instructions for building a model airplane. In both cases, the theory of constructivism suggests that learners constructknowledge out of their experiences. However, constructivism is often associated with pedagogic approaches that promote active learning, or learning by doing. Today constructivist teaching is based on recent research about the human brain.

The major views of constructivism can be summarized as follows:

- Emphasis learning and not teaching
- Encourage and accepts learner autonomy and initiative
- Sees learners as creatures of will and purpose
- Thanks of learning as a process
- Encourages learner inquiry
- Acknowledges the critical role of experience in learning
- Nurtures learners natural curiosity
- Takes the learner's mental model into account etc..

Social Constructivism

Social constructivism maintains that human development is socially situated and

knowledge is constructed through interaction with others. It is a sociological theory of knowledge that applies the general philosophical constructivism into the social assumptions of Social Constructivism. Social constructivism is based on specific assumptions about reality, knowledge, and learning. To understand and apply models of instruction that are rooted in the perspectives of social constructivists, it is important to know the premises that underlie them. The most important assumptions of the theory of social constructivism is

1. The assumption that human beings rationalize their experience by creating a model of the social world and the way that it functions
2. The belief in language as the most essential system through which humans construct reality

(2)Problem Based Learning (PBL)

Problem-based learning (PBL) is a student-centered pedagogy in which students learn about a subject through the experience of solving an open -ended problem. Students learn both thinking strategies and domain knowledge. Problem - based learning (PBL) is an approach that challenges students to learn through engagement in a real problem. It is a format that simultaneously develops both problem solving strategies and disciplinary knowledge bases and skills by placing students in the active role of problem-solvers confronted with an ill-structured situation that simulates the kind of problems they are likely to face as future managers in complex organizations. Problem-based learning makes a fundamental shift from a focus on teaching to a focus on learning. The process is aimed at using the power of authentic problem solving to engage students and enhance their learning and motivation. There are several unique aspects that define the PBL approach:

- Learning takes place within the contexts of authentic tasks, issues, and problems that are aligned with real world concerns.
- In a PBL course, students and the instructor become co-learners, co-planners, co-producers, and co-evaluators as they design, implement, and continually refine their curricula.
- The PBL approach is grounded in solid academic research on learning and on the best practices that promote it. This approach stimulates students to take responsibility for their own learning, since there are few lectures, no structured sequence of assigned readings, and so on.
- PBL is unique in that it fosters collaboration among students, stresses the development of problem solving skills within the context of professional practice,

promotes effective reasoning and self-directed learning, and is aimed at increasing motivation for life-long learning.

Problem-based learning begins with the introduction of an ill-structured problem on which all learning is centered. Most of the learning occurs in small groups rather than in lectures. Teacher's role is more like that of a facilitator and coach of student learning, acting at times as a resource person, rather than as knowledge-holder and disseminator. Similarly, your role, as a student, is more active, as you are engaged as a problem-solver, decision-maker, and meaning-maker, rather than being merely a passive listener and note-taker.

Characteristics of Problem-Based Learning (PBL)

Problem-Based Learning (PBL) is a pedagogical approach and curriculum design methodology often used in higher education and K-12 standard settings.

The following are some of the defining characteristics of PBL:

1. Learning is driven by challenging, open-ended problems with no one "right" answer
2. Problems/cases are context specific
3. Students work as self-directed, active investigators and problem-solvers in small collaborative groups (typically of about five students)
4. A key problem is identified and a solution is agreed upon and implemented
5. Teachers adopt the role as facilitators of learning, guiding the learning process and promoting an environment of inquiry

Learning outcomes of Problem Based Learning

A well designed Problem based learning task provides students with the opportunity to develop skills related to:

- Managing tasks and holding leadership roles
- Oral and written communication
- Self-awareness and evaluation of group processes
- Working independently
- Critical thinking and analysis

Basic Steps in designing a Problem Based Learning Task

There are some important aspects which we want to take care before going for a problem based learning task

1. Articulate the learning outcomes of the task. What do you want students to know or be able to do as a result of participating in the assignment?
2. Create the problem. Ideally, this will be a real-world situation that resembles

something students may encounter in their future class or lives. Cases are often the basis of PBL activities.

3. Establish ground rules at the beginning to prepare students to work effectively in groups.
4. Introduce students to group processes and do some warm up exercises to allow them to practice assessing both their own work and that of their peers.

(3)Brain Based Learning (BBL)

Brain - based learning refers to teaching methods, lesson designs, and school programs that are based on the latest scientific research about how the brain learns, including such factors as cognitive development-how students learn differently as they age, grow, and mature socially, emotionally, and cognitively. It is totally based on the structure and function of the brain. As long as the brain is not prohibited from fulfilling its normal processes, learning will occur. Brain-based learning is motivated by the general belief that learning can be accelerated and improved if educators base how and what they teach on the science of learning, rather than on past educational practices, established conventions, or assumptions about the learning process. For example, it was commonly believed that intelligence is a fixed characteristic that remains largely unchanged throughout a person's life. However, recent discoveries in cognitive science have revealed that the human brain physically changes when it learns, and that after practicing certain skills it becomes increasingly easier to continue learning and improving those skills.

Instructional techniques emerges from Brain Based Learning

The three instructional techniques associated with brain-based learning:

1. Orchestrated immersion: Creating learning environments that fully immerse students in an educational experience.
2. Relaxed alertness: Trying to eliminate fear in learners, while maintaining a highly challenging environment.
3. Active processing: Allowing the learner to consolidate and internalize information by actively processing it.

(4)Collaborative Learning

Effective communication and Collaboration are essential for becoming a successful learner. It is primarily through dialogue and examining different perspectives that students become knowledgeable, strategic and self-determined and empathetic. Moreover, involving students in real world tasks and linking new information to prior knowledge requires

effective communication and collaboration among teachers, students and others. Indeed it is through dialogue and interaction that curriculum objectives come alive. Collaborative learning affords students enormous advantages which is not available in traditional instruction.

"Collaborative learning" is an umbrella term for a variety of educational approaches involving joint intellectual effort by students, or students and teachers together. Usually, students are working in groups of two or more, mutually searching for understanding, solutions, or meanings, or creating a product. Collaborative learning activities vary widely, but most center on students' exploration or application of the course material, not simply the teacher's presentation or explication of it.

Collaborative learning represents a significant shift away from the typical teacher centered or lecture-centered milieu in college classrooms. In collaborative classrooms, the lecturing/ listening/note-taking process may not disappear entirely, but it lives alongside other processes that are based in students' discussion and active work with the course material. Teachers who use collaborative learning approaches tend to think of themselves less as expert transmitters of knowledge to students, and more as expert designers of intellectual experiences for students-as coaches or mid-wives of a more emergent learning process.

Essential features of Collaborative Learning

1. A group learning task is designed based on shared learning goals and outcomes
2. Students work in teams to master academic materials
3. Reward systems are group oriented than individual oriented
4. Co-operative behavior involves trust building activities, joint planning and understanding of team support.
5. Students involvement in learning activities are more
6. Encourages students to acquire an active-voice in shaping their ideas

Advantages of Collaborative Learning

1. Promotes social and intellectual involvement
2. Cultivation of teamwork, community building, and leadership skills
3. Enhanced student satisfaction and promoting positive attitudes
4. Open expression of ideas in groups
5. Patience in hearing others
6. Team building
7. Shared responsibility

(5) Flipped Learning

Flipped Learning is a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter.

Flipped Learning Short video lectures are viewed by students at home before the class session, while in-class time is devoted to exercises, projects, or discussions. The flipped classroom describes a reversal of traditional teaching where students gain first exposure to new material outside of class, usually via reading or lecture videos, and then class time is used to do the harder work of assimilating that knowledge through strategies such as problem solving discussion or debates.

Flipped Classroom and Implications for Teaching

The flipped classroom constitutes a role change for instructors, who give up their front-of-the-class position in favor of a more collaborative and cooperative contribution to the teaching process. There is a concomitant change in the role of students, many of whom are used to being cast as passive participants in the education process, where instruction is served to them. The flipped model puts more of the responsibility for learning on the shoulders of students while giving them greater impetus to experiment. Activities can be student-led, and communication among students can become the determining dynamic of a session devoted to learning through hands-on work.

(6) Blended learning

Blended learning is a planned combination of online learning and face-to-face instruction using variety of learning resources. It is a flexible learning strategy that integrates innovative and technological advances of online learning with interaction and participation of traditional face-to-face classroom learning.

Blended learning strategies vary according to the discipline, the year level, student characteristics and learning outcomes, and have a student-centered approach to the learning design. Blended learning can promote learner's access and flexibility, increase the level of active learning, and achieve better student experiences and outcomes. For teachers, blended learning can improve teaching and class management practices. A blend might include:

1. Face-to-face and online learning activities and formats
2. Traditional classes with different modalities, such as regular, weekend, evening, part time, semester

3. Use of technology interfaces like social media, wikis and various web sources
4. Group work, Simulation, debate, Online Assignments, Practicals etc.
5. Both usual classroom human factors and digital learning resources of the web
6. Psychological concerns are addressed in the face to face interaction and technological concerns are addressed in the online learning

Blended learning should be viewed as a pedagogical approach that combines the effectiveness and socialization opportunities of the classroom with the technologically enhanced active learning possibilities of the online environment, rather than a ratio of delivery modalities.

Teachers in the Blended learning modality can

- Foster a class culture of hard work and persistence
- Monitor students throughout the period for motivation and learning
- Intervene to personalize instruction when data shows that students are struggling
- Build personal relationships of trust and caring

(7) e-learning

e-learning is the use of electronic media and information and communication technologies (ICT) in education. E-learning is broadly inclusive of all
forms of educational technology in learning and teaching. Technology-Enhanced Learning (TEL), Computer-Based Instruction(CBI). Computer-Based Training (CBT), Computer-Assisted Instruction or Computer - Aided Instruction (CAI),Internet-Based Training (IBT), Web-Based Training (WBT), Online education, Virtual education, Virtual Learning Environments (VIE). e-learning can occur in or out of the classroom.

Synchronous and asynchronous

e -learning may either be synchronous or asynchronous. Synchronous learning occurs in real-time, with all participants interacting at the same time, while asynchronous learning is self-paced and allows participants to engage in the exchange of ideas or information without the dependency of other participants involvement at the same time.

Synchronous learning involves the exchange of ideas and information with one or more participants during the same period of time. A face-to-face discussion is an example of synchronous communications. In e-learning environments, examples of synchronous communications include online real-time live teacher instruction and feedback, Skype conversations, or chat rooms or virtual classrooms where everyone is online and working

collaboratively at the same time.

Asynchronous learning may use technologies such as email, blogs, wikis, and discussion boards, as well as web-supported textbooks, hypertext documents, audio video courses, and social networking. Asynchronous learning is particularly beneficial for students who have health problems or have child care responsibilities and regularly leaving the home to attend lectures is difficult.

e-Learning trends

1. Automation
2. Augmented Learning
3. Big Data
4. Going for Cloud Computing
5. Gamification
6. M - Learning
7. Personalization

(8) Video conferencing

Video conferencing is two-way interactive communication delivered using telephone or Internet technologies that allows people at different location to come together for a meeting. The video conference can be as simple as a conversation between two people in private offices involve several sites with more than one person in large rooms at different sites. A basic video conference setup has a camera and a microphone. Video from the camera and audio from the microphone is converted into a digital format and transmitted to a receiving location using a coding and decoding device, often referred to as a "codec". At that receiving location is another codec device that decodes the receiving digital stream into a form that can be seen and heard on monitors or televisions. At the same time, video and audio from cameras and microphones at the received location is sent back to the original location.

Benefits of Video Conferencing

Video conferencing saves travel time and money. Participants can see and hear all other participants and communicate both verbally and visually, creating a face- to- face

experience. PowerPoint and other on screen graphic, as well as other cameras are also available presentation options. People downtime is reduced and productivity gains are achieved by removing the logistics of flight preparations, airport delays, hotel stays, and all the other inconveniences of business travel. In distance education, video conferencing provides quality access to students who could not travel to or could afford to relocate to a traditional campus. Video conferences can also be recorded and made available in a variety of ways. Besides distance education, other applications include meetings, dissertation and thesis defenses, tele-medical procedures, and online conferences.

People use video conferencing when:

- a live conversation is needed.
- visual information is an important component of the conversation.
- parties of the conversation can't physically come to the, same location.
- expense or time of travel is a consideration.
- examples of how video conferencing can benefit people around campus.
- guest lecturer invited into a class from another institution.
- researcher collaborates with colleagues at other institutions on a regular basis.
- thesis defense at another institution.
- administrators from different parts of campus need to collaborate on administrator issues such as a campus strategic plan.
- researcher needs to meet with a review committee about a grant.
- student interviews with an employer in another city.

Conclusion

Every learner learns on his/her own unique way and strategy. The learning is taking place with an individual speed, depending on student's attitude and level of prerequisite knowledge. In designing the teaching process, teacher should take into consideration differences among the students in the target group. Enough of space must be provided for processing and memorizing the presented information. Combination of different teaching methods can produce quality in fulfilling all teaching functions.

Questions for Discussion and Reflection

1. Explain the teacher centered methods of teaching Mathematics.
2. Critically analyse the recent trends in teaching Mathematics.
3. Explain briefly the learner centered methods of teaching Mathematics.
4. Discuss the interactive methods of teaching mathematics.

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Unit - V Resources for Teaching Mathematics

Objectives:

After the completion of the unit, the learners will be able to:

1. explain the various types of resources for teaching Mathematics.
2. adopt the community resources in the instructional process.
3. utilize the information and communication technology resources in teaching
4. identify the needs of resources in teaching Mathematics.

Introduction

Teachers use a wide range of stimulating and exciting materials to teach the concepts outlined in the curriculum to ensure that students are actively involved in their learning. In time, students and parents witness a shift from textbook based to standards based instruction, bringing educational practices in line with the best school systems around the world. The power of the learning environment to influence and promote learning is significant and the learning spaces and learning resources provide important opportunities for students to explore ideas and knowledge, collaborate, solve problems and develop knowledge and skills. Carefully selected digital technology resources are used to enable children to access global connections and resources while also encouraging new ways of thinking. The introduction of technology rich environments and multi-sensory resources can also be useful in reaching each student strengths and engaging students to become life-long learners.

Print Resources

Print resource refers to paper publications circulated in the form of physical editions of books, magazines, journals and newsletters**.** Print resource improves the students reading skills and vocabulary development. It is an good source of additional information for teachers. It helps the teacher for both lecture and Linguistic.Lecture approach - source of information for the teacher's lessons .Linguistic Approach - help to develop ones vocabulary and reading skills.

(i) News papers

Teachers are always looking for new ways to create student interest in current events. One of the best ways to do so is to utilize newspapers in the classroom. In the past teachers would deem newspaper reading as boring, and leave it to a once a month lesson. Using newspapers in the classroom is an effective classroom teaching tools for several reasons:

1. It makes learning fun.
2. It's an inexpensive way to educate.
3. It's adaptable for all grades and curriculum.
4. Provides good reading habits.
5. Has a section of interest for everyone like comics and sports.
6. Reinforce math conceptsby challenging students to find and circle as many numbers as they can in the newspaper in two minutes. Then challenge them to find and circle as many math words as they can.
7. Make the students to solve the Sudokku and Puzzles.

Tips for Using the Newspaper in Class

1. Allow students time to read the paper.
2. Focus on one section at a time.
3. Introduce new vocabulary words first.
4. Explain the functions of a newspaper and how it works before you start a lesson.
5. Use the sports section to reinforce math concepts.

(ii)Journals

An academic or scholarly journal is a periodical publication in which scholarship relating to a particular academic discipline is published. Academic journals serve as permanent and transparent forums for the presentation, scrutiny and discussion of research. They are usually peer-reviewed or refereed. It is a daily record of news and events of a personal nature. Newspaper or magazine that deals with a particular subject or professional activity. Some of the Mathematics journals are:

a) Teaching Children Mathematics (TCM)

It is an official journal of the National Council of Teachers of Mathematics and is intended as a resource for elementary school students, teachers, and teacher educators. The focus of the journal is on intuitive, exploratory investigations that use informal reasoning to help students develop a strong conceptual basis that leads to greater mathematical abstraction.

b) Mathematics Teaching in the Middle School (MTMS)

Itis an official peer-reviewed journal of the National Council of Teachers of Mathematics and is intended as a resource for middle school students, teachers, and teacher educators. The focus of the journal is on intuitive, exploratory investigations that use informal reasoning to help students develop a strong conceptual basis that leads to greater mathematical abstraction.

(iii) Encyclopedia

An encyclopedia is a type of reference work holding a comprehensive summary of information from either all branches of knowledge or a particular branch of knowledge.Encyclopedias are divided into articles or entries, which are usually accessed alphabetically by article name.Encyclopedia entries are longer and more detailed than those in most dictionaries Generally speaking, unlike dictionary entries, which focus on linguistic information about words encyclopedia articles focus on factual information concerning the subject.Some of the Mathematics encyclopedia are the Encyclopedia of Mathematics (also EOM and formerly Encyclopedia of Mathematics) is a large reference work in mathematics and Britannica encyclopedia for the history of Mathematics

Audio Visual Resources

Audio visual aids are important tools for teaching learning process. It helps the teacher to present the lesson effectively and students learn and retain the concepts better and for longer duration. Use of audio visual aids improves students' critical and analytical thinking. It helps to remove abstract concepts through visual presentation. However, improper and unplanned use of these aids can have negative effect on the learning outcome. It develops the students listening skills as well as make learning more effective. In this approach students think deeply with these learning materials.

Audio resources:

(i) Radio talk

It is a radio format containing discussion about topical issues. Most shows are regularly hosted by a single individual, and often feature interviews with a number of

different guests. Talk radio typically includes an element of listener participation, usually by broadcasting live conversations between the host and listeners who "call in" (usually via telephone) to the show. Listener contributions are usually screened by a show's producer(s) in order to maximize audience interest and, in the case of commercial talk radio, attract advertisers. Generally, the shows are organized into segments, each separated by a pause for advertisements; however, in public or non-commercial radio, music is sometimes played in place of commercials to separate the program segments. Variations of talk radio include conservative talk, hot talk, liberal talk (increasingly known as Progressive talk) and sports talk.

(ii) Audio tapes

Audio tapes support students learning in the following ways. It

1. provides diverse teaching techniques for learning
2. gives the teacher a voice– this can reduce the feeling of isolation for cloud based students, but also helps located students feel connected
3. can be used to simplify and explain complex problems
4. can allow students to access the learning materials as often as required
5. allows students to learn at their own pace, with instant playback, rewind and pause
6. reduces frequently asked questions from students
7. can be re-used

(iii) DVDs and CDs

The introduction of educational CDs and DVDs for school children has made studies very interesting for students as well as parents. These tools provide children with real life examples helping them to easily understand what is being conveyed to them. These CDs and DVDs help the children in their overall development by familiarizing them with technology and their uses.

Today there is a wide range of educational CDs and DVDs for school children of all ages, available in various stores as well as online. They help in transforming our passive system of learning into an interactive one with the help of high quality graphics and videos along with text that help children retain things in their memory for a long time.

The benefits of learning through educational CDs and DVDs are:

1. They provide a good overall experience for children.
2. Preschooler can easily learn reading skill with the help of these digital tool.

3. School giving children can easily understand the concepts through various graphical representation and illustrations.
4. Practice session using the tools can enhance their knowledge considerably on various topics.

Visual Resources:

(i) Pictures

Pictures make concepts memorable and employable. When someone views the image, they rapidly associate it with the principle. This enables imagery to play a primary role in creating culture in an organization because every culture speaks a language. A set of images can quite literally represent an entire value system. There is significant impact on the learner when a visual aid is connected to a verbal explanation. It actually speeds up the learning process.

(ii) Charts

The primary advantage of using a chart in a presentation is that they help the audience to visualize the point of the presentation. It emphasize the main point, make the data more convincing, provide a compact way of presenting information and help audiences stay engaged. Disadvantages of using chart includes being time consuming to construct and costly to produce. They also require technology that some may lack.

(iii)Posters

Poster is the process of showing the content and the findings of a topic to an audience or a group of audiences at different times. It is often used to assess student learning in group research projects. Peer and tutor assessment can be used as part of the grading process.Poster assessment encourages creativity.Poster assessment is short and succinct. This would require the students to think distinctively and select the important factors that need to be shown. The ability to summarize is important.Poster assessment can be assessed by peers at different times even without the presence of the creator.

(iv)Photographs

A Photograph is worth a thousand words through which a complex idea can be conveyed with just a single still image. Pictures make it possible to absorb large amounts of data quickly. Using photographs for explaining complex phenomena is one of the teaching aids of modern education system all over the world. As the world is changing day by day so are the methods of instructions as the modern curriculum requires conceptual elaborations.

Visual aids have the tendency to materialize the thoughts of students in the form of graphics to give thoughts a concrete frame of reference. Use of photographs is important for students because they are more likely to believe findings when the findings are paired with colored images describing complex situations during learning as opposed to other representational data such as complex book text.

(v) Flash cards

There are many ways to help children learn math facts. Flash cards can be effective if it is used at right time. It is important to help children build a conceptual understanding of math facts so that one can transfer knowledge across contexts. After conceptually understanding math facts, flash cards can helps to improve math fact fluency by isolating individual concepts, encouraging to focus attention and effort on specific components of complex mathematics problems.

A flashcard or flash card is a set of cards bearing information, as words or numbers, on either or both sides, used in classroom drills or in private study. One writes a question on a card and an answer overleaf. Flashcards can bear vocabulary, historical dates, formulas or any subject matter that can be learned via a question-and-answer format. Flashcards are widely used as a learning drill to aid memorization by way of spaced repetition.

ICT Resources

(i)Radio

Radio has been used in different formats for educational purposes the world round. Radio technology was first developed during the late nineteenth century and came into popularity as an educational medium during the early twentieth century. Although often overshadowed as educational medium vis-à-vis other technologies such as television, radio remains a viable medium that has proven educational worth in terms of both pedagogical importance and geographical reach. Radio is capable of delivering high quality educational programming to highly diversified audiences located across broad geographical expanses – all at a low per unit production cost. Three main advantages of radio: (1) improved educational quality and relevance; (2) lowered per student educational costs; and (3) improved access to education, particularly for disadvantaged groups.

(ii) TV

When teachers use educational television programs during class, the relationship between them and their students changes. Usually the status quo of the classroom is the teacher imparts knowledge while students absorb the information. Educational programs

change the status quo by, in a way, making the educator and children peers who can share and discuss the viewing experience. Teachers can take advantage of this shift in roles by encouraging small group discussions after watching the show. Educators can set specific goals or activities for students in these small groups, which allows them to explore their own questions and share their ideas on the given topic with their classmates. The instructor can then ask one member of the small group to share their team's insights with the rest of the class, strengthening the absorption of knowledge.

(iii)Internet

The internet has a lot to offer the teacher. There are authentic resources and materials, places where you can find prepared lesson plans, ideas and worksheets. The advantages of the internet to teachers include

- The incredible expanse of the internet means the teacher has the ability to tailor lessons very specifically to students' needs and interests. Learners tend to respond better when they feel involved and engaged in the subject and the extent of the web means that if you can find out what the students are interested in, you can find it on the web.

- Much material is modern and up to date, which helps motivate students. Good web sites continually update their material.

- Students enjoy using the net in their free time, and will appreciate its use in class
- It's a dynamic medium involving movement from site to site, promoting decision-making and learner independence.

The internet contains a lot of resources that teachers can access and use to prepare teaching materials. These range from sites specifically designed for teachers and learners to sites from national and international newspapers, museums, galleries and so on. Teachers can use these materials much the same way as they would other print-based resources, to create worksheets. But if teachers are fortunate enough to have access to a computer room in their

school then it is possible to use the internet with students during a class, exploiting the net as a dynamic medium.

Using the internet brings the 'real world' into the classroom and gives the students an opportunity to explore learning in a different way. However, having students facing a computer rather than the teacher, means teachers of internet lessons do need to be vigilant.

(iv) Multimedia

One of the techniques to improving the students' meets the academic needs and helps them developing mathematical skills is providing multimedia during the process of teaching and learning in the classroom. *It* means the use of electronic media to store and experience *multimedia* content. *Multimedia* means that computer info can be represented through audio, graphics, image, video and animation in addition to traditional media. Multimedia classroom provide the students chances for interacting with diverse texts. The writing aims to find out some advantages of the use of multimedia in the classroom. Through the media the teacher could give more opportunity to students to express their opinions and enjoy during the course. The highly presence and motivation also bring positive aspects to students so that they can improve their skills.

(v)Interactive white board

We connect the white board to a computer and share documents, websites and even play games. With a large touch screen, students will be excited to come up to the white board to help complete notes, do examples or take part in one of the many interactive games and demonstrations that can be used.

Community Resources

Community experiences can enrich social studies in instructions in ways more than one. To achieve the purposes of social studies, the child must, become a real part of the community in which he lives, interact with it and contribute to it. To become an effective citizen, the child must become a responsible member of community with civic attitudes and ideals compatible with the spirit of democracy. There is no more effective way of becoming this kind of person than through practicing what such a person will do.

A variety of community experiences offer the child the laboratory in which he may experiment with life in the community and begin to find his place in it. It is good to note that

it is impossible to separate the school from the community. They are glued together the aspirations of the community are the manifestations of the school system. The idea of making the community the best of the school and the school the best of the community represents a fruitful and essential extension of accepted educational thinking and practice. In order to nourish and invigorate democracy, community study and service through school education must be made essential. This movement is the most significant single development of its kind in our generation, and it seem destined to grow greatly with continuing sound experimentation at all school levels, in all teaching field, with all types of students, and in all community areas – local, regional, national and international.The most important community resources for teaching Mathematics are Field trips, Mathematics Exhibition, Mathematics Lab, Mathematics Resource Centre and Mathematics Club.

(i) Field Trips

Field trips is undertaken for securing information, changing attitudes, awakening interest, developing appreciation, promoting ideals, enjoying new experiences. They can initiate a unit of study, they can be a part of the core of it or they can give it the finishing touch. They are a very good means of getting knowledge first hand of confirming and supplementing second hand knowledge. They are a means for sharpening observation, testing principles and doing everything.

Field trips are useful for educational purposes in many ways:

1. They stimulate imagination and learning by providing sensory perceptions
2. They integrate classroom instruction by exposing the artificially of traditional subject matter divisions and enable the pupils to view facts and forces as they exist in their everyday relationship in living communities.
3. Through the filled trips, the students may come to realize community in ways which bookish learning cannot by its very nature allow.
4. They enable the pupils to learn the art of living with others such as travelling in the same conveyances, sharing rooms, sitting at the same table.
5. They expand emotional and intellectual horizons by making them acquainted with people whose manner, customs, living standards, outlook and interests may be quite different from their own.

(ii) Math lab

A mathematics laboratory is a place where we find a collection of games, puzzles, teaching aids and other materials for carrying out activities. These are meant to be used both by the students by their own and together with their teacher to explore the world of mathematics, to discover, to learn and to develop an interest in mathematics. Although mathematics is not an experimental science in the way in which physics, chemistry and biology are, a mathematics laboratory can contribute greatly to the learning of mathematical concepts and skills.

The objectives of a mathematics laboratory

1. Remove the weaknesses of present day mathematics education which the mathematics laboratory and the mathematics laboratory alone can do it.
2. To develop the much needed confidence in students.
3. To generate interest in the subject.
4. To make the students divergent thinkers.

Here are some ways we think a mathematics laboratory could contribute to learning mathematics: A mathematics laboratory provides an opportunity for the students to discover through doing. In many of the activities, students learn to deal with problems while doing concrete activity, which lays down a base for more abstract thinking. It gives more scope for individual participation. It encourages students to become autonomous learners and allows a student to learn at his or her own space. It widens the experiential base, and prepares the ground for later learning of new areas in mathematics and of making appropriate connections.

It is a place where:

1. Students do experiments with numbers and geometrical shapes and try to generalize these patterns.
2. Students do most of their calculations with the help of scientific calculators.
3. Students draw graphs of large number of functions with the help of scientific or graphic calculators and try to become familiar with graphs of all the functions they usually deal with.
4. Students solve real life problems with real data because complex calculations are no longer a major consideration.

5. Students express their answers to mathematics problems in decimal numbers and not in symbols and have a good idea about their magnitudes.
6. Students get practice in estimating orders of magnitudes and obtaining approximate answers when exact answers are difficult to find.
7. Students make charts and models to illustrate mathematical ideas.
8. Students do almost all the work themselves, of course under the guidance of teachers, but the students are active all the time and are involved with what they are doing.
9. The creativity of students is allowed free play.
10. Students solve graphically equations involving all types of functions.
11. Students are free to discuss among themselves and with the teachers; in fact students and teachers form joint investigating teams.
12. Students find areas and volumes of both regular and irregular solids.
13. Students undertake projects both in mathematics and its applications.
14. The concepts and theorems are not given to the students; these arise naturally from their investigations.

(iii) Maths exhibition

It is important for the faculties to **support the kids** in presenting something that they have learned in the most beautiful manner. There are certain benefits of organizing such exhibitions in schools. Students get a platform to show what they have learned and what they are good at, as well.

There are many students who always try to implement the things that they learn and they find these **platforms of exhibitions** a great way to showcase what and all that they have tried. It is always good to give the students a chance for implementing the things that they have learned and also to a*pply their ideas and present things differently* in their own unique way.

It makes the students really creative and they have practical knowledge to learn what they read. It increases their thirst for knowledge and drives away their boredom and monotony. It has become a tradition in our educational field that students need not see, learn and practice the things they deal with practically. Arranging regular mathematics fair can contribute a great deal to sensitize their desire and interest for science and mathematics.

Students of this age want to create something. It is quite natural. When they get chance for creation, definitely it exercises a profound impact on their overall learning. It also helps develop the social skills of learns as it increase interaction and relations with local community which is a big part of learning.

(iv)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.

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 and joint responsibility

Organisation of Mathematics Club

Mathematics Club will be a great help in 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. This draft be prepared by the Mathematics teacher in consultation with the head of the institution. This draft constitution should provide all important details about the name of the club, aims and objectives of the club, details regarding membership and the fee etc. For efficient and successful working of Mathematics club an expert body has suggested the organization i.e 1) Patron 2) In-charge 3) Staff Advisor 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.

(v) Mathematics textbook

The mathematics textbook is an important source for learning mathematics and it plays a key role in effective teaching and learning. A textbook should stimulate reflective thinking and develop problem-solving ability among students. The textbooks should present real learning situations, which are challenging and interesting for the students and should not render itself as a means of rote learning.

Text books and teachers' guides occupy a unique place in the teaching learning process. Text book are an indispensable part of primary and secondary education. The text book is a teaching instrument. It is not only a source of information, but a course of study, a set of unit plans and learning guide. It helps to revise and reinforce the language material already taught. In the absence of any other instructional material, the text book becomes a potent tool in the hand of a teacher to teach the skill of a language and the more so of a foreign language.

Qualities of a Mathematics Textbook

The qualities of a good textbook in mathematics can be broadly classified under Physical features, Author, Content, Organization and presentations, Language, Exercise and illustration.

(i) Physical features:

1. Paper: the paper used in the textbook should be of superior quality

2. Binding: it should have quality strong and durable binding
3. Printing: it should have quality printing, bold font and easily readable font.
4. Size: bulky and thick. It should be handy
5. Cover: it should have an appealing and attractive cover page.

(ii) Author

1. Qualified author should write it
2. Experienced teacher should write it
3. Competent teachers should write it
4. It should be written by committee of experts constituted by the state government
5. For the authors, certain minimum academic and professional qualifications may be prescribed.

(iii)Content

1. It should be child centered
2. The subject matter should be arranged from simple to complex and concrete to abstracts.
3. The subject matter should create interest in the pupil.
4. It should be objective oriented
5. It should be written according to prescribed syllabus
6. It should satisfy the demands of examination
7. The answers given at the end of each section should be correct
8. It should include the recent developments in the mathematics relating to the content dealt with.
9. Oral mathematics should fine its due place in the textbook.

(iv) Organization and presentation

1. It should provide for individual differences.
2. There should be sufficient provision for revision, practice and review.
3. It should stimulate the initiative and originality of the students
4. It should offer suggestion to improve study habits.
5. It should facilitate the use of analytic, synthetic, inductive, deductive, problem solving and heuristic approaches to teaching.

6. Content should be organize in a psychological consideration.
7. Content should be organize in a logical way.
8. It should suggesting project work, fieldwork and laboratory work.

(v)Language

1. The language used in the textbook should be simple and easily understandable and within the grasp of the pupils
2. The style and vocabulary used should be suitable to the age group of student for whom the book is written.
3. The term and symbols used must be those, which are popular and internationally accepted
4. It should be written in lucid, simple, precise and scientific language.

(vi)Exercise and Illustrations:

1. The illustrations should be accurate
2. The illustrations should be clear and appropriate
3. It should contain some difficult problems
4. It should contain exercises to challenge the mathematically gifted students.
5. There should be well-graded exercises given at the end of every topic.
6. The exercise should develop thinking and reasoning power of the pupils.

Qualities of Mathematics Teacher

A Mathematics teacher should

1. motivate and engage the students.
2. convey the beauty of the subject.
3. encourage their students to go beyond the classroom with their learning.
4. help them feel confident in their mathematical abilities.
5. have sound subject knowledge.
6. make the subject easier by adopting suitable strategy.
7. provide guidance and support to the students while solving the problem.
8. provide alternate strategies to help struggling students grasp difficult concepts.
9. have good attitude and actions.

Conclusion

Imagination and creativity in using community resources can help students connect school science and mathematics with applications in the community, as well as helping students better learn basic concepts. Children learn science and mathematics from many sources, in a range of different ways, and for a variety of purposes. Taking students out onto the school grounds, exposing them to innovative materials, or inviting guests who can give unique insights are a few ways to increase their learning experiences. Teachers should be well trained through in-service training to maximize the benefits of using these aids. The curriculum should be designed such that there are options to activity based learning through audio-visual aids. In addition, government should fund resources to purchase audio-visual aids in schools.

Questions for Discussion and Reflection

1. Discuss the effect of ICT resources for teaching Mathematics.
2. What are print resources? Explain the need of print resources for teaching Mathematics.
3. Analyse the various types of resources in teaching Mathematics.
4. Bring out the need for community resources in the Mathematical instructional process.
5. Explain the different types of audio and video resources with examples.

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