M.A. 4th Semester

Course : EDUCE 205

Course Type / Nature: Discipline Elective

PEDAGOGY OF MATHEMATICS

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Pedagogy of Mathematics (Discipline Elective)
Course Code: EDUCE 205
Contents

	with reference to Mathematics.	

Course Code: EDUCE 205

Discipline Elective EDUCE 205

Course Title: PEDAGOGY OF MATHEMATICS

6 Credits Marks 100 (70+30)

Course Objectives

To enable the learners to;

- Understand the nature and characteristics of Mathematics.
- Understand the relationship of Mathematics with other subjects of school curriculum.
- Understand aims and objectives of teaching Mathematics at school stage.
- State objectives in behavioural terms with reference to concepts and generalizations.
- Apply various methods of teaching of mathematics.
- Understand the importance of curriculum and different principles of curriculum construction
- Explain the importance and uses of learning resources in Mathematics.
- Appreciate the importance of mathematics laboratory in learning Mathematics.
- Understand the role of text book, exhibitions and fairs in Mathematics.
- Differentiate between methods and techniques of teaching Mathematics.
- Prepare unit and lesson plans for teaching of Mathematics.

INSTRUCTIONS FOR THE PAPER SETTER AND CANDIDATES

The question paper for ESE will carry a total of 70 marks and consist of five sections: A, B, C, D & E. Section A will consist of 6 objective type questions (MCQ, True/False, Completion type) carrying one mark each and 4 short answer type questions carrying 2 marks each which will cover the entire syllabus uniformly. Sections B, C, D & E will have two long answer type questions from the respective Units 1, 2, 3 & 4 of the syllabus & carry 14 marks each. The long answer type questions may contain subparts carrying different marks. The marks for each sub- part and required word limit will be shown against it. Section A of the question paper will be compulsory and the candidates are required to attempt one question (and/or its sub-parts) each from the sections B, C, D and E of the question paper. Answers to short questions should be completed in around 80 to 100 words each. Answers to long answer type question should be completed in around 800 words.

Unit 1: Foundations of Mathematics Education

- Mathematics: Meaning, Nature and Importance of Mathematics in Life.
- Place of Mathematics in School Curriculum and Relationship of Mathematics with other School Subjects.
- Aims and Objectives of Teaching Mathematics

- Formulation and Classification of Objectives in Behavioural terms with reference to Cognitive, Psychomotor and Affective Domains.

Unit 2: Curriculum and Learning Resources in Mathematics

- Mathematics Curriculum: Concept, Principles of Curriculum Construction in Mathematics, Selection and Organization of Content, Factors affecting Change in Mathematics Curriculum.
- Mathematics Learning Resources: Need and Importance of Mathematics Laboratory, Organization of Mathematics Club and Mathematics Exhibitions.
- Importance of Various Teaching Aids in Mathematics and Uses of Smart Classroom in of Mathematics,
- Qualities of a Good Textbook in Mathematics.

Unit 3: Teaching Methods/Approaches and Techniques

- Methods/Approaches and Techniques of Teaching Mathematics (Algebra, Arithmetic and Geometry Separately): Meaning. Types of Methods/Approaches: Inductive-Deductive, Analytic-Synthetic, Project and Problem Solving Method.
- Techniques and Strategies of Teaching Mathematics: Drill and Practice, Assignments, Homework, Supervised Study, Play Way Technique and Activity-Based Technique.

Unit 4: Planning for Teaching and Evaluation in Mathematics

- Unit and Lesson Planning in Mathematics: Meaning, Need, Importanceand Principles.
- Steps in Unit and Lesson
- Planning in Mathematics
- Evaluation in Mathematics: Meaning and Types; Formative, Summative and Diagnostic Evaluation; Major Issues and Concerns in Teaching and Learning of Mathematics in Current Scenario; Methods of Providing Remedial Instruction.
- Continuous and Comprehensive Evaluation: Concept and Techniques with reference to Mathematics.

Sessional Work/Activities **Marks = 5 (under CCA Component)**

A candidate is required to undertake any one of the following activities and submit a detailed report to the concerned teacher/ PCP Coordinator. The activity will carry 5 marks:

1. Prepare any one self-made working (3-dimensional) teaching model from locally available resources for teaching of mathematics at senior secondary stage.
2. Power point presentation on any one topic of mathematics of standard VI to X.
3. Preparation of Enrichment program for gifted children in mathematics.
4. Any other activity/activities that the concerned course teacher may thinkappropriate can be allotted during PCP to the Candidates.

Unit - 1 Meaning, Nature and Importance of Mathematics

Structure

1.1 Introduction

Dear Learner, Mathematics plays a crucial role in our daily lives and its importance cannot be overstated. It is a fundamental discipline that impacts various aspects of our everyday existence. Here are some key reasons why mathematics is important in our daily life. Mathematics is essential for performing everyday tasks such as counting money, measuring ingredients for cooking, telling time, and making basic calculations. Without arithmetic skills, it would be challenging to handle simple financial transactions. Mathematics equips us with problem-solving skills that are applicable in various situations. Whether you're trying to figure out the most cost-effective way to purchase groceries, solve a household issue, or make decisions at work, problem-solving abilities rooted in mathematics are invaluable. In the age of information, data analysis is increasingly important. Mathematics is vital for interpreting data, making sense of statistics, and drawing conclusions. This skill is valuable for understanding news, research findings, and even personal health data. Mathematics is the language of science and technology. It is essential for fields like engineering, physics, computer science, and medicine. Without mathematics, advancements in these fields would not be possible. Mathematical skills are often a prerequisite for many careers and educational opportunities. Whether you're pursuing a career in science, technology, engineering, mathematics (STEM), or even in fields like economics and business, a mathematical foundation is essential. Mathematics fosters critical thinking and analytical reasoning. It encourages precision and logical thought processes, which can be applied to various aspects of life, from making informed decisions to evaluating arguments and making sense of complex issues. Even in fields traditionally associated with creativity,

such as art and design, mathematics plays a role. Concepts like symmetry, geometry, and proportions are fundamental to creating aesthetically pleasing and functional designs. Basic mathematical concepts, such as understanding maps, distances, and angles, are crucial for navigation and travel. Whether you're planning a road trip or using GPS, mathematics helps you get from one place to another. Mathematics is fundamental for time management. Whether it's scheduling appointments, managing deadlines, or optimizing your daily routine, mathematical skills are invaluable for making the most of your time. In summary, mathematics is not only a subject studied in school; it is a fundamental skill that permeates almost every aspect of our daily lives. It equips us with the tools to make informed decisions, solve problems, and navigate the complexities of our modern world. Whether you're balancing your check book, analysing data, or pursuing a career in any subject/field, mathematics is an integral part of daily life.

1.2 Learning Objectives

After completing this unityou will be able to:

- explain the meaning of mathematics.
- discuss the nature of mathematics
- explain the importance of mathematics.

1.3 Meaning of Mathematics

Dear learner, we all know what is mathematics, but when it comes to define it we seem to fail completely. A dictionary meaning of mathematics is a science dealing with study of quantities and their relationships expressed in numbers and other special symbols. Some people describe mathematics more of a language in which every symbol and every combination has precise meaning which can be determined by application of logical rules. This language can be used to describe and analyze anything in the universe. It is not easy to give one definition of mathematics, but we can explain aspects of mathematics by what it does.

Definitions of Mathematics

In many Indian languages the vernacular word for mathematics is "Ganita" which means the science of space and quantity which helps us in solving many problems of life using numeration and calculation. In Sanskrit, it is said, "GanitaShastra" which means science of counting and calculation for mankind. Mathematics as Noun, functioning as singular, a group of related sciences, including algebra, geometry, and calculus, concerned with the study of number, quantity, shape, and space and their interrelationships by using a specialized notation. Functioning as singular or plural, mathematical operations and processes involved in the solution of a problem or study of some scientific field. A few definitions of Mathematics are given below:

“Mathematics should be visualised as the vehicle to train a child to think, reason, analyse, and articulate logically. Apart from being a specific subject, it should be treated as a concomitant to any subject involving analysis and meaning” (National Policy on Education, 1986).

“We cannot overstress the importance of Mathematics in relation to science, education and research. This has always been so, but at no time has the significance of Mathematics been greater than what it is today-it is important that deliberate efforts are made to place India on the world map of Mathematics within the next two decades or so” (National Education Commission or Kothari Commission, 1964-66).

“Mathematics is a way to settle in the mind a habit of reasoning” (Locke).

“Mathematics is the study or use of numbers and shapes to calculate, represent, or describe things. Mathematics includes arithmetic, geometry, and algebra” (Chandel J.C).

“Mathematics is the mirror of civilization” (Hogben).

According to Cambridge Dictionaries Online, “Mathematics is the study of numbers, shapes, and space using reason and usually a special system of symbols and rules for organizing them”.

“It is the science of quantity” (Aristotle),

According to Scholastic Children's Dictionary (1996) mathematics is “the study of numbers, quantities, shapes, and measurements and how they relate to each other.”

“Mathematics is the indispensable instrument of all physical resource"” (Kant).

“Mathematics is a way to settle in the mind a habit of reasoning” (Locke).

“Mathematics is the gateway and key to all sciences” (Bacon).

From the above definitions, we can say that;

- Mathematics is the science of quantity and space.
- Mathematics is the science of numbers.
- Mathematics is the science of logical reasoning.
- Mathematics is the perfection of generalization
- Mathematics is the method of progress of various subjects.
- Mathematics is the important means of generalization

Mathematics is therefore is not only number work or computation, but is more about forming generalizations, seeing relationships and developing logical thinking and reasoning.

Self-Check Exercise - 1

1. Mathematics is _____

a) Science of number and space

b) Study of numbers and figures

c) Science of indirect measurements
d) All of the above
2. According to Locke “Mathematics is a way to settle in the mind a habit of _____
a) Calculation
b) Reasoning
c) Simplification
d) Analysis

1.4 Nature of Mathematics

Mathematics relies on both logic and creativity, and it is pursued both for a variety of practical purposes and for its intrinsic interest. For some people, and not only professional mathematicians, the essence of mathematics lies in its beauty and its intellectual challenge. For others, including many scientists and engineers, the main value of mathematics is how it applies to their own work. Because mathematics plays such a central role in modern culture, some basic understanding of the nature of mathematics is requisite for scientific literacy. To achieve this, student need to perceive mathematics as part of the scientific endeavor, comprehend the nature of mathematical thinking and become familiar with key mathematical ideas and skills. The nature of mathematics can be summarized as under:

- Mathematics is the science of quantity and space.
- Mathematics is the science of numbers.
- Mathematics is the science of logical reasoning.
- Mathematics is the perfection of generalization.
- Mathematics is the method of progress of various subjects.
- Mathematics is the important means of generalization.
- Mathematics is natural. The nature of mathematics is empirical. People do mathematics naturally.
- Mathematics exists independent of us we can perform experiments, explores, and investigate; we can test ideas and decide for ourselves.
- Mathematics is the study of structure, operations, order, shape, continuity andtransformation.
- Mathematics is the art of figuring things out.
- Mathematics is the science of patterns and relationships. As a theoretical discipline, mathematics explores the possible relationships among abstractions without concern for whether those abstractions have counterparts in the real world.
- Mathematics is also an applied science. Many mathematicians focus their attention on solving problems that originate in the world of experience. They too search for patterns

and relationships, and in the process they use techniques that are similar to those used in doing purely theoretical mathematics.

- Because of its abstractness, mathematics is universal in a sense that other fields of human thought are not.
- Mathematics is the chief language of science. The symbolic language of mathematics has turned out to be extremely valuable for expressing scientific ideas unambiguously.
- Mathematics provides the grammar of science- rules for analyzing scientific ideas and data rigorously.
- Mathematics and science have many features in common. These include a belief in understandable order; interplay of imagination and rigorous logic; ideals of honesty and openness; the critical importance of peer criticism.

Self-Check Exercise- 2

What is the nature of Mathematics?

1.5 Importance of Mathematics

"Mathematics is the mirror of civilization". The history of mathematics is the story of the progress of civilizations and culture. A country's civilization and culture is reflected in the knowledge of mathematics it possesses. Mathematics helps in the preservation, promotion and transmission of cultures. Various cultural arts like poetry, painting, drawing, and sculpture utilize mathematical knowledge. Mathematics has aesthetic or pleasure value. Concepts like symmetry, order, similarity, form and size form the basis of all work of art and beauty. All poetry and music utilizes mathematics. Hence, the teaching of mathematics is inevitable in our schools may be at any level. There are uses of mathematics in all the sciences, such as biology, chemistry, and physics; the in social sciences, such as economics, psychology, and sociology; engineering fields, such as civil, mechanical, and industrial engineering; and technological fields such as computers, rockets, and communications. There are even uses in the arts, such as sculpture, drawing, and music. In addition, anything which uses a computer uses mathematics, and you probably are aware of how many things that is. Furthermore, learning mathematics forces one to learn how to think logically and to solve problems using that skill. It also teaches one to be precise in thoughts and words. Mathematics teaches life skills. It is difficult to find any area of life that is not touched by mathematics. We are surrounded by mathematics, and also surrounded by people who do know mathematics. The importance of mathematics has never been greater than now and for the foreseeable future. Mathematical skills are crucial for a wide array of analytical, technological, scientific, security and economic applications. Training students to become expert users of mathematics and to appreciate its usefulness is of paramount importance for the future. If you love doing mathematics and helping others to understand how mathematics can be useful and important to them. The routine activities

of daily life demand a mastery of number facts and number processes. To read with understanding much of the materials in newspapers require considerable mathematical vocabulary. A few such terms are per cent, discount, commission, dividend, invoice, profit and loss, wholesale and retail, taxation, etc. As civilization is becoming more complex, many terms from the electronic media and computers are being added. Certain decisions require sufficient skill and understanding of quantitative relations. The ability to sense problems, to formulate them specifically and to solve them accurately requires systematic thinking. To understand many institutions and their management problem, a quantitative viewpoint (modelling) is necessary. It is illuminating to hear from an economist, an architect, an engineer, an aviator, or a scientist what in mathematics is helpful to them as workers. Many vocations need mathematical skills.

- Mathematics teaches us how to analyze a situation, how to come to a decision, to check thinking and its results, to perceive relationships, to concentrate, to be accurate and to be systematic in our work habits.
- Mathematics develops the ability to perform necessary computations with accuracy and reasonable speed. It also develops an understanding of the processes of measurement and of the skill needed in the use of instruments of precision.
- Mathematics develops the ability to make dependable estimates and approximations, devise and use formulae, rules of procedure and methods of making comparisons, represent designs and spatial relations by drawings, and arrange numerical data systematically and to interpret information in graphic or tabular form.

  Applications of Mathematics: The scope of mathematics in terms of its uses and applications of Mathematics is as under.
- **Mathematics and Society:** An important yardstick to measure the scope of mathematics may be in the form of drawing a picture of its contribution to the overall progress and contributions in society. Right from the earliest of civilizations to the present age of computerized progress, we may witness that the study of mathematics has always been the backbone of such progress. Trade and commerce, banking and financing, global marketing, construction and architectural progress, transportation and communication, a scientific and technological development that we have at our disposal are all the outcomes of the progress and development in mathematics which we are having today with us.
- **Mathematics and other School subjects:** The evidence about the largeness of the scope of mathematics in the realm of school education may be witnessed by looking at the uses and applications of mathematics in the teaching-learning of other subjects of the school curriculum. The studies of the subjects like languages, sciences including social sciences, work experience, health and physical education, art and painting, etc. are all quite helped and facilitated through the study of mathematics. We will be dealing with this issue in detail in chapter four of this text.

- **Mathematics and Career Development:** The scope of the study of the subject mathematics has been so widened and enlarged that now the key of all the important professions and avenues of career development lies in the art and skills related to mathematics. In general, entry, as well as success in the professions and careers like below, may be properly availed through the study of mathematics.
- **Careers in Mathematics:** Career-related to Engineering, Banking and Commerce, Finance and Accountancy, Economics and Business, Research, Teaching and Instructional Work, Statistics and Astrology, Astronomy and forecasting

Profession in Mathematics

- Teaching job in schools and higher academic institutions i.e. colleges and universities.
- Jobs related to Engineering
- Economist, auditor, tax consultant and corporate financial advisor.
- System analyst and operation research analyst.
- Statistician
- Research Scientist and Data Analyst
- Environmental Mathematician and Ecologist
- Geophysical Mathematician
- Chemical/physical/biological mathematician
- Computer scientist, space scientist and robotics engineer
- Astronomer and Astrologer
- Financial estimate makers and forecasting personnel
- Investment Advisors and planners.

Self-Check Exercise - 3

What is the importance of mathematics?

1.6 Summary

In thisunit, we studied the meaning, nature and importance of Mathematics. Definitions of mathematics given by different mathematicians/philosophers have been discussed. We found that “Mathematics is a way of thinking, an art and a human achievement. We have also discussed the nature of mathematics in the following contexts.

- Mathematics is a Science of Discovery
- Mathematics is an intellectual game
- Mathematics is the art of drawing Conclusions
- Mathematics is a tool subject
- Mathematics is a system of logical processes
- Mathematics is an intuitive method

Mathematics is so important and far-ranging a subject of study that the argument for its compulsory inclusion in the secondary curriculum may be made from a variety of viewpoints. It should necessarily be studied throughout the secondary school for many reasons: It is beautiful, develops the mind, underpins the study of other subjects, is a necessary component of many jobs and is necessary to be a successful citizen; it is historically of great significance; and, finally, it is unique amongst human intellectual development.

1.7 Glossary

Assignment: A learning task (consisting of essay-type questions, or short answer questions, or an activity, or a project, etc.) that a distance learner undertakes during his/her studies. At CDOE, besides being used as a means of didactic communication, it is used as an instrument of continuous assessment that carries 20-30 per cent of the weightage of final scores. Obviously, assignments are used for two purposes: to provide guidance through tutor-comments, and to assess learner achievement through grading/marking.

Formula: A rule that numerically describes the relationship between two or more variables.

1.8 Answers to Self-Check Exercises

Self-Check Exercises- 1

1. d) All of the above
2. b) Reasoning

Self-Check Exercises- 2

Nature of Mathematics;

1. Mathematics is a Science of Discovery
2. Mathematics is an intellectual game
3. Mathematics is the art of drawing Conclusions
4. Mathematics is a tool subject
5. Mathematics is a system of logical processes
6. Mathematics is an intuitive method

Self-Check Exercises -3

Answer:"Mathematics is the mirror of civilization". Mathematics helps in the preservation, promotion and transmission of cultures. Concepts like symmetry, order, similarity, form and size form the basis of all work of art and beauty. All poetry and music utilizes mathematics. Hence, the teaching of mathematics is inevitable in our schools may be at any level. There are uses of mathematics in all the sciences and arts, such as sculpture, drawing, and music. Mathematical skills are crucial for a wide array of analytical, technological, scientific, security and economic applications. To understand

many institutions and their management problem, a quantitative viewpoint (modeling) is necessary. Many vocations need mathematical skills.

1.9 References/Suggested Readings

- Aggarwal, S.M. (2005). Teaching of Modern Mathematics, Delhi: DhanpatRai and Sons.
- Das R.C. (1984). Curriculum and Evaluation, NCERT, New Delhi, p.42.
- K.S. Shukla, (1989). Vedic mathematics- the illusive title of Swamiji's book, Mathematical Education, Vol 5: No. 3, January-March.
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- NCERT A Textbook of Content-cum-Methodology of Teaching Mathematics, New Delhi Rai, B. C. (1978) Teaching of Mathematics, Lucknow; Prakashan Kendra.
- Report of the Secondary Education Commission, Government of India, Ministry of Education, New Delhi, 1953, p.65.3.
- Reymond, B. (2000). Math-tricks, puzzles and games. New Delhi: Orient Paperbacks Sharan, R., & Sharma, M. (2006) Teaching of Mathematics. New Delhi: A.P.H. Publishing Corporation.
- Sharma, R.C. (1975). Modern Science Teaching, DhanpalRai Publishing Company, p.82.
- Suxen, R. C. (1970). Curriculum and Teaching of Mathematics in Secondary School, New Delhi: NCERT.

1.10 Terminal Questions

1. Explain the meaning and nature of mathematics.
2. Discuss the importance of mathematics at school level education.

Unit 2 Place of Mathematics in Daily Life and School Curriculum

Structure

2.1 Introduction

Dear learner, this unit deals with the place of mathematics in school curriculum. The purpose of this unit is to understand the different concepts of foundations of mathematics education. Mathematics is seen as a science of number, shape, space, and their relationships and also as a universal language based on symbols and diagrams. It involves the handling (arrangement, analysis, manipulation and communication) of information, the making of predictions and the solving of problems through the use of a language that is both concise and accurate. Mathematics education provides the child with a wide range of knowledge, skills and related activities that help him/her to develop an understanding of the physical world and social interactions. It gives the child a language and a system through which he/she may analyse, describe and explain a wide range of experiences, make predictions, and solve problems. Mathematics education fosters creative and aesthetic development, and enhances the growth of reasoning through the use of investigative techniques in a mathematical context. It is also concerned with encouraging the child to be confident and to communicate effectively through the medium of mathematics. This unit will elaborate on these concepts in an extensive manner.

2.2 Learning Objectives

After completing this unit learners will be able to:

- describe the place of mathematics in daily life and school curriculum.

2.3 Place of Mathematics in Daily Life and School Curriculum

The most fascinating of all knowledge and the most phobia generating subject in the school curriculum is Mathematics. The way in which it is introduced to the learners devoid of its daily application has been the root cause of the present scenario as

experienced by everyone in the country. It is pertinent to note the ways in which one experiences mathematical applications in daily life from the time one gets up from bed till one goes to bed in the night. Mathematics is an essential and integral part of the school curriculum for several important reasons:

Critical Thinking and Problem-Solving Skills: Mathematics teaches students how to think critically, analyze problems, and develop problem-solving skills. These skills are valuable not only in mathematics but in various other aspects of life.

Quantitative Literacy: In our data-driven world, the ability to understand and work with numbers is crucial. Mathematics equips students with quantitative literacy, which is necessary for making informed decisions in various fields, including finance, science, and social sciences.

Scientific and Technological Advancements: Mathematics is the language of science and technology. Without a solid foundation in mathematics, students would struggle to comprehend and contribute to the advancements in fields such as physics, engineering, computer science, and more.

Career Opportunities: Many careers and professions require a strong background in mathematics. These include professions in science, technology, engineering, medicine, finance, and even fields like architecture and data analysis.

Logical Reasoning: Mathematics encourages logical reasoning, which is important not just for solving mathematical problems but for making rational decisions in everyday life.

Educational Foundation: Mathematics often serves as a foundation for learning other subjects. For instance, concepts in physics, chemistry, and economics are deeply rooted in mathematical principles.

Cognitive Development: Learning mathematics helps in cognitive development. It challenges the mind, encourages abstract thinking, and enhances memory and problem-solving abilities.

Real-World Applications: Mathematics is used in various real-world situations, from budgeting and personal finance to understanding probabilities and risks. A strong mathematical background is essential for making sound financial decisions.

Global Competitiveness: In a globalized world, students need to be competitive on a global scale. Proficiency in mathematics is often a benchmark for assessing a country's competitiveness in science and technology.

Personal Empowerment: Mathematics empowers individuals to understand and navigate the world around them more effectively. It can boost self-confidence and lead to a sense of achievement.

Innovation and Creativity: Mathematical thinking fosters creativity and innovation. Many breakthroughs in various fields have occurred through creative applications of mathematical concepts.

Cultural and Historical Significance: Mathematics has played a significant role throughout history and across cultures. Teaching mathematics also provides insight into the historical and cultural development of human knowledge.

In conclusion, mathematics is more than just a subject to be studied in school; it is a fundamental skill that equips individuals with the tools and knowledge they need to succeed in an increasingly complex and data-driven world. It fosters critical thinking, problem-solving, and logical reasoning, which are valuable skills for life and careers. Therefore, it is essential that mathematics remains a core part of the school curriculum.

Self-Check Exercise - 1

Discuss the place of mathematics in school curriculum?

2.4 Summary

In this unit, we attempted to understand the place of mathematics in school curriculum. Mathematics is so important and far-ranging a subject of study that the argument for its compulsory inclusion in the secondary curriculum may be made from a variety of viewpoints. It should necessarily be studied throughout the secondary school for many reasons: It is beautiful, develops the mind, underpins the study of other subjects, is a necessary component of many jobs and is necessary to be a successful citizen; it is historically of great significance; and, finally, it is unique amongst human intellectual development. Perhaps any one of these points would be sufficient reason alone for the compulsory study of mathematics.

2.5 Glossary

Whole Number: A whole number is a positive integer.

Finite: Not infinite; has an end.

2.6 Answer to Self-Check Exercise

Self-Check Exercise-1

Mathematics is an essential and integral part of the school curriculum for several important reasons like mathematics teaches students how to think critically, analyze problems, and develop problem-solving skills. Without a solid foundation in mathematics, students would struggle to comprehend and contribute to the advancements in fields such as physics, engineering, computer science, and more. Mathematics is more than just a subject to be studied in school; it is a fundamental skill that equips individuals with the tools and right knowledge. Therefore, it is essential that mathematics remains a core part of the school curriculum.

2.7 References/Suggested Readings

- Aggarwal, S.M. (2005). Teaching of Modern Mathematics, Delhi: DhanpatRai and Sons.

- Das R.C. (1984). Curriculum and Evaluation, NCERT, New Delhi, p.42.
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- Sood, J.K. (1989). New directions in Science Teaching, Kohli Publishers, Chandigarh, pp.103.
- Suxen, R. C. (1970). Curriculum and Teaching of Mathematics in Secondary School, New Delhi: NCERT.

2.8 Terminal Questions

1. Describe the place of mathematics in daily life and school curriculum.

Unit - 3 Aims and Objectives of Teaching of Mathematics

Structure

3.1 Introduction

Mathematics is a fundamental discipline that impacts various aspects of our everyday existence. Dear learner, this unit deals with the general aims and objectives of teaching of mathematics in school curriculum.

3.2 Learning Objectives

After completing this unit, you will be able to:

- explain the concept and general aims and objectives of teaching of mathematics.

3.3 Concept and General Aims and Objectives of Teaching of Mathematics

Education is a process of bringing changes in the individual in desired manners such as the development of interests, attitudes and skills, to carry out certain activities. This helps the individual to lead a productive and socially acceptable life. An objective presents the endpoint towards which action is directed and therefore it reflects the purposefulness of the educational process. It represents the first step in the teaching and learning process because it is the starting point of activities, planning and instruction. It also provides the basis for the selection of evaluation procedures and curriculum development. Thus objectives validate whole teaching-learning process. The term **"Objective"** is defined as "An objective is a point or end view of the possible achievement in terms of what a student can do when the whole educational system is directed towards educational aims." Thus, an objective is a part of the aim which a school can hope to achieve. Hence an objective is a narrower term when compared to an aim. It is a statement that describes what the pupil will do or be able to do towards the realization of an educational aim. When a pupil attains an objective he realizes a part of the broad aim. In other words, an objective is a statement of the terminal behavior expected of the pupils at the conclusion of a period of learning. In other words,

we can say that the objective is a statement or a form of category which suggests any kind of change. It indicates the direction of the pupil's growth and provides the basis for the selection of evaluation procedures. Objectives provide a link between teachers, pupils, testers and parents by focusing their attention on intended outcomes of learning. Thus objectives validate the process of education.

Dear learner we must too understand the difference between aims and objectives. Aims are general statements concerning the overall goals, ends or intentions of teaching. Objectives are the individual stages that learners must achieve on the way in order to reach these goals. Example a teacher might have an aim that a learner should be able to save work on a computer. To achieve this aim a series of objectives must be met e.g. to create a folder; navigate between menus, save a document. Aims and objectives can form hierarchical structures so that in complex curricula aim at one level might be seen as objectives at another. Objectives do not include the word "know" or "understand". They do include active verbs such as "state", "explain", "outline", "list" or "describe". They are statements of what you want your learners to do.The objectives are classified into two categories

1. Educational Objectives: Educational Objectives are broad and philosophical in nature. They are related to the schools and educational systems. Frust E.J has defined "Educational objective as a desired change in the behavior of a person that we try to bring about through education". According to Bloom "Educational objectives are not only the goals towards which the curriculum is shaped and towards which the instruction is guided, but they are also the goals which provide the detailed specification of the curriculum and use of evaluation techniques". The educational objectives are achieved with the help of teaching or instructional objectives.
2. Teaching Objectives: Teaching objectives are narrow and psychological in nature. Teaching objectives may be achieved during a certain period in the classroom. These are related to the expected change in behavior of the child. Therefore, they are called behavioral objectives. Teaching objectives are directly related to the learning process and they are well defined, definite, clear, specific and measurable. These give direction to the learning processes, learning-experiences and teaching. They provide the foundation of the entire educational structure. Therefore, teaching objectives are also called instructional objectives. The teaching strategies methods and techniques are selected based on teaching or instructional objectives.

Aims and the objectives may be compared based on the following points:

Difference between Aims and Objectives

Sr.	Aims	Objectives
1.	Aims are very broad and comprehensive	Objectives are narrower and specific
2.	Philosophy and sociology is the main source of aim	Psychology is the main source of objectives
3.	They are not definite and clear	They are definite and clear
4.	They are difficult to achieve	They can be achieved
5.	Long duration is required for the achievement of aims	Achieved within a short duration of time i.e. within the classroom period
6.	They are subjective	They are objective
7.	These cannot be evaluated	These can be evaluated
8.	These include objectives	Objectives are a part of the aims
9.	They are related with the whole education system and whole curriculum	These are related with the teaching of any specific topic
10.	It is the responsibility of the school, society and nation to achieve them	Generally teacher is responsible
11.	These are theoretical and indirect	Objectives are direct and concerned with the teaching learning process
12.	Aims are formal	These are functional and informative

General Aims and Objectives of Mathematics Teaching:

Aims of teaching mathematics can be classified under the following heads:

1. **Utilitarian or Practical Aim:-** The following are the practical aims of teaching mathematics.

- To enable the students to have clear ideas about the number concept.
- To give the individual an understanding of ideas and operations in number and quality needed in daily life.
- To enable the individual to have a clear comprehension of the way the number is applied to all measures but most particularly to those frequently used concepts such as length volume, area, weight, temperature, speed etc.
- To enable the individual to become proficient in the four fundamental operations of addition, subtraction, multiplication and division.
- To provide the basis of mathematical skills and processes, that are needed for vocational purposes.

- To enable the learner to acquire and develop mathematical skills and attitudes to meet the demands of (i) daily life (ii) future mathematical work and (iii) work in the related fields of knowledge. •
- To enable the students to make appropriate approximations.
- To enable the learner to understand the concept of ratio and scale drawing, read and interpret graphs, diagrams and tables.
- To enable the individual to apply his mathematics to a wide range of problems that occurs in daily life.

2. **Disciplinary Aim:** The teaching of Mathematics intends to realize the following disciplinary aims.

- To provide opportunities that enable the learners to exercise and discipline mental faculties.
- To help the learner in the intelligent use of reasoning power.
- To develop constructive imagination and inventive faculties.
- To develop the character through systematic and orderly habits.
- To help the learner to be original and creative in thinking.
- To help the individual to become self-reliant and independent.

3. **Cultural Aim:** The cultural aim can be summarized as follows:

- To enable the learner to appreciate the part played by mathematics in the culture of the post and that it continues to play in the present world.
- To enable the student to appreciate the role played by mathematics in preserving and transmitting our cultural traditions.
- To enable him to appreciate various cultural arts like drawing, design making, painting, poetry, music, sculpture and architecture.
- To provide through mathematical ideas, aesthetic and intellectual enjoyment and satisfaction and to allow creative expression.
- To help the students explore creative fields such as art and architecture.
- To make the learner aware of the strengths and virtues of the culture he has inherited.
- To develop in the individual an aesthetic awareness of mathematical shapes and patterns in nature as well as the products of our civilization.

4. **Social Aims:** The important social aims of teaching mathematics are as under:-

- To develop in the individual and awareness of the mathematical principles and operations which will enable the individual to understand and participate in the general social and economic life of his community.
- To enable the student to understand how the methods of mathematics such as scientific, intuitive, deductive and inventive are used to investigate, interpret and to make the decision in human affairs.
- To help the pupil acquire social and moral values to lead a fruitful life in society.

- To help the pupil in the formation of social laws and social order needed for social harmony.
- To provide the pupils scientific and technological knowledge necessary for adjusting to the rapidly changing society and social life.
- To help the learner appreciate how mathematics contributes to his understanding of the natural phenomenon.
- To help the pupil interpret social and economic phenomenon.

  The general aims of teaching mathematics are as under:
- Develop a positive attitude towards learning Mathematics speed and accuracy
- Perform mathematical operations and manipulations with confidence,
- Think and reason precisely, logically and critically in any given situation
- Develop investigative skills in Mathematics
- Identify, concretize, symbolize and use mathematical relationships in everyday life
- Comprehend, analyze, synthesize, evaluate, and make generalizations so as to solvemathematical problems
- Collect, organize, represent, analyze, interpret data and make conclusions and predictionsfrom its results
- Apply mathematical knowledge and skills to familiar and unfamiliar situations
- Appreciate the role, value and use of Mathematics in society
- Develop willingness to work collaboratively
- Acquire knowledge and skills for further education and training
- Communicate mathematical ideas

  Objectives of the Secondary School Mathematics Education

  Dr. Benjamin S. Bloom (1956) has classified the changes of behavior into three categories or Domains:-

  1. Cognitive Domain
  2. Affective Domain
  3. Psychomotor Domain

  Dr. B.S. Bloom and his associates at the University of Chicago gave the classification of objectives of all three domains.

  1. Classification of cognitive domain or objectives by Bloom (1956)
  2. Affective domain by Krathwohl (1964)
  3. Psychomotor Domain by Simpson (1986)

  Dr. Bloom concentrated on the study of the cognitive domain. He assumed that in thinking about a problem a hierarchy of cognitive process is involved. While teaching, a teacher follows this hierarchical order. This classification of objectives is known as “Taxonomy of Educational Objectives” or “Blooms Taxonomy” of objectives. The classification of objectives of secondary school mathematics education is as under;

Knowledge Domain: To induce children to understand and grasp the knowledge of the following:

- The directed numbers and the real number system;
- The algebraic symbols to describe relations among quantities and number patterns;
- The equations, inequalities, identities, formulas and functions;
- The measures for simple 2-d and 3-d figures;
- The intuitive, deductive and analytic approach to study geometric figures;
- The trigonometric ratios and functions,
- The statistical methods and statistical measures;
- The simple ideas of probability and laws of probability

Skill Domain: To develop the following skills and capabilities in:

- Basic computations in real numbers and symbols and an ability to judge reasonableness ofresults;
- Using the mathematical language to communicate ideas:
- Reasoning mathematically, i.e. They should conjecture, test and build arguments about the validity of a proposition;
- Applying mathematical knowledge to solve a variety of problems;
- Handling data and generating information; number sense and spatial sense;
- Using modern technology appropriately to learn and do mathematics;
- Learning mathematics independently and collaboratively for the whole life

Attitude Domain: To foster the attitudes to:

- Be interested in learning mathematics;
- Be confident in their abilities to do mathematics;
- Willingly apply mathematical knowledge;
- Appreciate that mathematics is a dynamic field with its roots in many cultures;
- Appreciate the precise and aesthetic aspect of mathematics;
- Appreciate the role of mathematics in human affairs;

Examples of Learning Objectives Verbs

The following list contains examples of verbs which describe the sorts of things you want your students to be able to do and may help you to write useful learning objectives.

Knowledge

analyze	Arrange	Calculate	Circle	Cite
classify	Compare	Contrast	Compare	Define
describe	Match	Differentiate	Group	Identify
interpret	Itemize	Label	List	Match
Name	Outline	Plan	Record	Revise
Select	Solve	State	Give examples	

evaluate	Recognize			

Skills

Adjust	Assemble	Chart	Collect	use
Draw	Employ	establish	Illustrate	imitate
interact	Locate	maintain	Measure	modify
Make	Organize	rearrange	Return	set up
practice	Manipulate	Master	Fit	perform
demonstrate				

Attitudes

Accept	Adopt	advocate	approve	Assess
challenge	Characterize	Choose	criticize	Defend
evaluate	Formulate	Judge	justify	Manage
Model	Persuade	recommend	resolve	Select
Specify	Value	Reassure	empathies	

The aims of teaching and learning mathematics are to encourage and enable students to:

- Recognize that mathematics permeates the world around us
- Appreciate the usefulness, power and beauty of mathematics
- Enjoy mathematics and develop patience and persistence when solving problems
- Understand and be able to use the language, symbols and notation of mathematics
- Develop mathematical curiosity and use inductive and deductive reasoning when solving problems
- Become confident in using mathematics to analyze and solve problems both in school and in real-life situations
- Develop the knowledge, skills and attitudes necessary to pursue further studies in mathematics
- Develop abstract, logical and critical thinking and the ability to reflect critically upon their work and the work of others
- Develop a critical appreciation of the use of information and communication technology in mathematics
- Appreciate the international dimension of mathematics and its multicultural and historical perspectives.

Objectives of Teaching Mathematics - National Policy of Education (1986): At the end of the high school stage, a student should be able to –

- To acquire knowledge and understanding of the terms, concepts, principles, processes, symbols and mastery of computational and other fundamental processes which are required in daily like and for higher learning in mathematics.
- To develop skills of drawing, measuring, estimating and demonstrating.
- To apply mathematical knowledge and skills to solve problems that occur in daily life as well as problems related to higher learning in mathematics or allied areas.
- To develop the ability to think, reason, analyse and articulate logically.
- To appreciate the power and beauty of mathematics.
- To show interest in mathematics by participating in mathematical competitions, and engaging in its learning, etc.
- To develop reverence and respect towards great mathematicians, particularly towards great Indian mathematicians for their contributions to the field of mathematical knowledge.
- To develop necessary skills to work with modern technological devices such as calculations, computers, etc.

Self-Check Exercise- 1

Discuss aims and objectives of teaching of mathematics.

3.4 Summary

In thisunit, general aims and objectives of teaching of mathematics are discussed in detail.

3.5 Glossary

Axiom: a proposition that is not actually proved or demonstrated, but is considered to be self-evident and universally accepted as a starting point for deducing and inferring other truths and theorems, without any need of proof.

3.6 Answers to Self-Check Exercise

Self-Check Exercise-1

An objective presents the endpoint towards which action is directed and therefore it reflects the purposefulness of the educational process. It represents the first step in the teaching and learning process because it is the starting point of activities, planning and instruction. Thus, an objective is a part of the aim which a school can hope to achieve. Objectives provide a link between teachers, pupils, testers and parents by focusing their attention on intended outcomes of learning. The aims of teaching and learning mathematics are to encourage and enable students to understand and be able to use the language, symbols and notation of mathematics. It develops the knowledge, skills and attitudes necessary to pursue further studies in mathematics

3.7 References/Suggested Readings

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3.8 Terminal Questions

1.What are the aims of objective of teaching Mathematics at Secondary state?

Unit –4 Formulations and Classification of Objectives in Behavioural Terms

Structure

4.1 Introduction

Dear learner, the previous unit you have studied the general aims and objectives of teaching of mathematics in school curriculum and in this unit formulation and organization of objectives in behavioural terms are discussed in detail.

4.2 Learning Objectives

After completing thisunit, you will be able to:

- describe the formulation and classification of objectives in behavioural terms.

4.3 Formulation and Classification of Objectives in Behavioural Terms

Behavioural objectives that are useful in the classroom must meet certain criteria. The four essential elements of a well-written behavioural objective are outlined below. When writing a behavioural objective, evaluate it using these criteria.

1. **Good behavioural objectives are student-oriented:** A behavioural objective, which is student-oriented, places the emphasis upon what the student is expected to do, not upon what the teacher will do. Sometimes teachers use instructional goals which emphasize what they are expected to do rather than what they expect of their students.
2. **Good behavioural objectives describe learning outcomes:** The important thing to keep in mind here is that we are interested in what the students will learn to do. In other words, it is the learning outcome that is important, not the learning activities that should lead to that outcome.
3. **Good behavioural objectives are clear and understandable:** It should contain a clearly stated verb that describes a definite action or behaviour and, in most cases, should refer to an object of that action.

4. **Good behavioural objectives are observable:** The evaluation of learning outcomes hinges on the ability to observe those outcomes. The key to an observable objective is an observable verb. Consequently, when selecting behavioural objectives for use in your teaching, watch the verbs. The verb must describe an observable action or an action that results in an observable product.

Characteristics/Guidelines for Writing Behavioural Objectives

- Observable and measurable
- Results oriented/clearly written /specific
- Measurable by both quantitative and qualitative criteria
- Communicate a successful learning in behavioural terms
- Written in terms of performance
- Begin each objective with an "action verb" which depicts definite, observable behaviour. For example: "write", "identify", "formulate", "list", "describe", "recall".
- State each objective in terms of student performance rather than teacher performance.
- State each objective as a learning product (outcome or terminal behaviour) rather than interms of the learning process.
- State only one outcome or behaviour in each objective.
- Make objectives clear, brief and unambiguous.
- Start a set of behavioural objectives for a lesson with a phrase such as: "At the end of the lesson the student will be able to:"
- Do not include trivial objectives.
- Objectives can be written in present or future tense.
- Objectives will include four4 distinct components: Audience, Behaviour, Condition and Degree.
- Objectives must be both observable and measurable to be effective.
- Use of words like know, understand and learn in writing objectives are generally not acceptable as they are difficult to measure.
- Written objectives are a vital part of instructional design because they provide the roadmap for designing and delivering curriculum.
- Throughout the design and development of curriculum, a comparison of the content to be delivered should be made to the objectives identified for the program. This process, called performance agreement, ensures that the final product meets the overall goal of instruction identified in the first level objectives.

Essentials of Learning Objectives: Learning objectives form the basis for what is to be learned, how well it is to be performed, and under what conditions it is to be performed. While there are specific objectives that means different things, such as educational, instructional, learningbehavioural, and performance objectives (Saettler,

1990); most instructional designers generally use two terms - terminal or performance objectives and enabling or learning objectives (Mager, 1975);

A Terminal or Performance Objective is developed for each of the tasks selected in the learning program. A terminal objective is at the highest level of learning, appropriate to the human performance requirements a student will accomplish.

Each terminal performance objective is then analyzed to determine if it needs one or moreEnabling or Learning Objectives. These supporting objectives allow the Terminal Objective to bebroken down into smaller, more manageable objectives. Each enabling learning objectivemeasures an element of the terminal performance objective. The Three Parts of an Objective:Every performance or learning objective contains at least three parts:

- Observable Action (task): This describes the observable performance or behaviour. An action means a verb must be in the statement, for example "type a letter" or "lift a load." Each objective should cover one behaviour, hence, normally only one verb should be present. If there is more than one behaviour or the behaviour is complicated, then the objective should be broken down into one or more enabling learning objectives that support the main terminal learning objective.
- At Least One Measurable Criterion (standard): A criterion states the level of acceptable performance of the task in terms of quantity, quality, time limitations, etc. This will answer any question such as “How many?”or “How fast?” or “How well?” For example, “At least 5 will be produced”, “Within 10 minutes”, and “Without error.” There can be more than one measurable criterion. Do not fall into the trap of putting in a time constraint because you think there should be a time limit or you cannot easily find another measurable criterion- use a time limit only if required under normal working standards.
- Conditions of performance: A condition describes the actual conditions, which the task will occur or be observed. In addition, it identifies the tools, procedures, materials, aids, or facilities to be used in performing the task. This is best expressed with a prepositional phase such as ‘without reference to a manual” or “by checking a chart.”

Examples of Performance Objectives

Example 1: Write the definition of rational numbers with 100% accuracy on their notebooks

Observable Action: Write the definition of rational numbers

Measurable Criteria: with 100 % accuracy

Conditions of Performance: on their notebooks

Four Parts of an ABCD Objective

- Audience
- Behaviour
- Condition

- Degree

The objective does not have to be written in this order (ABCD), but it should contain all of these elements

Audience

- Example: The 8th grade student.
- Example: The 6th class student.

Behavior

- Example... should be able to write a report...
- Example...should be able to describe the steps...

Condition

- Example: ...on their notebooks
- Example:...orally in front of class

Degree

- Example:... without error.
- Example:... 5 out of 10.
- Example:...within 30 seconds.

Example: The ninth grade student will be able to recall the definition of "prime numbers" on ashort-answer test and write it with 90% accuracy.

- Audience: Ninth grade student
- Behaviour: Will be able to recall and write
- Conditions: On a short-answer test
- Degree: With 90% accuracy

Self-Check Exercise- 1

Describe three essential conditions of writing objectives in behavioral terms.

4.4 Summary

In this unit, what is the procedure to formulate and classify objectives in behavioral terms is discussed in detail.

4.5 Glossary

Taxonomy - a classification of organisms based on similarities.

Blooms Taxonomy - A classification of educational objectives developed in the 1950s by a group of researchers headed by Benjamin Bloom of the University of Chicago. The taxonomy comprises three learning domains - cognitive, affective and psychomotor.

Knowledge - the result of perception, learning, and reasoning.

Synthesis - the combination of ideas into a complex whole.

4.6 Answers to Self-Check Exercise 1

Self-Check Exercise- 1

Behavioral objectives that are useful in the classroom must meet certain criteria. Good behavioral objectives must be student-oriented**.** Good behavioral objectives must describe learning outcomes.Behavioral objectives must be clear and understandable. It should contain a clearly stated verb that describes a definite action or behavior and, in most cases, should refer to an object of that action.Every performance or learning objective contains at least three parts:Observable Action (task), at Least One Measurable Criterion (standard) and Conditions of performance.

4.7 References/Suggested Readings

- Aggarwal, S.M. (2005). Teaching of Modern Mathematics, Delhi: DhanpatRai and Sons.
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4.8 Terminal Question

1. Describe any four characteristics of behavioral objectives.

Unit–5 Mathematics Curriculum: Concept, Principles of Curriculum Construction in Mathematics, Selection and Organization of Content

Structure

5.1 Introduction

Dear learner, this unit deals with the concept, principles of curriculum construction in mathematics, selection and organization of contentin mathematics curriculum.

5.2 Learning Objectives

After completing thisunit, you will be able to:

- explain the concept of curriculum.
- discuss the various principles of curriculum construction.

5.3 Concept of Curriculum

Dear leaner, first of all we must know the difference between syllabus and curriculum. Syllabus is a descriptive outline and summary of topics that are to be covered in an education or training course. The syllabus will usually provide specific information about the said training course and is often drafted by the governing body or by the instructor of the course. The syllabus also serves as a means for the students to be aware and understanding what they will be thought in the duration of the course. Syllabi, on the other hand, are the plural form of a syllabus. According to Dictionary.com, a syllabus is:

- An outline or other brief statement of the main points of a discourse, the subjects of a course of lectures, the contents of a curriculum, etc.

- A short summary of the legal basis of a court's decision appearing at the beginning of a reported case.
- A book containing summaries of the leading cases in a legal field, used especially by students.

A curriculum is the set of courses, and their content, offered at a school or university. The term, 'curriculum' is derived from the Latin word "Currere" which means to run/to proceed. Currere refers to the 'course of deeds and experiences through which children grow to become mature adults. Dictionary.com defines curriculum as:

- The aggregate of courses of study given in a school, college, university, etc.
- The regular or a particular course of study in a school, college, etc.

The main difference between a syllabus and a curriculum is that a curriculum is a more generalized or an overview of the subjects or topics that the students are meant to learn. However, a syllabus is a more detailed overview of the subject of study. For example: a mathematics curriculum may list basics of algebra, basics of geometry and basics of trigonometry. While, the class syllabus will list what topics will be covered under each of the basic topics, what will be the concepts that students may understand by the end of each topic, and it may even list what exercises or problems in the textbook will be covered during class. Hence, it can be said that syllabus is a subset of curriculum.

Meaning and Definitions of Curriculum

The term curriculum derives from the Latin word 'currere' which means a kind of route which the learner travels. All the activities going on the school or outside of the school is called curriculum. It is basic to the intellectual, physical, moral and emotional development of the child.

Secondary Education Commission (1952-53), "Curriculum is the totality of experiences that pupils receive through the manifold activities that go in the school, in the classroom, library, laboratory, workshop, playground and in the numerous informal contacts between the teachers and pupils".

Cunningham, "Curriculum is a tool in the hands of the artist (teacher), to mould his/her materials (students), according to his/her ideals (aims and objectives) in his/her studio (college/school)".

John Kerr, "All the learning which is planned and guided by the school, whether it is carried on in groups or individually, inside or outside the school".

Braslavsky states that, "curriculum is an agreement amongst communities, educational and the State on what learners should take on during specific periods of their lives."

A curriculum is a set of courses, including their content, offered at a school or university. The curriculum often contains a detailed list of subjects and the elements of teaching them. John Franklin Bobbitt's "The Curriculum" published in 1918 mentions

curriculum as an idea that has its roots in the Latin word 'race-course'. He also explained "The Curriculum" as the course of deeds and experiences through which children grow up into adults and get going for success in the society. A curriculum is more than putting together a set of academically required subjects. It must consider all aspects of the student life, the learning needs of students, the time available for the sessions and the teachers' idea, capability and workload.

Major Defects in the Present Curriculum

- It is examination oriented (examination ridden)
- Not in conformity with the aims and objective of the teaching mathematics
- Text book based examinations
- Emphasis on theory not practical
- Heavy syllabus
- Rote learning is encouraged
- Not to life oriented
- Not helpful to vocation
- Not developing the whole personality

Self-Check Exercise - 1

What is Curriculum?

5.4 Principles of Curriculum Construction

The principles of curriculum constructions are listed as under:

Principle of Child-Centeredness: The child should be central figure in any scheme of curriculum construction. In fact, curriculum is meant to bring about the development of the child in the desired direction so that he is able to adjust well in life. Curriculum is mainly meant for the students, so it should be child centred not teacher centred. The age, ability, interest, capability, capacity, needs and psychology of the learner should be taken into consideration while developing/constructing the curriculum.

Principle of Community-Centeredness: After getting the education in the school, he has to live in and for the society. Therefore, his needs and desires must be in conformity with the needs and desires of the society in which he is living. The values, attitudes and system that are prevailing in the community must be reflected in the curriculum. In other words the social needs of the society and the needs of the learner should be taken into account while constructing the curriculum. It should reflect the values of democracy, ethos and main concerns of the country.

Principle of Activity Centeredness: The curriculum should centre round the multifarious activities of pupils. It should provide well selected activities according to the needs, interests and developmental stages of children. It should provide constructive, creative and project activities. The purposeful activities both in the class-room and

outside the class-room should be provided. It is through a network of activities that the desired experiences can be provided and consequently desirable behavioural changes can be brought about in children

Principle of Utility: The main purpose of education is to prepare the child for living and learning. Itis one of most important consideration, so that the child can live a self-fulfilling life. It will be possible when curriculum should provide rich experiences (academic and social) to the students. The content, activities and experience of the curriculum at a particular stage / grade are useful to the learner for the further/higher studies.

Principle of Variety: The school curriculum should be broad based so that it can accommodate the needs of different category children. The needs of pupils also change from place to place. For example, the pupils studying in rural, urban and hilly areas will have different needs. All these considerations should be reflected in the curriculum.

Principle of Integration: Study of different subjects and activities have to serve the same purpose i.e., to increase the achievement of learner and fulfil the aims of education. The activities and subjects should not be put in after-tight compartments but these should be inter-related and well integrated so as to develop the personality of child. The curriculum should integrate; cognitive, affective and psychomotor objectives and abilities, knowledge and experience, objectives and content, child's activity. It should also be related to the social environment of the students.

Principle of Forward Looking: The main aim of education is to enable the child to lead a healthy and good social life. The aim of curriculum should not only to cater present needs of the child alone. But the future needs of his life should be taken into consideration. The curriculum should include skills, experiences, influences etc. which will develop in the child abilities and power to make effective adjustments in the later life.

Principle of Flexibility: In social milieu rapid developments are taking place everywhere almost in various fields. Therefore the needs of society are also changing with time and development. In this context the content of curriculum cannot be same for all times to come. It should not be static but dynamic. It must be changed with the changing needs and time. It should reflect the latest trends evolving in the field of education and psychology.

Principle of Creativity: It should place the pupil in the place of the discoverer and proper provision should be made for such type of activities. Principle of Preservation/Conservation: It should help in the preservation /conservation and transmitting the knowledge, traditions, standards of conduct on which the culture and civilization depend.

Principle of Contemporary Knowledge: The modern or current knowledge and theories should be taught to the students. That will give the knowledge of utilization of local resources (salt, plants, soil) to the students.

Principle of Conservation of our Cultural Heritage: Education is considered as a means for conserving our cultural heritage. Protection and transmission of culture areimportant components in this process. Mathematics curriculum needs to follow this principle and wherever possible, we need to include some activities, which would help in preserving and transmitting the cultural heritage. It is an important aspect that needs to be taken care of while framing curriculum.

Self-Check Exercise - 2

Discuss any two principals of curriculum.

5.5 Summary

Dear Learner, in this unit we have studied the concept, principles of curriculum construction in mathematics, selection and organization of contentin mathematics curriculum.

5.6 Glossary

Assessment - The process through which the progress and achievements of a learner or learners is measured or judged in compliance with specific quality criteria.

Attained Curriculum - Curriculum which indicates the knowledge, understanding, skills and attitudes that learners actually acquire as a result of teaching and learning, assessed through different means and/or demonstrated in practice. It may differ from the intended and the implemented curriculum.

5.7 Answers to Self-Check Exercises

Self-Check Exercise 1

Curriculum is a tool to accomplish the expected objectives of teaching a specific subject. It can be considered as the sum total of all the experiences gained by a child as a result of various formal as well as informal activities at school, home and in the community. Curriculum is the formal and informal content and process by which learners gain knowledge, develop skills and modify attitudes, appreciate the values.

Self-Check Exercise 2

There are many principles of curriculum construction but following are two main principles for curriculum construction.

1. Principle of Child-Centeredness: The child should be central figure in any scheme of curriculum construction. Curriculum is meant for the students, so it should be child centred not teacher centred. Therefore, while constructing curriculum age, ability, interest, capability, needs of the learner should be taken into consideration.

2. Principle of Community-Centeredness: After getting education in the school, child has to live in the society. Therefore, the values, attitudes and system that are prevailing

in the community must be reflected in the curriculum. It should reflect the values of democracy, ethos and main concerns of the country.

5.8 References/Suggested Readings

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5.9 Terminal Questions

1. Explain the concept and importance of curriculum.
2. Discuss the various principles of curriculum construction.
3. Describe the factors affecting change in mathematics curriculum.
4. Discuss the process of evaluation of mathematics curriculum at school level.

Unit –6 Factors affecting Change in Mathematics Curriculum

Structure

6.1 Introduction

Dear learner, this unit deals with the factors affecting change in mathematics curriculum.

6.2 Learning Objectives

After completing thisunit, you will be able to:

- describe the factors affecting change in mathematics curriculum and evaluation of mathematics curriculum at school level.

6.3 Factors affecting Change in Mathematics Curriculum

The education system of a country is affected by some particular factors, i.e. the National identity, historical and cultural backgrounds, political, economic, social, scientific and administrative factors. The impacts of all these factors show certain directions to the education system of the country. These directions can be useful in making newer policies and regulations for education according to the vision of the nation and its abilities on the whole.

1. Social Factors: The impact of social factors on education cannot be underestimated. From the influence of family dynamics and socioeconomic status to the role of peer relationships and cultural norms, these factors shape the educational experiences and outcomes of individuals. By recognizing the profound effects of social factors and implementing strategies to address them, we can create a more inclusive and equitable educational landscape that empowers every learner to reach their full potential. The needs and requirements of society are dynamic. The changes in values, beliefs, and expectations can prompt curriculum changes. For example, the increasing importance of

technology in our daily lives has led to a greater emphasis on Science, Technology, Engineering, and Mathematics education in school curriculum.

2. Technological Factors: The integration of technology in education has been a significant outcome of globalization. Smart classrooms, e-learning platforms, and digital resources have transformed the teaching and learning experience. Technology has made education more interactive, engaging, and accessible to students nationwide. Therefore, technology forced us to make modifications in the present curriculum. For example, the extensive accessibility of digital learning tools and online resources has led to a greater focus on blended learning and personalized instruction.
3. Globalization: In the context of education, globalization refers to the interconnectedness and exchange of ideas, knowledge, and resources across borders. It has facilitated the integration of education systems worldwide, enabling collaboration, innovation, and sharing of best practices. Globalization has opened up new avenues for educational growth and development in India. The increasing interconnectedness of the world has led to a greater emphasis on global education and cultural competency in school curriculums.
4. Economic Factors: Economic factors such as changes in job markets, workforce needs, and funding can also impact curriculum changes. For example, a shift towards more service-oriented jobs may prompt a greater emphasis on vocational training in schools.
5. Research and Development Factor: Advances in educational research and development can also influence curriculum changes. For example, new research on how students learn and retain information may lead to changes in teaching methods and curriculum design.
6. Political Factors: Political factors such as changes in education policy and government funding can also impact curriculum changes. For example, changes in government leadership or policies may result in changes to education funding or mandates for certain subject areas.

From the forgoing discussion, we can conclude that some aspects of doing mathematics have changed in the last decade, in large part because of technology. Changes in technology and the broadening of the areas in which mathematics is applied have resulted in growth and changes in mathematics itself. Technology makes it imperative that: (1) appropriate calculators should be available to all students at all times; (2) a computer should be available in every classroom for demonstration purposes; (3) every student should have access to a computer for individual and group work; and (4) all students should learn to use the computer as a tool for processing information and performing calculations to investigate and solve problems. Technology is changing the workplace, the home, and daily life. Moreover, the mathematics a person needs to know has shifted, and new mathematics is being created as technological applications emerge. Yet the teaching of mathematics has remained

relatively unchanged. As it has for centuries, mathematics often relies on rote memorization. The objectives of mathematics education must be transformed to meet the critical needs of our society: an informed electorate, mathematically literate workers, opportunity for all students, and problem- solving skills that serve lifelong learning. Both the content that is being taught and the way it is taught need to be reconsidered and, in many cases, transformed. Educational change involves changing teachers' beliefs and understanding as a prerequisite to improving teaching practices. Research indicates that teachers require a thorough understanding of the meaning of educational change before there is an acceptance and adoption of new programmes and approaches. Curriculum change requires in-school management teams, principals and SCERT, NCERT to lead the implementation of change in the school as an organization. Effective curriculum change and implementation requires time, personal interaction, in-service training, and other forms of people- based support (Fullan, 1993). The Department of Education (elementary and secondary) should devise a range of initiatives and programmes of professional development to support the phased implementation of change within schools nationally. These initiatives should be designed to increase the capacity of schools to respond to change and to plan for and implement that change at individual school level.

In order to realize the changing goals and roles of educational objectives, the curriculum should be conceptualized as a structure that articulates required experiences. For this, it should address some basic questions:

(a) What educational purposes should the schools seek to achieve due to the changing needs?

(b) What educational experiences can be provided that is likely to achieve these purposes?

(c) How can these educational experiences be meaningfully organized?

(d) How do we ensure that these educational purposes are indeed being accomplished?

Further, there is a deep disquiet about several aspects of our educational practice: (a) the school system is characterized by an inflexibility that makes it resistant to change; (b) learning has become an isolated activity, which does not encourage children to link knowledge with their lives in any organic or vital way; (c) schools promote a regime of thought that discourages creative thinking and insights; (d) what is presented and transmitted in the name of learning in schools bypasses vital dimensions of the human capacity to create new knowledge; (e) the "future" of the child has taken centre stage to the near exclusion of the child's "present", which is detrimental to the well-being of the child as well as the society and the nation.

Process of Evaluation of Mathematics Curriculum at School Level

In relation to curriculum, evaluation is the process of making value judgements about the merit or worth of a part or the whole of a curriculum. The nature of a

curriculum evaluation often depends on its audience and purpose. The potential audiences include:

- Policy makers and other stakeholders (administrators, teachers, students, parents, communities) to inform future action.
- Donors to attract funding or to report on the utilization of funds.
- Researchers - for international comparison and identification of effective practices.

Evaluation of curricula is typically concerned with the: Impact of the curriculum:

- ✓ on individual students, their needs, their level of engagement and their performance;
- ✓ on society, including the appropriateness of values communicated and attitudes fostered, and the level of public satisfaction;
- ✓ on the economy including labour markets as an indicator of economic development;
- process through which the curriculum was developed;
- content and design of the curriculum compared with:
- ✓ recent social, technological, economic or scientific changes;
- ✓ recent advances in educational research and educational paradigms; possible future directions for curriculum change.

Self-Check Exercise 1

Explain any two factors which affect the change in curriculum.

6.4 Summary

Dear Learner, in this unit we have studied the factors affecting change in mathematics curriculum.

6.5 Glossary

Child Friendly Environment - Supportive educational and community environment that is inclusive, healthy, friendly, protective and rights-based. The Child-Friendly School model, developed by UNICEF, promotes inclusiveness, gender-sensitivity, tolerance, dignity and personal empowerment.

Culturally Responsive Curriculum - A curriculum that respects learners' cultures and prior experiences. It acknowledges and values the legitimacy of different cultures, not just the dominant culture of a society, and encourages intercultural understanding. It incorporates cultural aspects into the curriculum, rather than adding them on as an extra or separate module or course.

6.6 Answers to Self-Check Exercise

Self-Check Exercise 1

The two main factors that affect change in curriculum are:

1. Social Factors: The impact of social factors on education cannot be underestimated. From the influence of family dynamics and socioeconomic status to the role of peer relationships and cultural norms, these factors shape the educational experiences and

outcomes of individuals. By recognizing the profound effects of social factors and implementing strategies to address them, we can create a more inclusive and equitable educational landscape that empowers every learner to reach their full potential. The needs and requirements of society are dynamic. The changes in values, beliefs, and expectations can prompt curriculum changes. For example, the increasing importance of technology in our daily lives has led to a greater emphasis on Science, Technology, Engineering, and Mathematics education in school curriculum.

2. Technological Factors: The integration of technology in education has been a significant outcome of globalization. Smart classrooms, e-learning platforms, and digital resources have transformed the teaching and learning experience. Technology has made education more interactive, engaging, and accessible to students nationwide. Therefore, technology forced us to make modifications in the present curriculum. For example, the extensive accessibility of digital learning tools and online resources has led to a greater focus on blended learning and personalized instruction.

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6.8 Terminal Question

1. Describe the factors affecting change in mathematics curriculum.

Unit –7 Mathematics Learning Resources: Need and Importance of Mathematics Laboratory, Organization of Mathematics Club and Mathematics Exhibitions

Structure

7.1 Introduction

Dear learner, this unit deals with the mathematics learning resources: need and importance of mathematics laboratory, organization of mathematics club and mathematics exhibitions. Research and evidence shows that the use of high-quality curriculum resources, together with pedagogy that responds to and adapts to the needs of students leads to increased engagement and improved student outcomes. In mathematics classrooms, it is important to create a rich learning environment that encourages a positive mind-set and opens up the potential for growth in mathematics teaching and learning. Using a range of teaching strategies that connect the content, skills and concepts will enhance understanding and engagement and build students' confidence as mathematics learners and thinkers. In the mathematics classroom, students are exposed to opportunities that help them to:

- develop and engage their mathematical thinking
- solve problems and demonstrate their understanding
- apply strategies and conceptual understanding in familiar and unfamiliar situations
- recognize the relevance of their experiences in their environment through a mathematical lens
- use and connect what they are learning to contexts outside the mathematics classroom.

Teachers help students to engage with, explore and make connections between their mathematical knowledge, skills and understandings with other learning areas and the world around them.

7.2 Learning Objectives

After completing this unit, you will be able to:

- explain the importance of mathematics learning resources.
- discuss the need and importance of mathematics laboratory.
- describe the organization of mathematics club and mathematics exhibitions.

7.3 Importance of Mathematics Learning Resources

Research highlights the potential of tools and resources used in mathematics teaching to create meaningful classroom discussions and learning opportunities for students. Video-clips and hypothetical scenarios are effective resources for promoting noticing skills in students, which are culture dependent. Additionally, content-specific structures, such as doing mathematics together, can aid in developing a strong understanding of mathematical concepts for students and teachers.

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. The successful implementation of the curriculum requires the use of a variety of resources that enable the student to learn through a rich and varied selection of instructional materials. Such materials may include books, independent and guided readers, writing programs, e-learning and other technological resources, "hands-on" manipulative and other practical or specialized resources that support the subject matter and student learning outcomes. In this context Clay P. Bedford has rightly said that, "You can teach a student a lesson for a day; but if you can teach him to learn by creating curiosity, he will continue the learning process as long as he lives." 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. For many social scientists, the words educational materials invoke images of large, print, classroom textbooks, out-dated information, and content that cover the breadth but not depth of a subject. But learning resources are more than that. They are any tool that helps teachers in teaching and students in learning. Learning resources are texts, videos, software, and other materials that teachers use to assist students to meet the expectations for learning defined by provincial or local curricula. Before a learning resource is used in a classroom, it must be evaluated and approved at either the provincial or local level. Evaluation criteria may include curriculum fit, social considerations, and age or developmental appropriateness. Learning resources includes

textbooks (print and digital), workbooks, worksheets, manipulative (blocks, beads, etc.), flashcards, educator workshops, non- fiction books, posters, educational games, apps, websites, software, online courses, activity books,graphic novels, reference books, DVDs, CDs, magazines & periodicals, study guides, teacher guides, labs,, models, movies, televisions shows, webcasts, podcasts, maps and atlases.

From the above discussion we can say that 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. 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's strength and engaging students to become life-long learners.

Self-Check Exercise - 1

What is Mathematics Learning Resources?

7.4 Need and Importance of Mathematics Laboratory

The mathematics laboratory is a place where anybody can experiment and explore patterns and ideas. It is a place where one can find a collection of games, puzzles, and other teaching and learning material. The materials are meant to be used both by the students on their own and with their teacher to explore the world of mathematics, to discover, to learn and to develop an interest in mathematics. The activities create interest among students or in anybody who wants to explore, and test some of their ideas, beliefs about mathematics. The mathematics laboratory provides an opportunity for the students to discover mathematics through doing. Many of the activities present. a problem or a challenge, with the possibility of generating further challenges and problems. The activities help students to visualize, manipulate and reason. They provide opportunity to make conjectures and test them, and to generalize observed patterns. They create a context for students to attempt to prove their conjectures. It is important to note that while in science experiments provide evidence for hypotheses or theories, this is not so in mathematics. Observed patterns can only suggest mathematical hypotheses and conjectures, not provide evidence to support them. Mathematical truths are accepted only on the basis of proofs, and not through experiment.

Mathematics laboratory is a place to enjoy mathematics through informal exploration. It is a place where anyone can generate problems and struggle to get an answer. It is a space to explore and design new mathematical activities. So, the

mathematics lab should not be used to assess students' knowledge of mathematics. Often mathematics lab takes students' knowledge beyond the curriculum.

Mathematics laboratory is a self-explanatory lab with activities, in which students could come anytime and engage in the work, continue working on the problems/tasks, and use teachers as and when they are stuck. In this way, the role of the teacher is not to teach how to progress in the activity but to facilitate inquiry with the mathematics in it. The facilitation could be done either by probing questions, giving an extra resource or asking to follow or discuss with peers.

The activities are suitable for students of class 6 to class 10. We have also included a couple of activities suitable for a lower level the place-value snake and the fraction chart. The items have been grouped under two broad headings: (i) activities and (ii) games and puzzles. The activities could be done individually by students, with guidance from a teacher, or could be used for demonstration with a small group of students. Some of the activities could also be used as teaching aids in a classroom. The games and puzzles are fun to do individually and all of them contain some element of mathematics which can be explored while doing them or as a sequel.

A Mathematics Laboratory is a place where some of the mathematical activities are carried out and is akin to any other science laboratory. The way students get hands-on experience in a science laboratory, even in a Mathematics Laboratory, students should get hands-on experience and scope for new innovations. Further Mathematics Laboratory should be a learning environment where many young minds decide that mathematics is more than practicing "sums" that the teacher assigns.

Objectives of Mathematics Laboratory

- To provide readily accessible rich manipulative materials to emphasis on learning by doing
- To develop an attitude of enquiry
- Remove the weakness of present day mathematics education
- To develop confidence in students
- To generate interest in the subject
- To make the students divergent thinkers
- To make the children to look for pattern and ask questions.

Self-Check Exercise- 2

Highlight the objectives of mathematics laboratory.

7.5 Organization of Mathematics Club and Mathematics Exhibitions

Organization of Mathematics Club: For supplementing the teaching of Mathematics in the classroom and to widen the knowledge of his students a good mathematics teacher can involve his students in a number of co-curricular activities such as Mathematics club, visits and excursion, broad-casts, gramophone lectures etc.

There is no limit to such extra-curricular activities and teacher is free to undertake one or more such activities in his school for the benefit of his students. Some of these activities and their organizational set up are taken up in the next few pages. As in some other subjects so also in Mathematics, the students are encouraged to organize themselves into Mathematics clubs and Mathematics associations. Under this organization, discussions and lectures etc. are arranged. Such functions are quite helpful in creating interest in Mathematics. Under such organization certain games based on some concepts of mathematics and mathematical problems can also be arranged. This is likely to help the students in having an idea of the practical utility of mathematics in addition to creating their interest in mathematics.

Importance of Mathematics Clubs

- It is useful in arousing and maintaining interest in mathematics.
- It stimulates the active participation of the students.
- It develops in the students a habit of selective study. This helps them to make a distinction between relevant and irrelevant material.
- The knowledge gained by students in various function of such club activities supplements the class teaching.
- It provides the students an opportunity to free discussion and they are benefited from one another's view.
- Gifted students get an opportunity to satisfy their needs and interests by actively participating in the activities of such clubs and associations.
- Students get an opportunity to listen to some well-known and distinguished mathematicians.
- It gives the students basic training in organizing such programmes.
- It is helpful in making proper utilization of leisure time.
- Through participation in such clubs students get acquainted with the Contribution of Great Mathematicians in their fields.

Steps for Organization of Mathematics Club

A mathematics club, if properly organized, will be a great help in refreshing the teaching of mathematics. Such a club should be run by the students under the guidance and supervision of her/his teacher. For proper running of a club the most important thing is the preparation of a draft constitution of the club. This draft is prepared by the mathematics teacher in consolation with the head of the institution. This draft constitution should provide all important details about the name of her/his club, aims and objectives of the club, details regarding membership and the fees etc.

- One of the senior mathematics teachers is asked to be the sponsor of the club.
- Membership of the club is open to all the mathematics students of the school.

- Associate membership may be allowed to some other students interested in mathematics.
- The club may have an elected executive committee. The members of executive committee.
- Such a club should have the head of institution as its patron.

Organization of Mathematics Exhibitions: Exhibitions are the imaginary way to reach out to a broad public in real life. They are shown in galleries, at museums, in schools, banks, universities, parks or train stations. Exhibitions are diverse: they can include images, interactive programs, sculptures, puzzles, games, text boards, etc. In education, the term exhibition refers to projects, presentations, or products through which students "exhibit" what they have learned, usually as a way of demonstrating whether and to what degree they have achieved expected learning standards or learning objectives. An exhibition is typically both a learning experience in itself and a means of evaluating academic progress and achievement.

Objectives of Exhibitions

- to provide a forum for children to pursue their natural curiosity, creativity, innovation and inventiveness;
- to make children feel that science and mathematics are all around us and we can gain knowledge as well as solve many problems by relating the learning process to the physical and social environment;
- to lay emphasis on the development of science and mathematics as a major instrument for achieving goals of self-reliance, socio-economic and socio-ecological development of the nation and the world;
- to analyze how science and mathematics have developed and are affected by many diverse individuals, cultures, societies and environment;
- to appreciate the role of science and mathematics in meeting the challenges of life such as climate change, opening new avenues in the areas of agriculture, fertilizer, food processing, biotechnology, green energy, disaster management, information and communication technology, astronomy, transport, games and sports etc.
- to create awareness about environmental issues and concerns and inspire children to devise innovative ideas towards their prevention and mitigation

In contrast to worksheets, quizzes, tests, and other more traditional approaches to assessment, an exhibition may take a wide variety of forms in schools:

- Oral presentations, speeches, or spoken-word poems
- Video documentaries, multimedia presentations, audio recordings, or podcasts
- Works of art, illustration, music, drama, dance, or performance
- Print or online publications, including websites or blogs
- Essays, poems, short stories, or plays

- Galleries of print or digital photography
- Scientific experiments, studies, and reports
- Physical products such as a models, sculptures, dioramas, musical instruments, or robots
- Portfolios of work samples and academic accomplishments that students collect over time

Self-Check Exercise- 3

Write short note on Mathematics Exhibitions.

7.6 Summary

Dear learner, in this chapter, you have studied the need and importance of mathematics learning resources like mathematics laboratory, organization of mathematics club, and mathematics exhibitions in detail.

7.7 Glossary

DTH (Direct-to-Home Satellite Television) - A digital receiver is needed to receive the multiplexed signals and view them on a TV.

Absolute URL - The full internet address of a page or other World Wide Web resource. The absolute URL includes a protocol, such as “http,” network location and optional path and file name. For example, http://example.microsoft.com/ is an absolute URL.

7.8 Answers to Self-Check Exercise

Answers to Self-Check Exercise1

The mathematics learning resources includes textbooks (print and digital), workbooks, worksheets, manipulative (blocks, beads, etc.), flashcards, educator workshops, non-fiction books, posters, educational games, apps, websites, software, online courses, activity books, graphic novels, reference books, DVDs, CDs, magazines & periodicals, study guides, teacher guides, labs,, models, movies, televisions shows, webcasts, podcasts, maps and atlases.

Answers to Self-Check Exercise2

The main objectives of mathematics laboratory are:

- To provide readily accessible rich manipulative materials to emphasis on learning by doing
- To develop an attitude of enquiry
- Remove the weakness of present day mathematics education
- To develop confidence in students
- To generate interest in the subject
- To make the students divergent thinkers

- To make the children to look for pattern and ask questions.

Answers to Self-Check Exercise3

Exhibitions are the imaginary way to reach out to a broad public in real life. Exhibitions are diverse; they can include images, interactive programs, sculptures, puzzles, games, text boards, etc. In education, the term exhibition refers to projects, presentations, or products through which students “exhibit” what they have learned, usually as a way of demonstrating whether and to what degree they have achieved expected learning standards or learning objectives.

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7.10 Terminal Questions

1. Explain the importance of mathematics learning resources.
2. Describe the need and importance of mathematics laboratory.
3. Discuss the organization of mathematics club and mathematics exhibitions.

Unit –8 Importance of Various Teaching Aids in Mathematics and Uses of Smart Classroom in of Mathematics

Structure

8.1 Introduction

Dear learner, in this unit the importance of various teaching aids in mathematics and uses of smart classroom in mathematics are discussed in detail.

8.2 Learning Objectives

After completing this unit, you will be able to:

- explain the importance of various teaching aids in mathematics.
- discuss the uses of smart classroom in of mathematics.

8.3 Importance of Various Teaching Aids in Mathematics

Teaching Mathematics with visual aids is really fun and interesting. Teachers use visual aids to catch the attention of the pupils. Wise choice of instructional materials could maintain the alertness and interest of pupils during class hours. Pupils enjoy learning when they see real objects, pictures, and other forms of visual aids. They can relate easily to the lesson with the use of these. They can easily respond to the lesson especially if they can manipulate the teaching materials used. Displaying the visual aids and constantly seeing them can help the pupils master the skills. It is said that in Mathematics, real objects are the best visual aids. There are so many skills in Mathematics that correlate with real objects. Using marbles, sticks and other materials in counting and in understanding the four fundamentals are some of these. The use of different objects like balls, handkerchief, and other real objects help pupils recognize shapes and sizes. Determining the area can be best taught through farms, floor and ceiling. Slicing cakes, fruits and others help them relate with fractions. There are

varieties of visual aids in teaching Mathematics. They can choose and use different materials according to their creativeness. Teachers must be very careful in making and in presenting visual aids. The materials should suit the teachingobjectives and should carefully correlate with the techniques and methods that the teacher will use. Here are some pointers to be considered in choosing and making visual aids:

The Importance of Visual Aids in Teaching Mathematics

- Visual aids must be big enough to be seen by everyone in the classroom. It should be seen even by the last pupil at the back.
- Visual aids should clearly explain and transmit the concepts and ideas.
- Visual aids should get everyone's attention.
- Visual aids should be used according to the purpose it is intended for.
- Visual aids must be communicative. It can transmit the ideas the teacher wants to convey.
- Visual aids should be suited to the principles of teaching and learning.

The use of visual aids in teaching Mathematics plays a very important part in understanding the different skills. Just always remember that the effectiveness and the success of the visual aids as a tool in teaching depend on how the teacher manipulate and use it.

Developing/Preparing Low Cost improvised Teaching Aids

Modem world is witnessing most revolutionary changes in science and technology. The meaning of education is given as bringing up or leading out or making manifest the inherent potentialities in a pupil. John Dewey speaking of education as that reconstruction or organization of experience which adds to the meaning of experience and which increases ability to direct the course of subsequent experience, Education proceeds from birth to death and the school in not the only agency that imparts education. Though the school exerts greater influence in educating the child, other social agencies like home, religion, press, radio, library, television etc., supplement its work. Education lays emphasis on the inculcation and fostering of scientific spirit, knowledge of scientific principles and factor and also framing scientific methods.

Low Cost Teaching Aids

Low cost teaching aid refers to aid prepared with simple materials costing very little by involving teacher and student. In expensive aid could be prepared easily with little or no money to make learning effective, comprehensive and fascinating. The science teacher with a certain amount of skill and enthusiasm can replace many pieces of apparatus by an adequate if unconventional, improvised substitutes. Low cost teaching aids have an advantage of offering learning by doing approach to the teaching learning process. When teachers and students plan, produce or create their own educational materials, they invariably manifest pride and pleasure in utilizing them to the maximum. Effective science and mathematics teaching depends on three factors,

teacher, equipment's and materials. Locally produced low cost equipment, teaching aids or models can serve the needs of the teacher, the student and the curriculum more effectively and is easier to maintain.

Developing Low Cost Teaching Aids

Main task of the teacher is to develop low cost teaching aids by using locally available materials. The teacher should be the active participant in preparing the low cost teaching aids. Teacher by himself or with the help of students may carry out the process. To design the effective low cost teaching aid, teacher should have thorough knowledge of the objectives and science & mathematics concepts. The teachers should have adequate knowledge to provide learning experiences, locally available resources and environmental conditions. To enhance the learning process, the mathematics/science teachers who have real interest in the field prepare their own teaching aids with the help of available resources. By sufficient encouragement from the superiors, parents and the community, the quality and effectiveness of these low cost teaching aids may be improved.

Effective Design of Low Cost Teaching Aids

The following basic principles may be used while preparing low cost teaching aids.

- The concept should be explained accurately, and in a simple way, so that all the students can understand the situation.
- It must attract attention and promote sharp thinking.
- The low cost teaching aids must be very simple and easy to handle.
- Much money can be saved and some complexities of sophisticated appliances avoided.

Advantages of Low Cost Teaching Aids

Improvisation and experimentation play a major role in the success of science/mathematics teaching.

- It helps to have more knowledge and understanding
- Improvisation makes science/mathematics doing instead of talking.
- It promotes pupils maximum participation in the learning process
- Improvisation ensures longer retention of the information gained
- It provides first-hand experience in a variety of ways
- Develops scientific attitude in children
- Cultivates research mindedness in children
- Promotes interaction between teachers and students
- Promotes interaction among students
- Improvisation generally add an interest and involvement in lesson
- Encourage co-operative attitude in children
- Develops self-confidence of pupils

- Helps the students to make use of their leisure time
- Helps the school to become self sufficient
- With the help of the improvised aids the presentation of the content will also be attractive and stimulating
- It also facilitates the propagation of new curricular ideas
- It helps to improve efficiency
- It accelerates the rate of learning and increases the span of retention
- Learning experiences appending to the senses are far more effective than abstract learning experiences.

To create interest in teaching learning process low cost teaching aids can be used. Real learning takes place only when the students observe the experiments or when they perform the actual experiment. This is impossible in our country due to lack of facilities. Before the preparation of aids it is important to understand how to explain the concepts. Teachers should know how to prepare, use and evaluate the low cost teaching aids; so that their classroom interaction becomes meaningful. In service training should be given to the teachers in this field. India is economically a backward country, teachers should implant a healthy outlook towards the use of low cost teaching aids. Science/mathematics teachers should encourage their students to make the low cost teaching aids with help of locally available resources. The pupils should be given a very clear picture of the resources available in the locality. Attempts can even be made to allot a separate period of the preparation of the aids. Teachers should as far as possible, make use of the low cost teaching aids rather than sophisticated ones, while they demonstrate or teach lessons.

Self-Check Exercise- 1

Write few advantages of low cost teaching aids?

8.4 Uses of Smart Classroom in Teaching of Mathematics

A smart classroom is a classroom that has an instructor equipped with computer and audio-visual equipment, allowing the instructor to teach using a wide variety of media. These include smart interactive white board, DVD's, PPT's and more, all displayed through a data projector. Smart class is a digital initiative of EDUCOMP, which is rapidly transforming the way teachers teach and students learn. With the help of school curriculum, smart classes bring in technology right next to the blackboard for teachers in the classroom. This makes learning an enjoyable experience for the students while improving their overall academic performance in school. Smart Classes, providing education better through presentations and videos. I think a student can learn better through visualization. All the students may not understand the teaching methodology of a teacher, but can understand by smart classes. This can be seen in case of movies, i.e. students remember movies better than the lessons taught in

classroom. This type of teaching creates an attention called as interest in them. So e-learning is absolutely better. But this should not be applied to all the topics in every subject, because imagination and visualization and application capability of student regarding the subject may be reduced. So smart classes are better only up to certain limit. The new revolutionary program in school education system, 'Smart Classes' has changed the very concept of learning (classroom teaching). It's an innovative technology that has aimed to revolutionize the way teachers teach and students learn in class. Obviously, this methodology has proved beneficial for the students. Firstly, the curriculum is converted into animated visuals which not only becomes an enjoyable experience for students but they can relate to and remember facts easily. For them, while learning in the classroom becomes a thrilling and exciting experience, at the end they find abstract and difficult concepts easy to comprehend thereby enhancing their academic performance. Such teaching helps to maintain the student's interest and focus by engaging them fully for the entire learning experience. Secondly, from the teacher's point of view. with the arrival of this digital initiative which is so practical to modern time and friendly to use, teachers can instantly evaluate/assess the learning achieved by their students in his/her class. If a concept taught is not understood then teacher can repeat with greater clarity and emphasis. He/she can identify areas of student's strength as well as weaknesses. These ultimately help the student's for better understanding. The new revolutionary program in school education system. 'Smart Classes has changed the very concept of learning (classroom teaching). It's an innovative technology that has aimed to revolutionize the way teachers teach and students learn in class. Obviously, this methodology has proved beneficial for the students. Smart classrooms are very much beneficial in teaching-learning process in a school. We make use of an appeal to audio- visual senses of students in using smart boards. These smart boards are like a computer screen which is finely handled by a teacher and also by students to provide active participation. Some of the benefits for Smart board used inside a classroom are:

- **Appeal to Audio-visual Senses:** By using smart boards in a classroom, we are appealing to both the audio sense and visual senses of students. Learning in such a way is very effective as the information is strongly embedded in kids mind this way.
- **No Wastage of Time:** In traditional type of classroom, a lot of time was wasted in drawing diagrams on the black/white boards, whereas in Smart-boards, diagrams are in memory and thus time is utilized more for the active learning part.
- **No Chalk Dust:** Some teachers and even front line students used to suffer from chalk dust getting into their eyes and lungs. This had ill effect on health. Using smart-board we are eliminating this health issue.

- **Virtual field Trips:** Students are taken virtually to field trips while teaching, say, a teacher is covering a lesson on desert animals, using smart-board, we could give a tour of desert like Sahara or Kalahari to teach this topic.
- **Marker Feature:** Smart board teaching is not 'see-only', we could use special markers to underline or mark an important location while teaching. We can even write on it to make the concept clearer.
- **Inbuilt Library:** Smart board has an inbuilt library in it which enables a teacher to have an instant look at it in case of requirement. He/she may not have to scan a real library for this.
- **Active Learning:** Smart boards leads to active learning process where both the teacher and the students are involved. This leads to strong reinforcement of information in students.

From the foregoing discussion it can be concluded that Smart Class provides teachers with instant access to multimedia content and instruction materials mapped exactly to the specific curriculum guidelines for use in class. It also enables teachers to instantly assess and evaluate the learning achieved by their students in class with innovative use of technology. Smart Class helps teachers to ensure that every child in the class is learning, given the wide diversity of learning styles in the classroom. It is also highly efficient in maintaining student's interest and engagement in learning inside the classroom. Smart Class simplifies the problems of teaching abstract curriculum concepts that are difficult for students to visualize or relate to through the provision of three dimensional, interactive multi-media modules. Thus, smart class brings about a complete transformation in classrooms. This results in faster and accurate understanding of the concepts in class and helps improve the overall academic performance of students. Teachers are able to keep students engaged in the learning process and also get an instant and accurate assessment of learning outcomes achieved at the end of the class.

Self-Check Exercise- 2

List three benefits of smart class rooms in teaching of mathematics.

8.5 Summary

Dear students in this chapter you have studied the importance of various teaching aids in mathematics, benefits of smart classrooms in detail.

8.6 Glossary

Fixed Mindset: Mindset refers to the beliefs and attitudes held by a person and can affect their learning outcomes and achievement. Individuals with a fixed mindset (also referred to as entity theory) are outcomes-focused; don’t view intellectual ability as being

malleable, and give up quickly on learning a new skill when learning becomes more challenging and difficult.

Pedagogy: Pedagogy is the method, practice and study of effective teaching. In order to be effective, instructors must have both subject-based knowledge and pedagogic knowledge and skills.

8.7 Answers to Self-Check Exercises

Answers to Self-Check Exercise1

The advantages of low cost teaching aids are:

- It helps to have more knowledge and understanding
- Improvisation makes science/mathematics doing instead of talking.
- It promotes pupils maximum participation in the learning process
- Improvisation ensures longer retention of the information gained
- It provides first-hand experience in a variety of ways
- Develops scientific attitude in children
- Cultivates research mindedness in children
- Promotes interaction between teachers and students

Answers to Self-Check Exercise2

The three benefits of smart classrooms are:

1. Appeal to Audio-visual Senses: By using smart boards in a classroom, we are appealing to both the audio sense and visual senses of students. Learning in such a way is very effective as the information is strongly embedded in kids mind this way.

2. No Wastage of Time: In traditional type of classroom, a lot of time was wasted in drawing diagrams on the black/white boards, whereas in Smart-boards, diagrams are in memory and thus time is utilized more for the active learning part.

3. No Chalk Dust: Some teachers and even front line students used to suffer from chalk dust getting into their eyes and lungs. This had ill effect on health. Using smart-board we are eliminating this health issue.

8.8 References/Suggested Readings

- Aggarwal, S.M. (2005). Teaching of Modern Mathematics, Delhi: DhanpatRai and Sons.
- Das R.C. (1984). Curriculum and Evaluation, NCERT, New Delhi, p.42.
- National Curriculum for Primary and Secondary Education: A Frame Work, NCERT, New Delhi, 1985, (From Preface).
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8.9 Terminal Questions

1. Describe the importance of various teaching aids in mathematics.
2. Explain the importance of smart classroom in teaching of mathematics.
3. Discuss the qualities of a good textbook in mathematics.

Unit –9 Qualities of a Good Textbook in Mathematics

Structure

9.1 Introduction

Dear learner, in this unit qualities of a good textbook in mathematics are discussed in detail.

9.2 Learning Objectives

After completing thisunit, you will be able to:

- describe the qualities of a good textbook in mathematics.

9.3 Qualities of Good Textbook in Mathematics

The textbook plays an important role in teaching and learning. It represents a useful resource for both teachers as a course designers and learners. However, the use of a ready-made textbook has its advantages and disadvantages. Textbooks give a great contribution in the teaching-learning process both to the teachers and to learners. They offer a framework of guidance and orientation. Characteristics and Qualities of Text-books are listed below:

- Text-books that are intended to be used should be useful for the students as well as teachers. .
- They should be so designed that on the one hand they may be written according to the psychological requirements of the students and on the other they should serve the purpose of the teacher who wish to impart knowledge to the students in a successful and interesting manner.
- The size of the book should be handy. It should be possible for the students to carry them properly. They should not be bulky. This is especially true about books intended for the primary classes.

- Printing and get-up of the books should be interesting and attractive. They should be printed in the letters that they do not require strain on the eyes of the students. On the other hand they should be correctly and neatly printed.
- The exterior of the picture should be attractive. If the exterior is attractive, students would like to carry them and keep them. This is true of the books intended for primary classes.
- They should serve the purpose of the subject matter as well as the aims and objects of teaching. They should be written with a view on the aims and objects of the teaching.
- The text-books should be accurately written. They should present the subject-matter in such a manner that there is no fault in them. The subject-matter, presented therein should be up to date.
- The style of the books should also serve the psychological requirements of the students of different stages. Text books intended for the students of the primary classes should be written in a story form. In the text-books meant for higher classes the author may use the regional method or some other method that is useful for the students of the stage.
- The text-books should continue to keep the interests of the students alive in the subject-matter. The subject-matter should be presented in a simple and lucid style and clear form.
- The text-books should contain all the necessary and relative material required for particular stage of education.
- Text-books should be free from prejudice. The presentation of the subject-matter should be unbiased. There should be no material which can injure the susceptibility of any class or category of people. They should contain objective description of the people and conditions of different countries.
- The text-books should contain charts, maps, diagrams etc. as and where required. Without the charts, maps and diagrams etc. the subject-matter of Geography cannot be taught properly. It is, therefore, necessary to give place to all these things in the text-books.
- Geography is a developing subject. Every day we find that new researches have been made in the field of Geography. Up to date knowledge of Geography must be given place in the text-books.
- At the end of every chapter of the text-book there should be certain questions that may be used for the revision of the subject-matter. Without these questions the text-books shall not be useful.

  Evaluation of Mathematics Text Book prescribed by Himachal Pradesh Board of School education/ CBSE for Elementary and Secondary Stage: Textbook evaluation is often presented as an activity that goes hand in hand with textbook selection, although this is not necessarily true. As Rubdy (2003) observes, evaluation criteria are

not always readily accessible to teachers and as such, selection may be done in an ad hoc manner. Textbook evaluation should ideally inform selection, and become an on-going activity during, and even after, use of the textbook. Masuhara, (1998) and Tomlinson (2003) note that evaluation differs according to purpose and may be done systematically in three stages: pre-use (materials selection), whilst-use and after-use. McGrath (2002, pp.14-15) examines similar processes, "pre-use", "in-use" and "post-use" evaluation. Rubdy (2003b) suggests a framework including psychological validity (learners' needs, goals and pedagogical requirements); pedagogical validity (teacher's skills abilities, theories and beliefs); process and content validity (the thinking underlying the materials writer's presentation of the content and the approach to teaching and learning respectively). In order to make an informed selection, with long-term sustainability in mind, Hutchinson (1987, pp. 42-43) advocates that teachers look "underneath materials" in order to make selections and develop awareness of their own teaching-learning situation. The practice of materials evaluation develops awareness by encouraging teachers to analyze their presuppositions about the nature of language and learning establish priorities, and view materials as an integral part of teaching and learning. The overall suggestions for teachers to take into account during materials evaluation, as follows:

- Teaching contexts and situations
- Authenticity
- Sensitivity to socio-cultural issues
- Organization of the materials
- Methodology
- Textbook content
- Tasks (Exercises, activities etc.)
- Self-instruction
- Supplementary materials
- Visual Design
- Practical Concerns
- Quality of the textbook

The material should present more than one point of view, and be free from discriminatory, exclusionary, or inappropriately value-laden language, photographs, and illustrations. Format Suitability for Student Use Textbooks must be intended primarily for use by students, rather than for use by teachers. The organization should be logical and easy to follow to promote ease of comprehensibility. Durability Textbooks must be constructed of high-quality materials sufficiently durable to support frequent use by many students. For print materials, the size, weight, and shape of the textbook should be such that the textbook is easily transported with little risk of damage.

- The textbook includes a detailed overview of the functions, structures and vocabulary that will be taught in each unit.
- The layout and design is appropriate and clear.
- The textbook is organized effectively.
- An adequate vocabulary list or glossary is included.
- Adequate review sections and exercises are included.
- An adequate set of evaluation quizzes or testing suggestions is included.
- The teacher's book contains guidance about how the textbook can be used to the utmost advantage.
- The materials objectives are apparent to both the teacher and student
- The textbook provides a balance of activities (Ex. There is an even distribution of free vs. controlled exercises and tasks that focus on both fluent and accurate production).
- The activities encourage sufficient communicative and meaningful practice.
- The activities incorporate individual pair and group work.
- The grammar points and vocabulary items are introduced in motivating and realistic contexts. The activities promote creative original and independent responses.
- The textbook's activities can be modified or supplemented easily.
- The materials include and focus on the skills that I/my students need to practice.
- The materials provide an appropriate balance of the four language skills.
- The textbook pays attention to sub-skills, that is, listening for gist, note-taking, skimming for information.
- The textbook highlights and practices natural pronunciation (that is, stress and intonation).
- The language used in the textbook is authentic, that is, like real-life English.
- The language used is at the right level for students' current English ability.
- The progression of grammar points and vocabulary items is appropriate.
- The grammar points are presented with brief and easy examples and explanations.
- The subject and content of the textbook is relevant to students' needs as an English language learner(s).
- The subject and content of the textbook is generally realistic.
- The subject and content of the textbook is interesting, challenging and motivating.
- There is sufficient variety in the subject and content of the textbook.
- The materials are not culturally biased and they do not portray any negative stereotypes.
- The textbook is appropriate for the language-learning aims of my institution.
- The textbook raises my (students) interest in further English language study.

From the above discussions we can say that textbook should be evaluated on following points:

- material organization,
- language proficiency,
- teaching reading comprehension,
- teaching writing.
- teaching grammar and vocabulary,
- teaching listening comprehension.
- teaching oral skills,
- content, examination practice.

Self-Check Exercise- 1

Write short note on importance of text book.

9.4 Summary

Dear students in this chapter you have studied the importance and qualities of text books in detail.

9.5 Glossary

Bound - A book with a cover of any type, or a periodical that has a cover other than its published wraps.

Imprint - A term that can refer either to the place of publication or to the publisher.

9.6 Answers to Self-Check Exercise

Answers to Self-Check Exercise1

The textbook plays an important role in teaching and learning. It represents a useful resource for both teachers as a course designers and learners. Textbooks give a great contribution in the teaching-learning process both to the teachers and to learners. They should be so designed that on the one hand they may be written according to the psychological requirements of the students and on the other they should serve the purpose of the teacher who wish to impart knowledge to the students in a successful and interesting manner.

9.7 References/Suggested Readings

- Aggarwal, S.M. (2005). Teaching of Modern Mathematics, Delhi: DhanpatRai and Sons.
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9.8 Terminal Questions

1. Discuss the qualities of a good textbook in mathematics.

Unit – 10 Meaning of Methods/Approaches and Project Method

Structure

10.1 Introduction

Dear learner, this unitdeals with meaning of methods/approaches and Methods of Teaching Mathematics (Project Method)in detail.

10.2 Learning Objectives

After completing this unit, you will be able to:

- discuss the meaning of methods/approaches.
- explain the project method.

10.3 Meaning of Methods/Approaches

There are, and have been, many approaches, methods, and strategies in teaching of mathematics. Approaches deal with general philosophies of teaching. Methods deal with more practical nuts and bolts. Strategies deal with specific actions. Method refers to how you are going to teach it: lecture, small-group work, PowerPoint, worksheet, class discussion, etc. In a sense, then, as mentioned above by the previous editor, in education, too, approach is general and method is specific. Approach and Method are two words that are often confused due to the appearing similarity in their meanings. Strictly speaking there is some difference between the two words. Approach refers to an act or means of coming near or approaching as in the expression "made an approach. In the expression needs a new approach', the word 'approach' has the sense of a way of dealing with a person or a thing. A method on the other hand is a word meaning 'a way' or 'a process. It refers to the manner in which a work is executed. This is the main difference between approach and method. You approach a problem with a view to tackle it. On the other hand you resort to a method with a view to solving it. In

other words you can say that the word 'approach' is based on 'tackling' things whereas the word "method" is based on solving problems. Approach is the cause whereas method is the effect. The approach to a bridge (method) has to be good for you to reach the other end of the river in a safe manner. These are the differences between the two concepts, namely approach and method. In other words we can say that method is the way in which something is done. Method is always organized, structured and systematic. It can refer to a step by step description of tasks to be completed in order to perform a task. For example, if you are writing a critical essay on a novel, method would be the areas you are going to analyze and the way in which you analyze. If you are conducting research, method is the way in which you gather data and analyze them. Method basically explains how to do something and how something is done. Approach is the way in which you are going to approach a project or task. It refers to the angle you are using or the direction you are going to take. There can be a more than one way to approach a task. In academic field, approach can refer to the theoretical framework you are going to use in a project.

Difference between Method and Approach

Method	**Approach**
Method is the way in which something is done.	Approach is the way in which something is approached.
Method refers to a process.	Approach can refer to the direction or angle.
Method can be selected after deciding the approach.	Approach can refer to the theoretical framework in general.
Method refers to step by step guidelines.	Approach has to be decided before selecting the method.

Self-check Exercise1

Method is always organized, ---------- and systematic.

10.4 Methods of Teaching Mathematics (Project Method)

To teach different topics in mathematics, first of all we need to understand different methods and approaches. There are different methods and techniques to teach different topic of mathematics. To teach algebra inductive-deductive methods are more suitable and to teach geometry analytic and synthetic methods are more suitable. The detail of each method and approach is as under.

Project Method: Project method is an outcome of Dewey's philosophy or pragmatism. This method is developed and advocated by Dr.Kilpatrick.

Meaning of Project

- Project is a plan of action - Oxford's Advanced Learner's Dictionary
- Project is a bit of real life that has been imported into school-Ballard

- A project is a unit of wholehearted purposeful activity carried on preferably in its natural setting-Dr.Kilpatrick
- A project is a problematic act carried to completion in its most natural setting – StevensonBasic Principles
- Learning by doing
- Learning by living
- Learning through association, co-operation and activity

Psychological Laws of Learning: Project method is based on the basic laws of psychology.

- Law of readiness
- Law of exercise
- Law of effect

Steps involved in Project Method

- Providing/Creating the situations
- Proposing and choosing the project
- Planning the project
- Execution of the project
- Evaluation of the project
- Recording of the project

Step 1:Creating the situation: The teacher creates problematic situation in front of students and while creating the appropriate situation student's interest and abilities should be given due importance.

Step 2: Proposing and choosing the project: While choosing a problem teacher should stimulate discussions by making suitable suggestions. The proposed project should be according to the needs of students. The purpose of the project should be well defined and understood by the children.

3: Planning the project: For the success of the project, planning of project is very important. The children should plan out the project under the guidance of their teacher.

Step 4: Execution of the project: Every child should contribute actively in the execution of the project. It is the longest step in the project.

Step 5: Evaluation of the project: When the project is completed the teacher and the children should evaluate it jointly discussed whether the objectives of the project have been achieved or not.

Step 6: Recording of the project: The children should maintain a complete record of the project work. While recording the project some points like how the project was planned, what discussion were made, how duties were assigned etc. should be kept in mind.

Few Projects for Mathematics: A few projects suitable for elementary and secondary school level mathematics are listed below:

- Execution of school bank
- Running stationary stores in the school.
- Laying out a school garden
- Executing the activities of mathematics clubs

Merits

- It is based on various psychological laws and principles of learning.
- It develops self-confidence and self-discipline among the learners.
- It provides sufficient scope for skill development and training.
- It promotes independent work habit and individual development.
- It promotes habits of critical thinking and encourages the students to adopt problem-solving methods.
- It is based on principle of activity, reality, effect, and learning by doing etc.
- It develops discovery attitude in the child.
- It provides self-motivation as the students themselves select plan and execute the project.

Demerits

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

Self-check Exercise2

1. Who advocated/developed project method?

10.5 Summary

Dear learner, in this unit you have studied the concept of methods/approaches and project method of teaching mathematics.

10.6 Glossary

Alternative analysis - The evaluation of possible courses of action for project work in order to find the most suitable course of action.

Approach analysis - During the project planning phase, this type of analysis is used to examine the various methods by which a project's goals may be achieved.

10.7 Answer to Self-check Exercises

Self-check Exercise1

1. Answer: Structured

Self-check Exercise2

1. Dr.Kilpatrick

10.8 References/Suggested Readings

- Nanda, N. N. (1972). Teaching Mathematics, Ludhiana; Sharda Brothers.
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10.9 Terminal Questions

1. Discuss the meaning of methods/approaches.
2. What is the difference between project and problem solving methods?

Unit –11 ProblemSolving Method

Structure

11.1 Introduction

Dear learner, this unit deals meaning and importance of Problem Solving Methodin detail.

11.2 Learning Objectives

After completing this unit, you will be able to:

- explain the project and problem solving methods.

11.3 Problem Solving Method)

There are different methods and techniques to teach different topic of mathematics. To teach algebra inductive-deductive methods are more suitable and to teach geometry analytic and synthetic methods are more suitable. The detail of problem solving method is as under.

Problem Solving Method: Problem solving may be defined as a process of raising a problem in the minds of students in such a way as to stimulate purposeful reflective thinking in arriving at a rationale solution. Problem solving involves concept formation and discovery learning. Problem- solving is a process - an on-going activity in which we take what we know to discover, what we don't know. It involves overcoming obstacles by generating hypotheses, testing those predictions, and arriving at satisfactory solutions. Problem-solving involves three basic functions:

1. Seeking information
2. Generating new knowledge
3. Making decisions

Problem-solving is, and should be, a very real part of the curriculum. It presupposes that students can take on some of the responsibility for their own learning and can take personal action to solve problems, resolve conflicts, discuss alternatives,

and focus on thinking as a vital element of the curriculum. It provides students with opportunities to use their newly acquired knowledge in meaningful, real-life activities and assists them in working at higher levels of thinking.

Characteristics of a Problem

- The problem should be meaningful, interesting and practical.
- It should be well defined.
- It should have some educational value.
- As much as possible the problem should be related with the daily life of the child.
- It should be challenging so that the powers of thinking and reasoning can be developed.
- It should have correlation with other school subjects also.
- It should be related with the previous knowledge of the child.
- It should be according to the mental level of the child.
- It should develop imagination and critical power.
- It should develop mathematical skills.
- It should develop scientific attitude amongst the children.

Steps in Problem Solving Method

1. Selection and Formation of Problem: The nature of problem should be made very clear to the pupils. The pupil should feel the necessity of finding out the solution of the problem which is selected and formulated. The selection of the problem should be done by the teacher and child both.
2. Presentation of the Problem: After selecting and formulating a problem, teacher should present the problem well before the students. The teacher should also make it clear that how this problem can be solved and how the related data and information can be collected to get the solution of the problem.
3. Formulation of Hypothesis: Formulation of hypothesis means; preparation of a list of possible reasons of the occurrence of the problem. Formulation of hypothesis develops thinking and reasoning powers of the child. It should be kept in mind that formulated hypothesis must be testable.
4. Collection of Relevant Data and Information: The child should be stimulated to collect data and information in a systematic and scientific manner. The teacher can suggest many points regarding collection of data to the students. He can ask them to refer extra books and literature.
5. Analysis and Organization of Data: On the basis of collected data and information, the formulated hypothesis is tested. Various statistical techniques are used to analyze and organize the data.
6. Drawing Conclusions: After analyzing and organizing the data, conclusions are drawn. The selection and rejection of hypothesis are made on the basis of data. Care should be

taken that judgments are made only when sufficient data is collected. Discussions and conclusions should be arranged collectively or individually with each child.

7. Testing of Conclusions: No conclusion should be accepted without being properly verified. The student must be asked to be critical while testing conclusions. Thus the correctness of the conclusion is proved by applying them in new or different situations.

Merits

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

Demerits

- It is not suitable for lower classes.
- There is lack of suitable books and reference for children.
- It is not economical.
- It is wastage of time and energy.
- Teachers find it difficult to cover the prescribed syllabus.
- To follow this method talented teachers are required.
- There is always doubt of drawing wrong conclusions.

Self-check Exercise1

1. What are three basic functions of problem solving method?

11.4 Summary

Dear learner, in this unit you have studied the problem solving method of teaching mathematics in detail.

11.5 Glossary

Intervention - Changing one or more aspects of a situation with a specific purpose or outcome in mind. Intervention may be planned or unplanned but is always deliberate - there is always some end in view.

Solution - A course of action that leads to the desired results that define the solved state. In effect, a solution is a course of action that closes the gap between what is and what should be and, in so doing, eliminates the requirement for action.

11.6 Answer to Self-check Exercise

Self-check Exercise1

1. Three basic functions of Problem solving method are seeking information, generating new knowledge and making decisions.

11.7 References/Suggested Readings

- Nanda, N. N. (1972). Teaching Mathematics, Ludhiana; Sharda Brothers.
- National Curriculum for Primary and Secondary Education: A Frame Work, NCERT, New Delhi, 1985, (From Preface).
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11.8 Terminal Questions

1. What do you understand by problem solving method?

Unit – 12 Inductive-Deductive Approach of Teaching Mathematics

Structure

12.1 Introduction

Dear learner, this unit deals with inductive-deductive approach of teaching mathematics.

12.2 Learning Objectives

After completing this unit, you will be able to:

- list and describe the inductive-deductive approach of teaching mathematics.

12.3 Approaches of Teaching Mathematics - Inductive-Deductive

Inductive-Deductive Approach: Inductive and deductive is a combination of two separate approaches, inductive-deductive. Therefore to understand these approaches, we have to know about each approach individually.

Inductive Approach: Inductive approach takes into account the process of induction. In inductive reasoning one proceeds from particular to general, from concrete facts to abstract rules and from specific examples to the general formula. The results are always generalized by studying particular concrete cases and examples.

Teaching with the help of Inductive Approach

1. **Knowledge of Sum of Three Angles of a Triangle:** Children may be asked to construct a few triangles of any size or shape. Then they may ask to measure and sum up the angles in each case with the help of "D". They may find that the sum of angles of triangles is same in each case. Then it may lead to conclude that; "The sum of three angles of any triangle is equal to 180 degree or two right angle triangles".
2. **Establishing the Formula $(a+b)^2= a^2+b^2 +2ab$:** The students may be asked to find out the square value in each cases like (a+b), (m+n) and (p+q) etc by simple method of multiplication. After doing these different multiplications, they may be helped in generalizing that;

In this case $(a+b)^2$, $(m+n)^2$,$(p+q)^2$ are particular cases, we solve them in following way;

Particular Form: $(a+b)^2=(a+b) \times (a+b) = a^2+b^2+ab+ba-a^2+b^2+2ab$

Particular Form: $(m+n)^2= (m+n) \times (m+n) = m^2+n^2+mn+nm-m^2+n^2+2mn$

Particular Form: $(p+q)^2= (p+q) \times (p+q)= p^2+q^2 + pq+qp = p^2+q^2+2pq$

Particular Form: $(x+y)^2$ ----------do----------

Particular Form: $(b+c)^2$ ---------- do ----------

Generalized Form:

$(1^{st}$ term $+2^{nd}$ term$)^2 = (1^{st}$ term$)^2+(2^{nd}$ term$)^2 + 2 \times (1^{st}$ term$) \times (2^{nd}$ term$)$

3. **Establishing the Formula of Simple Interest i.e. S.L.-PxRxT/100:** The pupils may be asked to solve a few problems on Simple Interest with the help of Unitary method.

The summary then may be written on the black board in the following way

S. L. of Rs. 300 for 2 Years at 4% annum = 300x2x4/100=24.00

S. I. of Rs. 400 for 3 Years at 5% annum = 400x3x5/100 = 60.00

S. I. of Rs. 600 for 4 Years at 3% annum = 600x4x3/100 = 72.00

A close analysis of above results may lead to conclude that

S.I. = Principal x Rate x Time/ 100

i.e. S.I. = PxRxT/100

Merits

- It is a scientific approach because knowledge attained by this method is based on real facts.
- The child gets the knowledge of the purpose of deciding and generalizing laws, formulas etc.
- The knowledge gained by the use of this approach is more durable because in this method childhimself attains the knowledge by examples, observation and testing.
- The critical observation and logical power of children are developed by inductive approach.
- This is a psychological approach because many important principles of psychology are used in this approach.
- This approach guides the child to the work himself develops in them self-reliance and self-confidence.
- This approach helps to ascertain or establish many laws, relations, formula and new principles of mathematics.
- This is very useful and suitable for lower classes.
- This develops curiosity and interest in the child to learn mathematics.
- In this approach child themselves attain the knowledge with the help of examples so they don't feel bored (fatigue). They remain active to attain new knowledge.

Demerits

- This is very slow process, so gaining knowledge by this method costs more time andlabour.
- It needs sharp mind, proper planning and enough labour. So it is not easy to attainknowledge by this method for students of all levels.
- This approach is useful only for lower classes because syllabus is very wide in higherclasses and it is not possible to cover the whole syllabus.
- Only an experienced and able teacher can use this approach successfully.
- The ability and capacity of problem solving cannot be developed by the use of thisapproach.
- It is neither easy for teachers nor for students to select or present real examples forgeneralization.
- Results drawn by the use of this approach are not always true. Their truthfulness depends upon a number of examples on which they are based. Because the truthfulness of reliability of any result is more if it is drawn from more number of specific examples.

Deductive Approach: In deductive approach one follows deductive reasoning which is just opposite to inductive reasoning. In this way deductive reasoning begins with the deductive results or generalized conclusions. Therefore in deductive approach one proceeds from general to particular, from abstract rules to concrete cases and from general formula to specific examples.

Teaching Mathematics with the help of Deductive Approach

1. The teacher may announce that today he is going to teach S.I. he will then give the relevant formula i. e. S.I. = PxRxT/100
2. For acquainting the students with its applications, he may also solve a few problems. Then he may ask the students to solve similar problems directly with the help of given formula.
3. The teacher may tell the students that the sum of the three angles of a triangle is equal to two right angles. Afterwards, student may be asked to verify this established fact by measuring the angles of different triangles. Students may be told about the formula of the area of rectangle i.e. A= length x breadth. Then they may be asked to apply it in finding the area of different rectangles.

Merits

- By using this approach mathematics work becomes very easy and comfortable.
- By deductive approach cramming power of students increases.
- By using this approach the speed of gaining knowledge increases because students directly use the formula for solving the problem.
- This approach should be used when there is shortage of time.

- This approach is used for teaching theorem and axioms of geometry, tables in arithmeticetc.
- Both the teacher and pupil do not find any difficulty in using this approach.
- More knowledge can be attained in less time.
- Laws, principles and formulas can easily be checked by using this approach.
- Children can do the exercise quickly and easily by using this approach.
- This approach is short as well as practical.

Demerits

- This approach is not in accordance with psychological principles.
- In this approach more emphasis is given on cramming than understanding or discovering.
- In this approach students work like machines without knowing the purpose of proceeding in that particular way.
- Knowledge gained by this approach is unclear and unstable, because it is not gained by own efforts.
- In this approach there is not scope of developing powers like logical thinking and investigation.
- This approach is not suitable for lower classes because it is very difficult for the students'of lower classes to understand different formula, laws etc.
- By using this approach the teaching learning process becomes uninteresting and dull.
- Children don't get opportunities to gain new knowledge by using this method.

Self-Check Exercise

Q.1 In inductive reasoning one proceeds from particular to generaland from specific examples to …….

12.4 Summary

Dear learner, in this unit we have discussed the inductive-deductive approach of teaching mathematics in detail.

12.5 Glossary

1. Inductive Reasoning, the process is to move from a specific observation to a broader and more generalized conclusion.
2. Deductive Reasoning, the process begins with a general statement to be proved with a logical conclusion.

12.6 Answer to Self-Check Exercise

Answer 1. the general formula

12.7 References/Suggested Readings

- Nanda, N. N. (1972). Teaching Mathematics, Ludhiana; Sharda Brothers.
- National Curriculum for Primary and Secondary Education: A Frame Work, NCERT, New Delhi, 1985, (From Preface).
- NCERT, A Textbook of Content-cum-Methodology of Teaching Mathematics, New Delhi Rai, B. C. (1978). Teaching of Mathematics, Lucknow; Prakashan Kendra.
- Reymond, B. (2000). Math-tricks, puzzles and games. New Delhi: Orient Paperbacks
- Sharan, R., & Sharma, M. (2006). Teaching of Mathematics. New Delhi: A.P.H. Publishing Corporation.
- Sidhu, K. S. (2006). The Teaching of Mathematics, New Delhi: Sterling Publishers private Ltd.
- Singh, M. (2006). Modern Teaching of Mathematics, New Delhi: Anmol Publications Pvt. Ltd.

12.8 Terminal Questions

1. List and describe the approaches of teaching mathematics (inductive-deductive and analytic-synthetic).

Unit – 13 Analytic-Synthetic Approach of Teaching Mathematics

Structure

13.1 Introduction

Dear learner, this unit deals with analytic-synthetic approach of teaching mathematics.

13.2 Learning Objectives

After completing thisunit, you will be able to:

- list and describe analytic-synthetic approach of teaching mathematics.

13.3 Approaches of Teaching Mathematics (Analytic-Synthetic)

Analytic-Synthetic Approach

Analytic Approach: According to the Webster Comprehensive Dictionary the "Analysis" means, the resolution of a whole unit into its parts or elements or the process of resolving a problem into its first element (inductive reasoning).Analysis is the ability to break down material to its fundamental elements for better understanding of the organization. Analysis may include identifying parts, clarifying relationships among parts and recognizing organizational principles of scientific system. In this approach we proceed from unknown to known facts. In this approach the problem is analyzed to find out the relations. A statement is analyzed into simpler statements and then truth is discovered. It is based on inductive reasoning and critical thinking. All the related facts are analyzed to seek help in proceeding to the known conclusion. It is a logical method which leaves no doubt in the minds of students in understanding the core concept and discourages cramming and rote memory of the learner. It facilitates the understanding of the students and motivates them to discover facts by him. It is a psychological method based on the principle of interest, which inculcates the spirit of inquiry and investigation in the students.

Procedure:

If $a/b=c/d$, prove that $(ac-2b^2/b=(c^2-2bd)/d$
The unknown part is $(ac-2b^2)/b=(c^2-2bd)/d$ is true,
Ifacd = $2b^2$ d = b c^2 = $2b^2$ d is true,
Ifaed = b c is true,
if a d = b c is true
that is, if a/b = c/d is true,
which is known.

Merits

- This approach is based on psychological principles.
- It is based on heuristic approach.
- It develops scientific attitude.
- It leads to the spirit of enquiry and investigation.
- Analysis is the process of thinking
- It helps in developing self-confidence and logical abilities in the child.
- Knowledge gained by this approach is permanent.
- It is a formative approach and based on inductive reasoning.

Demerits

- This is a lengthy approach.
- It is not possible to acquire speed and efficiency.
- Every teacher cannot use this approach successfully.
- The whole syllabus cannot be completed within the certain period.
- The use of analytic approach' is possible only when we have the knowledge of known facts and unknown conclusions.

Synthetic Approach: The "Synthesis" means the assembling of separate or subordinate parts into a new form. It is a process of reasoning from whole to a part and from general to the particular (deductive reasoning). The synthesis requires the formulation of new understanding of scientific systems. If analysis stresses the parts, synthesis stresses the whole components of scientific systems may be recognized into new patterns. Unlike analysis, synthesis asks students to put parts together, to make patterns that one, new to them. This approach is just opposite to the analytical approach. In this approach we proceed from known to unknown as synthesis means combing together various parts. In mathematics various facts are collected and combined to find out the result which is unknown. According to Rehman and Katozai there are certain merits and demerits of the synthetic method. It is a short method and save time in teaching learning process. It is suitable both for intelligent and weak students. But at the other hand, it encourages the memory work and does not develop any reasoning power and students are unable to discover new idea.

Procedure:

The known part is $a/b = c/d$

Subtract $2b/c$ on both sides (But why and how the child should remember to subtract $2b/c$ and not any other quantity)

$a/b-2b/c = c/d-2b/c$

or $(ac-2b^2)/b\ c = (c^2-2bd)/cd$

or $(ac-2b^2)/b=(c^2-2bd)/ d$

Which is unknown

Merits

- It is a short and quick approach.
- It glorifies the memory of the child.
- It formulates records and presents concisely the discovered facts.
- It omits the trials and errors like in analysis
- This is the approach of setting out the solution in a concise form.
- It is informative method it takes less time.

Demerits

- There is no scope of discovery.
- It leads to rate memory.
- It creates many doubts in the mind of the child.
- There is no opportunity for developing thinking, reasoning, and other mental abilities.
- The recall of each step cannot be possible for every child.

Self-Check Exercise 1

Q.1. The "Synthesis" means the assembling of separate or subordinate parts into a ……

13.4 Summary

Dear learner, in this unit we have discussed analytic- synthetic approach of teaching mathematics in detail.

13.5 Glossary

Competence: Competence is used to mean the ability to perform in jobs according to the standards/norms required in employment. It requires a combination of knowledge and skills.

Concept Map: It is a graphic representation of the content of text showing semantic and/or thematic relationship amongst various concepts. This provides meaningful insights into learning, recall and access in self-instructional materials.

13.6 Answer to Self-Check Exercise

Answer 1: new form

13.7 References/Suggested Readings

- Nanda, N. N. (1972). Teaching Mathematics, Ludhiana; Sharda Brothers.
- National Curriculum for Primary and Secondary Education: A Frame Work, NCERT, New Delhi, 1985, (From Preface).
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13.8 Terminal Questions

1. List and describe the approaches of teaching mathematics (analytic-synthetic).

Unit – 14 Techniques and Strategies of Teaching Mathematics (Drill and Practice, Assignments, Homework, Supervised Study, Play Way and Activity-Based Techniques)

Structure

14.1 Introduction

Dear learner, this unit deals with techniques like drill and practice, assignments, homework, supervised study, play way and activity-based techniques and strategies of teaching of mathematics.

14.2 Learning Objectives

After completing this unit, you will be able to:

- explain the various techniques and strategies like drill and practice, assignments, homework, supervised study, play way and activity-base for teaching mathematics.

14.3 Techniques and Strategies of Teaching Mathematics (Drill and Practice, Assignments, Homework, Supervised Study, Play Way and Activity-Based Technique): There are various techniques and strategies of teaching mathematics effectively to the secondary level classes. Some of these techniques are as under:

- Drill & Practice
- Assignment
- Homework
- Supervised Study
- Play Way Technique
- Activity Based Teaching

Drill & Practice: Drill and exercise occupy an important place in mathematics teaching and learning. Drill work is based on the psychological principles such as

learning by doing and law of exercise. Drill plays a prominent role in learning because it affords a convenient and fairly efficient medium for the rapid memorization of details and the automatization of processes. Drill must be recognized as an essential means of attaining some of the desired controls, just as a strong emphasis upon concept and meanings must be regarded as essential for understanding. Both are necessary and neither alone is sufficient.

Drill provides an opportunity of self-learning and improvement. The speed and accuracy in mathematics cannot be possible without drill work. Be certain that understanding precedes the drill. Otherwise, the practice becomes an exercise in academic futility and no one benefits.

How to Make Drill Effective

- Drill exercises should be conducted in such a manner that pupils can work at different trades and at different levels according to their abilities.
- Drill exercise should be brief and distributed over a period of time.
- Drill should consist of several distinct activities involving different strategies of learning.
- Drill exercises should contain enough material to keep all the students profitably occupied throughout the drill period.
- Drill should be concentrated upon particular skills or even on particular details of operation
- Efforts should be made to detect mistakes in children's work and eliminate them at the outset
- The students should be enabled to take pleasure in drill work.

Importance/Advantages of the Drill Work

- Learnt material can be retained for a longer time.
- It is a good technique of learning for beginners:
- Speed of the learning material can be adjusted according to need.
- Accuracy of learned material can be improved.
- Memory of the child can be checked.
- Pronunciation of the child can be corrected.
- It is very economical device of learning and teaching
- It is a less time consuming technique of learning.
- Immediate reinforcement through practice and application is desirable.

Disadvantages of Drill Work

- It is not suitable for all topics.
- Drill work creates disturbance in the other classes.
- It is not effective without good and clear voice.
- Sometimes drill becomes an exercise in academic futility and no one benefits.
- Careful questioning by the teacher is usually needed in drill work.

Assignment: Assignment is the work given to the students either before the lesson or after the lesson and it may be completed at school or at home. Assignment is a sort of undertaking or commitment on the part of the learner. The child undertakes upon himself the responsibility of carrying out the work assigned to him. Assignment should be brief, so that pupil will be more willing to try to do it. Assignment in Mathematics includes two different kinds of problems:

- Repetitive Problems
- Review Problems

Repetitive problems are based on new work. By assigning problems on several different topics, the teacher provides the child with variety in his assignment, which might add some interest to the task of assignment. The repetitive problems serve to emphasize some aspects of what has been newly learned in the classroom that day. Thus these problems provide the child an opportunity to see if he has really mastery over what was taught.

The review problems are that which spiral back over the skills and concepts learned in previous topics. Hence they also called spiral assignments. The spiral assignment contains both repetitive and review problems. These are the problems that do not allow the child to forget the mathematics he has learned previously. So these problems should be selected very carefully.

Purpose of Assignment in Mathematics

- To solve mathematical problems.
- To prepare illustrations for a topic.
- To collect mathematical data.
- To trace out the background of a mathematical problem/ concept.
- To formulate problem on a topic/ concept.
- To carry out some mathematical projects.
- To apply the mathematical knowledge in solving the problems.
- create interest in mathematics.
- To develop the skill of problem solving.
- To develop the habit of practice/ exercise.
- To correlate the experiences and previous knowledge of the child.

Characteristics of Good Assignment

- It should remove the difficulties of the child.
- There should be clarity and definiteness in assignment.
- It should be stimulating and direct learning activities of the child.
- It should correlate experiences with the previous knowledge of the child
- Individual differences should be recognized while giving assignment.
- It should be motivating and interesting.

- It should give proper reinforcements to the child.

How to make an Assignment Effective

An assignment should not be a mere dictation of question but for its successful completion, proper hints should be given to the children.

- An assignment should be insightful.
- It must be motivating, clear up doubts and misunderstandings.
- It should be a cooperative activity in which the teacher and pupils take an active part.
- Interaction between pupil and teacher is must in an assignment.
- References books, text books and other teaching learning material should always be used to stimulate and direct the pupil's assignment activities.
- There should be advanced planning of assignment work.
- The task of assignment should be pin pointed because vague and lengthy assignments are of no use to achieve better results.

Homework: In modern days the curriculum in secondary schools is so vast, that school time is not sufficient to cover everything provided in the curriculum. So if the teachers want to do justice with the curriculum they have to counterpart with homework. It has to be given regularly. Homework plays a vital role, as the teachers get very short time to cover the heavy load of the curriculum so under the circumstances; it is not only important but also essential to give homework to the students. The homework in mathematics may consist of some problems based on facts taught in the classroom. Students may be asked to learn certain principals, definitions, facts, draw graphs, charts, tables etc. by giving homework means creating in the children a study environment at home. The nature and amount of homework should be given according to the capacities of the children. Homework should assist as a part of internal assessment and proper weightage should be given.

Objectives of Home Work

- It utilizes the leisure time of the child; otherwise the child will waste it in gossiping.
- It cultivates the habit of regularity and hard work among the children.
- It provides the opportunity of independent work.
- It provides opportunity for the application and the practice of the gained knowledge.
- It supplements the classroom teaching.
- It acts as link between parents and teachers.
- It creates an environment of school feeling at home among the children.

Principles of Homework

- Principle of accuracy
- Principle of interest
- Principle of clearness Principle of relevance
- Principle of economy

- Principle of sequence

Importance/ Advantages of Homework in Mathematics

- It brings about closure relationship among the parents and the school
- It promotes the habit of self-study in children.
- It develops a sense of responsibility among the children.
- The constant anxiety of doing homework promotes the progress of the child.
- It provides opportunity to utilize the pleasure time of the students.
- It develops self-confidence and self-reliance amongst the students.

Disadvantages of Homework in Mathematics

- It takes too much time of the children after the school.
- Homework does not provide suitable conditions for work.
- Many pupils involve their parents or others to complete their homework.
- Some children develop emotional tensions because of homework.
- Homework is sometimes misused as punishments.
- It also deprives the children of their leisure time.
- Homework may adversely affect the health of the children.
- Load of homework in one subject may affect the achievement in other subject.

Precautions while Assigning Homework in Mathematics

- Do not assign the problems to the children discriminately.
- Do not assign too many problems at a time.
- Homework should be given in brief, so that the pupils will be more willing to try to complete it.
- Only the problems on the newly developed topic of the day should not be given in homework.
- Homework should not be used as a punitive device.
- Clear direction should be given to the students.

Supervised Study: It is useful for the teaching of understanding level. In this technique, both the teacher and the child remain active. In this, every child has to devote his prescribed time for self- study. It creates a formal atmosphere for the self-study. The child learns according to his abilities and capacities. The teacher supervises the activities of the child.

Forms of Supervised Study: It may be in the form of conference plan, special teacher plan, divided period plan, double period plan and periodic plan.

Steps for Supervised Study

- Preparation for the study
- Instructions for the study
- Supervision by the teachers
- Development of blackboard summary

Importance/Characteristics of Supervised Study: Child get opportunity to learn according this abilities, capacities, interest, develops habits of; self-study, group feeling, regularity etc.

Precautions while using Supervised Study: More freedom and facility for mutual exchange, teacher should possess insights and resourcefulness etc.

Play Way Technique: Play-way method of teaching mathematics involves a serious teaching along with playing games. This method was introduced by Froebel who is known as "Father of Kindergarten method". The Mathematics teacher should provide some simple games and make the child to play for acquiring math. Usually, this method is more suitable for primary level students. Obviously, mathematics is taught from our childhood at the age of four or five. For a better future, a strong foundation should be laid down at this particular age. Mainly, the teacher has to teach arithmetic skill to this age group of students. So, it can be easily incorporated with games. The teacher can use as many apparatus for gaming such as toys and playing objects. This will make the child to learn mathematics with more desire. By learning in play-way method, the child learns mathematics clearly and more easily. Thus learning will not be burden for them. There is a theory, which states that a child understands his needs and goals while playing. So it is very important to teach children with the play way method. It has been proved that maximum amount of learning results while playing games. While playing games the environment is very relaxed, this makes learning interesting and fun. This is the most desirable method of learning for kids. The informal and free atmosphere gives the kids a chance to learn concepts, ideas, math and even language. Toys can sometimes be the root of mathematical concepts. Thus, in the play way methodology toys and apparatus like checkers, magic squares, puzzles and building blocks are used to make teaching and learning a memorable experience for the learners.

Advantages of Play Way Technique

- It is a psychological method.
- It helps in the all-round development of the personality.
- Proves an effective activity centered method.
- Helps in gaining useful and permanent knowledge.
- Provides opportunities for healthy competition.
- Helps in reducing fatigue.
- Development of group feelings.

Limitations of Play Way Technique

- Possibility of going astray
- Danger of losing play way spirit
- Wastage of time and energy
- Not suitable to the shy and unwilling students

- Possibility of utilizing unfair means

Activity Based Teaching: Activity Based Teaching (known as Activity Learning Method) is another method to be used for teaching mathematics to the students of primary level. This method was adopted by an English man David Horsburgh. This method made the students as an active learner and not as a passive learner. Here the teacher should provide activities and experiments for each subject theme. The activity should be appropriate to several constraints like age of the students, concept of the subject. The activity should not deviate the child from learning the concepts. Such activities give a pleasure of learning and develop self-reliance in students. Gradually, it encourages the student to learn new concepts and makes the learning in a joyful manner. Mathematics can be taught using this method in a niche manner. The concept of arithmetic and algebra shall be easily implemented with this method of teaching.

Comparison between Play Way and Activity Based Teaching

Play Way Technique	**Activity Based Teaching**
High range of fun	Somewhat less when compared to play-way method
Engages indirect learning	Engages direct learning
Indirect involvement in subject	Direct involvement in subject
Gives more fun to the students	Less fun to the students
Active participation of Students	Active participation of Students
Games are provided	Activities are provided

Self-Check Exercise 1

What is do you understand by drill and practice?

Self-Check Exercise2

What do you understand by supervised study?

14.4 Summary

Dear learner, in this unit the techniques like drill and practice, assignments, homework, supervised study, play way and activity-based techniques and strategies of teaching mathematics are discussed in detail.

14.5 Glossary

Feedback: It is the process of asking response from participant about a system, process, or activity so as to improve or take correcting action, if needed. In distance education it usually refers to the comments of the tutors on assignments submitted by the students.

Instructional Methods - Methods are used by teachers to create learning environments and to specify the nature of the activity in which the teacher and learner will be involved

during the lesson. While particular methods are often associated with certain strategies, some methods may be found within a variety of strategies.

14.6 Answers to Self-Check Exercises

Self-Check Exercise1

Answer: Drill and exercise occupy an important place in mathematics teaching and learning. Drill provides an opportunity of self-learning and improvement. The speed and accuracy in mathematics cannot be possible without drill work. Be certain that understanding precedes the drill. Otherwise, the practice becomes an exercise in academic futility and no one benefits.

Self-Check Exercise2

Answer: SupervisedStudy is useful for the teaching of understanding level. In this technique, both the teacher and the child remain active. In this type of study, every child has to devote his prescribed time for self- study. It creates a formal atmosphere for the self-study. The child learns according to his abilities and capacities. The teacher supervises the activities of the child.

14.7 References/Suggested Readings

- Nanda, N. N. (1972). Teaching Mathematics, Ludhiana; Sharda Brothers.
- National Curriculum for Primary and Secondary Education: A Frame Work, NCERT, New Delhi,1985, (From Preface).
- NCERT, A Textbook of Content-cum-Methodology of Teaching Mathematics, New Delhi Rai, B. C. (1978). Teaching of Mathematics, Lucknow; Prakashan Kendra.
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- Sidhu, K. S. (2006). The Teaching of Mathematics, New Delhi: Sterling Publishers private Ltd.
- Singh, M. (2006). Modern Teaching of Mathematics, New Delhi: Anmol Publications Pvt. Ltd.

14.8 Terminal Question

1. Explain the various techniques and strategies like drill and practice, assignments, homework, supervised study, play way and activity-base for teaching mathematics.

Unit – 15 Unit Planning in Mathematics: Meaning, Need, Importance and Principles. Steps in Unit Planning in Mathematics

Structure

15.1 Introduction

Dear learner, in this unit the meaning, need, importance, principles and steps followed in unit planning in mathematics are discussed in detail.

15.2 Learning Objectives

After completing thisunit, you will be able to:

- explain the need, importance, principles and steps of unit lesson planning in mathematics.

15.3 Meaning, Need, Importance and Principles of Unit Lesson Planning in Mathematics

In simple terms, a unit plan is simply a shorter-term, more detailed view of your teaching map than your long-term plan. Yet in many ways, it has a very similar purpose. Unit planning provides you with a sense of direction and organization that again helps you and the class to achieve significant academic gains within a particular time period. More specifically, creating a plan to reach short-term goals has the following benefits:

- A unit plan forces you to make difficult decisions about what to teach and how to teach it. After taking the time to develop a unit plan, you are less likely to be side-tracked by objectives, lessons, or activities that do not advance your ultimate quest for academic achievement. Tempting diversions will look much less appealing if you have your sights set on your students achieving a particular set of goals in a particular four-to-six- week period.
- A unit plan keeps you on pace to reach your unit (and ultimately long-term) goals. Our unit plan, which should be referred to with almost daily frequency, is your point of

reference when we ask ourselves, "Given where I want to be in two [or four or six] weeks, am I where I need to be now? Am I spending too much time on certain skills and concepts given the other skills and concepts that must be included in these X weeks, or X days?" Given the limited number of weeks, days, and lessons in a unit, each moment becomes more precious, forcing you to pace yourself appropriately in order to meet your end goals.

- A unit plan provides an opportunity to stimulate student interest through overarching content that is relevant to students. When you design your unit plan, consider what content will engage your students given their interests and backgrounds. Content is most likely to be organized coherently when it is selected in a principled way, guided by ideas about what students should learn from studying the topic."

Steps in Unit Lesson Planning in Mathematics

While planning a lesson, a teacher should think about each of the following categories:

1. Goals: Think about (1) broad objectives of the course, (2) goals of the particular lesson, (3) what students should be able to achieve after the lesson.
2. Objectives within the lesson; Define what your students will do to acquire further knowledge and skills and how they will be able to demonstrate that they have learned.
3. Prerequisites
4. Materials: What will be needed, e.g. what is available (make a list/bibliography) and what will have to be prepared.
5. Lesson Description: Describe the general focus of the lesson and include thoughts to share with other teachers. May include leaning level.
6. Lesson Procedure

- Introduction: Describe how you introduce ideas and objectives; get student's attention and motivation, etc.
- Main activity: Define the sequence of activities, in particular pedagogic methods like presentation, demonstration, explanation, discussion.
- Closure/conclusion: Describe how you plan to draw ideas together and to provide feedback to students.
- Follow up Lessons/Activities:

7. Assessment/Evaluation: Define how you will assess student's learning. Also evaluate if students engaged in suggested practice.

Self-Check Exercise 1

What is unit lesson planning?

15.4 Summary

Dear learner, in thisunit, we have discussed the meaning, need, importance, principles and steps followed in unit lesson planning in mathematics in detail.

15.5 Glossary

Summative Evaluation: It refers to end of the course/programme test to make some kind of formal judgement about the performance of the learner giving mark or grade. Term-end examination is a kind of summative evaluation.

Terminal Questions: Questions based on the content and objectives of a unit and given

15.6 Answer to Self-Check Exercise

Self-Check Exercise 1

Answer: Unit plan is simply a shorter-term, more detailed view of your teaching map than your long-term plan. Unit planning provides you with a sense of direction and organization that again helps you and the class to achieve significant academic gains within a particular time period. More specifically, creating a plan to reach short-term goals.

15.7 References/Suggested Readings

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15.8 Terminal Question

1. Explain the advantages and disadvantages of unit lesson planning in mathematics.

Unit – 16 Lesson Planning in Mathematics: Meaning, Need, Importance and Principles. Steps in Lesson Planning in Mathematics

Structure

16.1 Introduction

Dear learner, in this unit the meaning, need, importance, principles and steps followed in lesson planning in mathematics are discussed in detail.

16.2 Learning Objectives

After completing thisunit, you will be able to:

- explain the need, importance, principles and steps of lesson planning in mathematics.

16.3 Meaning, Need, Importance and Principles of Lesson Planning in Mathematics

Lesson planning is at the heart of being an effective teacher. It is a creative process that allows us to synthesize our understanding of second language acquisition and language teaching pedagogy with our knowledge of our learners, the curriculum, and the teaching context. It is a time when we envision the learning we want to occur and analyze how all the pieces of the learning experience should fit together to make that vision a classroom reality. There are a number of benefits to writing a lesson plan. First, lesson planning produces more unified lessons (Jensen, 2001). It gives teachers the opportunity to think deliberately about their choice of lesson objectives, the types of activities that will meet these objectives, the sequence of those activities, the materials needed, how long each activity might take, and how students should be grouped. Teachers can reflect on the links between one activity and the next, the relationship between the current lesson and any past or future lessons, and the correlation between learning activities and assessment practices. Because the teacher has considered these connections and can now make the connections explicit to learners, the lesson will be more meaningful to them. The lesson planning process allows teachers to evaluate their own knowledge with regards to the content to be taught (Reed & Michaud, 2010).

Meaning and Definitions of Lesson Planning

James Michael Lee's,"A lesson plan is an organized statement of general and specific educational goals together with the specific means by which these goals are to attained by the learners under the guidance of the teacher on a given day".

Bining and Bining, "Daily lesson planning involves defining the objectives, selecting and arranging the subject matter and determining the method and procedure".

Lester B. Stands,"A lesson plan is actually a plan of action. It, therefore, includes the working philosophy of the teacher, his knowledge of philosophy, his information about and understanding of his pupils, his comprehension of the objective of education, his knowledge of the material to be taught, and his ability to utilize effective methods".

N.L. Bossing,"Lesson plan is the title given to a statement of the achievements to be realized and the specific means by which these are to be attained as a result of the activities engaged in day-by-day under the guidance of the teacher".

From above it is concluded that a lesson plan

- Is a blue print
- Is a guide map for action
- Is a creative piece of work
- Is a comprehensive chart of classroom teaching
- Is an elastic but systematic approach for the teaching of concepts, skills and understandings etc.?
- Is the teacher's mental and emotional visualization of the classroom experience as he plans to occur

Thus we can say that a lesson plan is a teacher's detailed description of the course of instruction, or 'learning trajectory for a lesson. A daily lesson plan is developed by a teacher to guide class learning. Details will vary depending on the preference of the teacher, subject being covered, and the needs of the students. A lesson plan is a teacher's detailed description of the course of instruction, or 'learning trajectory' for a lesson. A daily lesson plan is developed by a teacher to guide class learning. Details will vary depending on the preference of the teacher, subject being covered, and the needs of the students. There may be requirements mandated by the school system regarding the plan. A lesson plan is the teacher's guide for running a particular lesson, and it includes the goal (what the students are supposed to learn), how the goal will be reached (the method, procedure) and a way of measuring how well the goal was reached (test, worksheet, homework etc.)

Need and Importance of Lesson Planning

1. Lesson-Planning has certain definite functions to perform which are indispensable in good teaching. The teacher who has planned his lesson wisely, enters the class-room

without anxiety, ready to embark with confidence upon a job he understands and prepared to carry it to a workman like conclusion.

2. It provides for adequate lesson summaries, ensures a definite assignment for class, and availability of materials for lesson when needed.

3. It stimulates the teacher to introduce pivotal questions and illustrations:

4. Since lesson planning establishes proper connections between different lessons or units of study, it provides and encourages continuity in the teaching provides and encourages continuity in the teaching process.

5. It ensures association between various lessons in the same main, unit, the selection and organization of subject-matter, materials and activities.

6. It enables the teacher to know the most desirable type of teaching procedures and to prepare tests of progress and checks for judging the outcomes of instruction.

7. Lesson-planning prevents waste because it helps the teacher to be systematic and orderly. It saves him form haphazard teaching.

Principles of Teaching

Knowledge: In order to make a good lesson plan, teachers should have a clear picture of the students, the syllabus, activities, language skills, language types, subject and content, and institution and its restrictions (Harmer1993: 265). Such knowledge guarantees that the activities and materials can be appropriate for lesson objectives and also for specific group of students.

Variety: Variety of activity and interaction helps to make teaching and learning enjoyable, unpredictable, and de-monotonous. Classroom variety refers to different activities ranging from listening, speaking, reading, and writing, each of which has further varieties. Classroom variety also refers to a wide range of materials to be used in class. Furthermore, classroom variety means adopting different kinds of interaction, for example, lockstep, group work, pair work, and individual work.

Coherence and Cohesiveness: All activities serve common objectives and each activity should be connected by teachers using connective devices to make the lesson a wholeness of harmoniousness. If activities are not connected in content and purpose, there will be no flow of classroom movement. "Good lesson plan is the art of mixing techniques, activities and materials in such a way that an ideal balance is created for the class" (Harmer 1993: 259).

Flexibility: Being flexible is very important. Following the plans rigidly tend to make the teaching flat. Also, what the teacher has prepared is not suitable for that specific class. Then it is required that the teacher should be creative and adaptable to make the classroom going smoothly and effectively. Many experienced teachers comment that they do not look at the lesson plan while teaching and that they often make impromptu changes in actual teaching.

Principles for Good Lesson Planning

There are four major principles behind good lesson planning. They are variety, flexibility, learnability, and linkage.

1. Variety means planning a number of different types of activities and where possible introducing students to a wide selection of materials so that learning is always interesting, motivating and never monotonous for the students.
2. Flexibility means planning to use a number of different methods and techniques rather than being a slave to one methodology. This will make teaching and learning more effective and more efficient..
3. Learnability means the contents and tasks planned for the lesson should be within the learning capability of the students. Of course, things should not be too easy either. Doing things that are beyond or below the students? Coping ability will diminish their motivation (Schumann, 1999).
4. Linkage means the stages and the steps within each stage are planned in such a way that they are somehow linked with one another. Language learning needs recycling and reinforcement.

Steps in Lesson Planning in Mathematics

While planning a lesson, a teacher should think about each of the following categories:

1. Goals: Think about (1) broad objectives of the course, (2) goals of the particular lesson, (3) what students should be able to achieve after the lesson.
2. Objectives within the lesson; Define what your students will do to acquire further knowledge and skills and how they will be able to demonstrate that they have learned.
3. Prerequisites
4. Materials: What will be needed, e.g. what is available (make a list/bibliography) and what will have to be prepared.
5. Lesson Description: Describe the general focus of the lesson and include thoughts to share with other teachers. May include leaning level.
6. Lesson Procedure

- Introduction: Describe how you introduce ideas and objectives; get student's attention and motivation, etc.
- Main activity: Define the sequence of activities, in particular pedagogic methods like presentation, demonstration, explanation, discussion.
- Closure/conclusion: Describe how you plan to draw ideas together and to provide feedback to students.
- Follow up Lessons/Activities:

7. Assessment/Evaluation: Define how you will assess student's learning. Also evaluate if students engaged in suggested practice.

Self-Check Exercise 1

What is lesson planning?

16.4 Summary

Dear learner, in thisunit, we have discussed the meaning, need, importance, principles and steps followed in lesson planning in mathematics in detail.

16.5 Glossary

Entry Behaviour: It refers to the knowledge, skills, attitude and relevant experience thata learner should have before starting a new lesson/unit/module/course/programme.

16.6 Answer to Self-Check Exercise

Self-Check Exercise 1

Answer: Lesson plan is an organized statement of general and specific educational goals together with the specific means by which these goals are to attain by the learners under the guidance of the teacher on a given day.

16.7 References/Suggested Readings

- Aggarwal, S.M. (2005). Teaching of Modern Mathematics, Delhi: DhanpatRai and Sons.
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- Sood, J.K. (1989). New directions in Science Teaching. Kohli Publishers, Chandigarh, pp. 103.

- Suxen, R. C. (1970), Curriculum and Teaching of Mathematics in Secondary School, New Delhi: NCERT

16.8 Terminal Question

1. Explain the advantages and disadvantages of lesson planning in mathematics.

Unit – 17 Evaluation in Mathematics: Meaning and Types; Formative, Summative and Diagnostic Evaluation

Structure

17.1 Introduction

Dear learner, this unit deals with the meaning and types ofmathematics evaluation.

17.2 Learning Objectives

After completing thisunit, you will be able to:

- explain the meaning and types of evaluation.

17.3 Meaning and Types of Evaluation

Evaluation is a broader term than the Measurement. It is more comprehensive than mere inclusive than the term Measurement. It goes ahead of measurement which simply indicates the numerical value. It gives the value judgment to the numerical value. It includes both tangible and intangible qualities. Evaluation is a systematic process of collecting, analyzing and interpreting information to determine the extent to which pupils are achievement instructional objectives. Evaluation may be defined as a systematic process of obtaining information for the purpose of making decisions. Thus the ultimate purpose of evaluation is decision-making. In education we conduct evaluation to make decisions about students, teachers, curricula and teaching methods and strategies Evaluation has a wider meaning. It goes beyond measurement. When from useful information including measurement, we make a judgment, which is evaluation. Example:- The teacher may evaluate the student Geeta that she is doing well in mathematics, because most of the class scored 50/100. This is an example of evaluation using quantitative data (measurable information). The teacher might also make an evaluation based on qualitative data, such as her observations that Geeta

works hard, has an enthusiastic attitude towards mathematics and finishes her assignments quickly.

- Evaluation is a science of providing information for decision making.
- It Includes measurement, assessment and testing
- It is a process that involves
- Information gathering
- Information processing
- Judgment forming
- Decision making

From the above, we can arrive at the following concept of evaluation

- Evaluation is a concept that has emerged as a prominent process of assessing, testing and measuring. Its main objective is qualitative improvement.
- Evaluation is a process of making value judgments over a level of performance of achievement. Making value judgments in evaluation process presupposes the set of objectives
- Evaluation implies a critical assessment of educative process and its outcome in the light of the objective.

Purpose of Evaluation

- Evaluation is the process of determining the extent to which the objectives are achieved.
- It is Concerned not only with the appraisal of achievement, but also with its improvement.
- Evaluation is a continuous and a dynamic process. Evaluation helps in forming the following decisions.

Types of Decisions

- Instructional
- Curricular
- Selection
- Placement or Classification
- Personal

Among the above decisions, we shall learn how evaluation assists a teacher in taking instructional decisions. Evaluation assists in taking certain instructional decisions like:

- To what extent students are ready for learning experience?
- To what extent they can cope with the pace of Learning Experiences provided?
- How the individual differences within the group can be tackled?
- What are the learning problems of the students?
- What is the intensity of such problems?
- What modifications are needed in the instruction to suit the needs of students?

Types of Evaluation

There are three broad types of evaluation: (a) diagnostic, (b) formative, and (c) summative. These are not independent types because aspects of one type of evaluation may be found and used in another. However, there are differences among them, and these differences relate to the purpose for which each is conducted.

(a) Diagnostic Evaluation: Diagnostic evaluation is usually done at the beginning of a course of study or a series of lessons to ascertain students' entry behaviors. This can be achieved by written or oral tests, teacher-made or otherwise. This is to facilitate a close fit between new material to be taught and students' cognitive level of development and current achievement. The assumption is that the closer the fit, the more likely learning will take place. This type of evaluation may also be useful during a program of instruction to identify the specific difficulties that students may be experiencing and to determine why they are having these difficulties. The information obtained can be used to design appropriate remediation, differentiated, and follow-up programs. By accurately diagnosing students' problems, teachers are in a better position to help the students. Diagnosis may be done through written and oral tests, written work, and interviews or one-on-one conferences involving the teacher and students. A combination of different sources of information about students (written work, interviews, observations, etc.) is likely to result in a more accurate diagnosis. An example of diagnostic evaluation in mathematics is the use of a written test to determine students' readiness for a formal course in geometry.

(b) Formative evaluation: Formative evaluation may be done during a program of work: for example, during a lesson. Its primary objective is to provide feedback to students and teachers who will then decide in what direction to proceed. For example, if during a lesson evaluation indicates that students are grasping what is being taught, the teacher may decide to continue as planned. On the other hand, if the evaluation indicates that students are not following the lesson, the teacher wisely deviates from his/her plan. The teacher may do additional and different examples, re-teach part(s) of the lesson, use a different strategy or method, and so on. In other words, formative evaluation is intended to help the teacher to improve his/her instructional practices so as to promote better learning by the students. The teacher can also use formative evaluation to keep students informed about their individual progress toward a goal so that the students can take the necessary measures to improve their performance. In a wider sense, formative evaluation may direct a re-examination of the appropriateness of objectives, materials, content, teaching methods and evaluation procedures related to a program of work. Formative evaluation requires that the teacher monitor the students' progress closely. An examination of students' written work could reveal whether they are following the lesson or not. Therefore, it is necessary for the teacher to assign written activities during a lesson and to move around the class to spot check students' work.

(c) Summative Evaluation: Summative evaluation, the most common and most frequently used of the three types of evaluation, is usually done at the end of a program of work or a series of lessons. For example, it is done at the end of a month, quarter, semester, grading period or academic year. Its main intention is to obtain and report information about students, Based on this information a final grade (or certificate/diploma in some cases) is awarded. This final grade could be a combination of several grades. Generally, summative evaluation is not used often to provide feedback information. However, we do not see why it cannot be used for this purpose. The practice of providing students with the opportunity to redo their assignments with the objective of improving them (as well as their grades) as explained earlier in this paper is also relevant to summative evaluation Summative evaluation usually takes the form of quizzes, tests, examinations, portfolios, individual and group projects, and presentations, or any combination of these.

Self-Check Exercise 1

What is evaluation?

17.4 Summary

Dear learner, in this unit we have discussed the meaning and types of mathematics evaluation in detail.

17.5 Glossary

Continuous Evaluation: It is a process of assessment of learner performance throughoutthe learning period placed at regular intervals. Usually the result of continuousevaluation is formative in nature. It is done through tutor marked assignmentsand computer marked assignments.

17.6 Answer to Self-Check Exercise

Self-Check Exercise 1

Answer: Evaluation is a broader term than the Measurement. It is more comprehensive than mere inclusive than the term Measurement. It goes ahead of measurement which simply indicates the numerical value. It gives the value judgment to the numerical value. It includes both tangible and intangible qualities.

17.7 References/Suggested Readings

- Aggarwal, S.M. (2005). Teaching of Modern Mathematics, Delhi: DhanpatRai and Sons.
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17.8 Terminal Question

1. Explain Formative, Summative and Diagnostic Evaluation in detail.

Unit – 18 Major Issues and Concerns in Teaching and Learning of Mathematics in Current Scenario

Structure

18.1 Introduction

Dear learner, this unit deals with major issues and concerns in teaching and learning of mathematics in current scenario.

18.2 Learning Objectives

After completing thisunit, you will be able to:

- discuss the major issues and concerns in teaching and learning of mathematics in current scenario.

18.3 Major Issues and Concerns in Teaching and Learning of Mathematics in Current Scenario

Mathematics is one of the most important subjects in school, yet it is also one of the most feared by students. Researches have shown that nearly 50% of students have math anxiety, which means they have a fear of math. Math anxiety can cause students to underperform in their math classes and can even discourage them from pursuing careers in science, technology, engineering, and mathematics (STEM) fields.In many schools, there is a lot of pressure on students to perform well in mathematics as it is seen as a key subject for future success. This pressure develops anxiety and the fear of failure. Following are some of key aspects associated with mathematics learning.

Fear and Failure: Mathematics is the subject whose study evokes wide emotional comment. The mathematics anxiety and phobia are the consequences of that emotional comment. Mathematics is taught in the schools in such a way that it alienates the children and causes them to stop attending schools. Such fear of Mathematics is closely linked to a sense of failure. Manyschool going children begin to considering themselves

as unable to cope with the requirements generated by Mathematics. In high school, among children who fail only in one or two subjects, the majority of them fail in the subject of Mathematics. The largest numbers of the board exam failures also occur in the subject of Mathematics. The cumulative nature of Mathematics mainly causes such fear and failure. All the concepts of Mathematics are linked to each other requiring the clarity and understanding of all. The other main reason is the predominance of symbolic language. When symbols are manipulated without the understanding, then after a certain point children start dissociating from the subject. The language of Mathematics learnt in school is completely different from their everyday speech and becomes a major force of alienation in its own right.

Disappointing Curriculum: Any Mathematics curriculum that prioritises procedure and memorisation of formulas over understanding of concepts enhances the anxiety and phobia. Mathematics is the subject that sees great motivation and talent even at an early age in a small number of children. These children take to quantisation and algebra easily and carry on with great facility. The curriculum does not offer conceptual depth and thus settles for the minimal use of children's motivation. The learning procedures may be easy for them, but their understanding and capacity for reasoning remain unutilised.

Crude Assessment: The crude methods of assessment are the barriers for the effective teaching and learning of Mathematics. Those methods of assessment encourage perception of Mathematics as mechanical computation. Tests are designed for assessing a student's knowledge of procedures and memory of formulas and facts and thus concept learning is replaced by procedural memory. The children who are unable to make such replacement successfully experience the anxiety and suffer failure. In all the subjects except the Mathematics, partial knowledge may be tried and demonstrated but in case of Mathematics such a perception is easily coupled to anxiety and panic. The evaluation procedures in Mathematics have seen a little change in our schools over a hundred years or more.

Inadequate Teacher Preparation: Mathematics education depends heavily on teacher's understanding of Mathematics and his preparation of teaching Mathematics. It is the teacher’spedagogic techniques that make the teaching and learning of Mathematics so fascinating. Text book centered pedagogy marks the teacher's own Mathematics activity. Teaching of Mathematics poses special problems. At the primary level most of the teachers consider themselves known to all the Mathematics needed and in the absence of any specific pedagogic training ends up perpetuating problems across time and space. At the secondary and higher secondary level, some teachers find a different situation. The syllabi have considerably changed since their school days and in the absence of systematic and continuous education programmes for teachers, their basics or fundamentals in many areas of concept are not strong enough to draw

the attention of the children. This establishes reliance on notes or guides available in the market offering not so consolidated concepts.

Compartmentalisation: This includes very little systematic communication between primary school and high school teachers of Mathematics and none at all between the high school and college teachers of Mathematics. Most of the school teachers have never even seen or interacted with the research mathematicians.

Curricular Acceleration: It involves the rapid and frequent change of the course curriculum making the shape of Mathematics education as taller and more spindle, rather than broad and rounded.

Gender Issue: Mathematics is the subject which tends to be regarded as a masculine domain and this perception is further aided by the complete lack of references in text books to women mathematicians. The classroom research also reflects a fairly systematic devaluation of girls as inefficient in mastering the subject of Mathematics. It has been found that the teachers tend to address boys more than girls.

“Mathematics is not about numbers, equations, computations, or algorithms: it is about understanding.” – William Paul Thurston. Mathematics phobia is a real problem that students and teachers are facing today. The following points may be also the cause of mathematics phobia:

i) Weak teaching method and weak mathematics background
ii) Teachers' aggressive, stressful and irritating characteristics
iii) Inability to solve mathematics problems
iv) Bad relationships between a teacher and a student
v) Inability to solve too much home assignment
vi) Not to understand mathematics in class
vii) Unable to solve mathematical tasks
viii) Use of abusive words by teacher
ix) Negative attitude towards mathematics
x) Not able to solve mathematics problem in time
xi) Not to be child-friendly teaching environment
xii) Mathematics learning difficulty (dyscalculia)
xiii) Community Influence (negative perception)
xiv) Low self esteem
xv) Lack of analogies.

So, the mathematics teachers and parents especially need to understand the causes and effects of mathematics phobia as well as the ways to help students to overcome it. Different research shows that if teachers as well as the parents deal with the mathematics phobic student in time by different way to shift into positive mindset, it is not impossible. So many students may have suffered from mathematics phobia due to the result of several negative experiences and perception in the past. It can be

overcome by controlling anxiety, improving mathematics skills and developing positive attitude towards mathematics. The following steps are the way forward from mathematics phobia and perhaps find a way to view mathematics in a more positive light.

i) Reinforce the child's sense of intelligence and skill in mathematics learning
ii) Create a supportive environment for learning mathematics
iii) Encourage the child to tackle in mathematics
iv) Explain the child about positive uses of mathematics
v) Familiarize the child into mathematics teaching aids
vi) Make mathematics teaching fun with games and puzzles
vii) Avoid to compare the child's abilities to others
viii) Increase the use of instructional materials in teaching
ix) Use of innovative and contemporary teaching approaches
x) Develop and maintain close student-teacher relationship
xi) Motivate students to treat mathematics positively
xii) Provide access of reference material
xiii) Use of modern facilities, devices, and tools
xiv) Use of ICT in teaching learning situation
xv) Make enough and effective practice of mathematics.

Self-Check Exercise 1

List three major issues related to mathematics learning.

18.4 Summary

Dear learner, in this unit we have discussed major issues and concerns in teaching and learning of mathematics in current scenario.

18.5 Glossary

Dyscalculia - Dyscalculia is a learning disorder that affects a person's ability to understand number-based information and math. People who have dyscalculia struggle with numbers and math because their brains don't process math-related concepts like the brains of people without this disorder. However, their struggles don't mean they're less intelligent or less capable than people who don't have dyscalculia.

18.6 Answer to Self-Check Exercise

Self-Check Exercise 1

Answer: Three issues associated with mathematics leaning are:

1. Fear and Failure
2. Curricular Acceleration
3. Inadequate Teacher Preparation

18.7 References/Suggested Readings

- Aggarwal, S.M. (2005). Teaching of Modern Mathematics, Delhi: DhanpatRai and Sons.
- Das R.C. (1984) Curriculum and Evaluation, NCERT, New Delhi, p.42.
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- Suxen, R. C. (1970), Curriculum and Teaching of Mathematics in Secondary School, New Delhi: NCERT

18.8 Terminal Question

1. Discuss some major Issues and concerns in teaching and learning of mathematics in current scenario.

Unit – 19 Methods of Providing Remedial Instruction

Structure

19.1 Introduction

Dear learner, this unit deals with the methods of providing remedial instruction and techniques used with reference to mathematics.

19.2 Learning Objectives

After completing thisunit, you will be able to:

- describe the methods of providing remedial instruction in teaching of mathematics.

19.3 Methods of Providing Remedial Instruction

Not all students are the same and hence they require different efforts from teachers. Many students find it difficult to understand a subject or skill. Multiple teaching strategies can be used by teachers to help such students so that they can stay up with the rest of the students. One such approach is the remedial teaching strategies. A remedial teaching method is a method of instruction that is aimed at helping students who are struggling with a particular subject or skill. The primary goal of remedial teaching strategies for teachers is to identify and address the root causes of a student's difficulties, rather than simply providing them with extra practice or repetition of the same material. This approach involves providing additional support, instruction, and guidance to help students overcome their difficulties and improve their academic performance. The strategies of remedial teaching is helpful to teachers in many ways such as it allows teachers to identify students who may be struggling and provide them with the targeted support they need to succeed. By addressing the root causes of a student's difficulties, remedial teaching strategies can help prevent students from falling further behind or becoming disengaged from the learning process. The first step towards remedial teaching methods is to identify the difficulties being faced by the students. It is important for a teacher to first know the difficulties and then apply the

appropriate remedial teaching strategies. Here are some of the learning difficulties that can be identified:

- Poor memorization potential
- Low level of comprehension
- Lack of motivation toward learning
- Failure to understand instructions and implement them
- Inability to grasp abstract ideas
- Need additional time to complete certain task(s)
- Low self-assurance with minimum self-expectation
- Difficulties in problem-solving

Objective of Remedial Teaching Strategies

The objective of remedial teaching strategies is to help students who are struggling with a particular subject or skill to overcome their difficulties and improve their academic performance.

- The primary objective of remedial teaching strategies is to support students who are not doing well as their peers.
- The role of a teacher is to provide a comprehensive education to their students by tailoring their curriculum and teaching methods to meet the needs and skills of each individual.
- This includes creating personalized instructional plans that offer intensive remedial support to help students consolidate their knowledge in various subjects, improve their learning processes, and build confidence in their abilities.
- Teachers should receive formal training to help students develop important generic skills such as communication, problem-solving, self-management, critical thinking, creativity, and technology use.
- Offering remedial education, teachers can lay the foundation for students' lifelong learning, helping them develop positive attitudes and values and prepare them for future studies and careers.

Strategies of Remedial Teaching

Remedial teaching strategies for teachers involve a variety of techniques and methods that are designed to help students who are struggling with their academic performance.

1. Individualized Education Plan

Individualized education plan is a combined approach that includes the student, teacher and parents. This is most suitable for students in the primary grade. The learning difficulties are identified by the teacher and then specialized instructions are provided to the students. It is one of the most effective remedial teaching strategies as it is a tailored approach as per the learning style of the students.

2. Support Program

Students who excel in certain subjects can act as a helping hand to their peers. This can be done by forming groups in which the students help each other to clearly understand the subjects. Teacher must help the students to reinforce their understanding of the subject, communication skills and interpersonal relationships.

3. Reward Scheme

Teachers can create rewards schemes for students. For this the students will set their own goals and choose their learning styles. Teachers can make sure whether the goals are clear and achievable or not. Parents and teachers can get involved in this and help students with their learning process.

4. Multi-Sensory Learning

Multi-sensory learning is a teaching strategy that engages multiple senses to help students better understand and retain information. This can involve using visual aids, hands-on activities, and other interactive tools to reinforce key concepts.

5. Technology- Based Resources

Technology-based resources, such as educational apps, online learning platforms, and multimedia resources, can be a valuable tool for remedial teaching. These resources can help students learn at their own pace, provide additional support and practice, and reinforce key concepts in a variety of ways.

6. Positive Reinforcement

Positive reinforcement is a teaching strategy that involves providing positive feedback and recognition for progress and achievement. This can help students feel more confident and motivated in their ability to learn, and can help them stay engaged and focused on their goals.

Types of Remedial Teaching

1. One-on-one tutoring, where you can give individualized instruction to address specific learning needs of every student.
2. Small group instruction includes targeted teaching for a small group of students who have similar kinds of needs.
3. Differentiated instruction: Adapting teaching methods for diverse learners in a classroom.
4. Multisensory instruction engages multiple senses to reinforce learning.
5. Technology based remediation uses educational technology tools for customized learning.

6. Collaborative Learning, where peer interaction and group work is used for enhanced understanding.

Remedial Teaching is one of the strategies to help those students who find it difficult to match with their peers and have difficulty in learning. These strategies that we discussed above are a great way to help students with their learning difficulties and grow.

Self-Check Exercise 1

What is remedial teaching?

19.4 Summary

Dear learner, in this unit we have discussed the methods of remedial instruction in detail.

19.5 Glossary

Remedial teaching is a teaching that is designed to help students who are falling behind in their studies or having difficulty learning the subject matter. In other words, remedial teaching is the instruction that is provided to struggling students so that their basic skills can be improved. It is beneficial for those students-

- having difficulty with basic skills such as reading, writing, and numeracy.
- having behavioral issues such as attention and discipline problems.
- who are struggling to find their career.

Remedial teacher: Remedial teacher is a specially trained professional who provides students with the necessary guidance and support in order to remove their learning difficulties.

19.6 Answer to Self-Check Exercise

Self-Check Exercise 1

Answer: A remedial teaching method is a method of instruction that is aimed at helping students who are struggling with a particular subject or skill. The primary goal of remedial teaching strategies for teachers is to identify and address the root causes of a student's difficulties, rather than simply providing them with extra practice or repetition of the same material. This approach involves providing additional support, instruction, and guidance to help students overcome their difficulties and improve their academic performance.

19.7 References/Suggested Readings

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19.8 Terminal Question

1. List any two methods of providing remedial instruction.

Unit – 20 Continuous and Comprehensive Evaluation: Concept and Techniques with reference to Mathematics

Structure

20.1 Introduction

Dear learner, this unit deals with the concept of continuous and comprehensive evaluation and techniques used with reference to mathematics.

20.2 Learning Objectives

After completing thisunit, you will be able to:

- describe the concept of continuous and comprehensive evaluation and techniques with reference to mathematics.

20.3 Continuous and Comprehensive Evaluation: Concept and Techniques with reference to Mathematics

Continuous and Comprehensive Evaluation (CCE) refers to a system of school based evaluation of the learner that covers all aspects of the learner development. This development profile of the leaner is facilitated through continuous assessment of one's learning content, the responses, the nature and success of its applications and the behavioral outcomes and further by the measurement of the holistic development through comprehensive tools of assessment. The term 'continuous implies that evaluation of diverse aspects of learners' growth and development is built into the total teaching learning process and spread over the entire span of the academic session. It means regular assessment of every student. It is more a process than an event. Such assessment would help to diagnose learning gaps and pave the way for remedial measures. The second term 'comprehensive' acknowledges to the fact that learning can be both formal and informal; it can occur through several facets of activities and therefore the learning profile of the learners needs to be assessed in different contexts

of learning both formal and informal. Thus it endorses the expression of learning through a variety of activities and hence their assessments through multiple tools of assessment. In short, it is intended to scan the entire learning map of the each student

Objectives of CCE

- To help develop cognitive, psychomotor and affective skills
- To lay emphasis on thought process and de-emphasize memorization
- To make evaluation an integral part of teaching-learning process
- To use evaluation for improvement of students achievement and teaching-learning strategies on the basis of regular diagnosis followed by remedial instructions
- To use evaluation as a quality control device to maintain desired standard of performance
- To determine social utility, desirability or effectiveness of a programme and take appropriate decisions about the learner, the process of learning and the learning environment
- To make the process of teaching and learning a learner-centered activity

Functions of CCE

- It helps the teacher to organize effective teaching strategies
- Continuous evaluation helps in regular assessment to the extent and degree of Learner's progress
- Continuous evaluation serves to diagnose weaknesses and permits the teacher to ascertain an individual learner's strengths and weaknesses and her needs. It provides immediate feedback to the teacher, who can then decide whether a particular unit or concept needs a discussion again in the whole class or whether a few individuals are in need of remedial instruction
- By continuous evaluation, children can know their strengths and weaknesses. It provides the child a realistic self-assessment of how he/she studies. It can motivate children to develop good study habits, to correct errors, and to direct their activities towards the achievement of desired goals. It helps a learner to determine the areas of instruction in where more emphasis is required
- Continuous and comprehensive evaluation identifies areas of aptitude and interest. It helps in identifying changes in attitudes and value systems
- It helps in making decisions for the future, regarding choice of subjects, or courses
- It provides information/reports on the progress of students in Scholastic and Co-Scholastic areas and thus helps in predicting the future success of the learner

One of the major objectives of the school education is to prepare a student for life. For realizing this objective CCE stress on the development of Scholastic and co-scholastic areas of the child. CCE aims at creating good citizens possessing sound health, appropriate skills and desirable qualities besides excellence. For that it is

important to equip teachers with required skills and competencies of evaluation well with the teaching-learning process. The CCE system demands continuous and comprehensive assessment of both scholastic and co-scholastic aspects of the child. Assessment in co-scholastic areas need to be done systematically and methodologically by using specific observable and measurable indicators and finding grade points resulting into grades.

Some Problem in School Mathematics Education

- A majority of children have a sense of fear and failure regarding Mathematics. Hence, they give up early on and drop out serious mathematical leaning.
- The curriculum is disappointing not only to this non-participating majority but also to the talented minority by offering them no challenges.
- Problems, exercises and methods of evaluation are mechanical and repetitive and too much emphasis given on composition. Areas of Mathematics such as analytical reasoning, logical reasoning not developed in the curriculum.
- Teachers have lack of confidence, preparations and support. Teacher still uses the old traditional method; most of the school do not have a space for opening mathematics lab.

The twin concerns of Mathematics curriculum are: What can Mathematics education do to engage the mind of very student, and how can it strengthen the student resources? Mathematics is a compulsory subject at the secondary stage. Most of the skills taught in primary school Mathematics are useful. Curriculum at primary level designed to prepare child for secondary education it serve only the 'narrow' aim of education. Reconstruction of curriculum required to achieve higher aims' mentioned above will make better use of time that children spend in school in terms of the problem solving and analytical skills that it builds, and in preparing children to meet a wide variety of problems in life.

Self-Check Exercise 1

What do you mean by CCE?

20.4 Summary

Dear learner, in this unit we have discussed the concept of continuous and comprehensive evaluation and techniques used with reference to mathematics in detail.

20.5 Glossary

Evaluation - is the process of examining the performance of an organization, program, project, policy, or any other intervention to determine its relevance, adequacy, effectiveness, efficiency, and progress to identify areas for improvement. Essentially, it refers to the combination of evidence and values to determine whether an intervention has merit, worth, or significance.

20.6 Answer to Self-Check Exercise

Answer: Continuous and Comprehensive Evaluation (CCE) refers to evaluation of the learner that covers all aspects of the learner development. This development profile of the leaner is facilitated through continuous assessment of one's learning content, the responses, the nature and success of its applications and the behavioral outcomes and further by the measurement of the holistic development through comprehensive tools of assessment. The term 'continuous implies that evaluation of diverse aspects of learners' growth and development is built into the total teaching learning process and spread over the entire span of the academic session. It means regular assessment of every student. It is more a process than an event.

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- Suxen, R. C. (1970), Curriculum and Teaching of Mathematics in Secondary School, New Delhi: NCERT

20.8 Terminal Question

1. Describe the concept of continuous and comprehensive evaluation and techniques with reference to mathematics.