Unit-I:

AIMS AND OBJECTIVES OF TEACHING MATHEMATICS

Meaning, Nature, Scope, Need and Significance, Values, Aims and Objectives: Instructional objectives and Behavioural Objectives – Need and Importance of Instructional Objectives. Bloom's Taxonomy of Instructional Objectives: Cognitive, Affective and Psychomotor Domains, Revised Bloom's Taxonomy 2001 (Anderson &Krathwohl) Interrelation among the domains – Correlation between subjects.

1.1 INTRODUCTION

The world of today, which learns more and more heavily on science and technology, demands more and more mathematical knowledge on the part of more and more people. And the world of tomorrow will make still greater demands on a person to be "well educated" in the technological society of today, and as such he or she should have some degree of mathematical literacy.

Though mathematics has been with us for more than 5000 years, the subject has never been made as lively as it is today. The peace of mathematical discovery and invention has accelerated amazingly during the last few decades. It has been said that mathematics is the only branch of learning in which theories of two thousand years old are still valid.

1.2 Meaning of Mathematics

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

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

1.3 Definition of Mathematics

Earlier **Aristotle** defined "Mathematics as the science of study". In Aristotle's classification of the sciences, discrete quantities were studied by arithmetic, continuous quantities by geometry.

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

Locke Said "Mathematics is a way to settle in the mind of children a habit of reasoning"

Benjamin Peirce emphasized that "Mathematics is the science that draws necessary conclusion"

According to **Gauss** "Mathematics is the queen of sciences and arithmetic is queen of all mathematics".

Augusta Comte's definition tried to explain the role of mathematics in coordinating phenomena in all other fields: "The Science of indirect measurement". The "indirectness" in Comte's definition refers to determining quantities that cannot be measured directly, such as the distance to planets or the size of atoms, by means of their relations to quantities that can be measured directly.

1.4 Nature of Mathematics

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

Mathematics – a science of discovery
Mathematics – a intellectual game
Mathematics – the art of drawing conclusions
Mathematics – a tool subject
Mathematics – logical sequence
Mathematics – an intuitive method.

1. **Mathematics – a science of discovery**

Mathematics is the discovery of relationships and the expression of those relationships in symbolic form – in words, in numbers, in letters, by diagrams, or by graphs. According to A.N.Whitehead, "Every child should experience the joy of discovery". Initially a child's discoveries may be observational. But later when its power of abstraction is developed, it will be able to appreciate the true of the Mathematical conclusions that it has drawn. This will give it the joy of discovering Mathematical truths and concepts.

2. **Mathematics – a intellectual game**

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

3. **Mathematics –The Art of drawing Conclusion**

One of the important functions of the school is to familiarise children with mode of thought which helps them in drawing right conclusions and influences.

4. **Mathematics – a tool subject**

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

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

5. Mathematics – A system of Logical Process

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

Polya described the second face of mathematics by saying 'Mathematics in the making appears as an experimental, inductive science". It is based on the principle that if a relationship holds good for some particular cases, it holds good for any similar case and hence the relationship can be generalized. Such a process is called inductive reasoning. For example, the student generalizes that the 'sum of the angles in a triangle is 180^0' after having observed this property in a number of triangles.

6. Mathematics – An intuitive Method

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

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

1.5 Scope of Mathematics

Mathematics provides us inductive and deductive knowledge to enrich our imagination and modes of thinking and even behavior to excel in life. The material progress of the present-day world is the work of our Mathematicians to improve the quality of life by reducing time, distance and human effect. For example, computer the new magic of mathematics has a wonderful contribution towards human growth and development.

Almost every subject of study depends directly or indirectly on the application of Mathematics in Physics Chemistry, Astronomy Geology Engineering etc. Mathematics has vital scope for scientists to design than experiments and analyse the data to its perfection Social sciences such as Economics, Psychology, Sociology etc. directly depends on the preparation of various models offering strategies, statistical aids, formula so on to make sound decisions for predictions, planning and allied things. It is possible by extending the scope of mathematics according to our hypothesis and designs and approaches to find required solutions to the problems facing day to day activities.

Scope of Mathematics has rapidly increased all the more due to its study as a compulsory subject in the X Std. in India. It is an important subject in our daily life Mathematics is used largely than other subjects. Educated and uneducated use mathematics in their daily life.

The Education Commission of India states the importance of Mathematics as follows. "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 today. It is important that deliberate effort is made to place India on the World map of Mathematics' within next two decades or so".

The World of today depends more and more on Science and Technology Science and Technology demands more and more mathematical knowledge on the part of more and more people. And the world of tomorrow will still make greater demands on a person with mathematical literacy Mathematics relics on both logic and creativity and it is perused both for a variety of practical purposes and for its intrinsic interest For scientists and engineers, the chief value of mathematics is how it applies to their own work in modem world some basic understanding of the mathematics is required not only for scientific literacy but also in all fields namely business, agriculture, industry, administration, medicine and social and Natural sciences.

Mathematics is the basic for our growth in science and technology Because of mathematics; today we lead a comfortable and happy life. There is a demand for people having good mathematics knowledge for employment in all fields.

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

Basic Mathematics or Pure Mathematics

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

The following are sub branches of Pure Mathematics.

Algebra

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

Geometry

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

ModernMathematics

It consists of following topics.

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

Topology–General topology, Topological groups, Differential topology, Algebraic topology.

Algebraic System-Groups, Rings, Field, Vector Spaces.

Analysis

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

Applied Mathematics

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

The following are sub-branches of applied Mathematics

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

1.6 Need and Significance of Teaching Mathematics

Mathematics is the queen of all sciences. The aims and objectives of mathematics teaching have undergone an immense change in the computer era in the growth and development of an individual and to apply mathematics knowledge and skills in the working place, we need mathematics. We cannot give the importance of mathematics in a few lines. Any how the following points will tell us the need and importance of mathematics

- To know the world around us
- To enable the individual to meet the demands of daily life.
- To develop skill in the use of mathematical tables, statistical tables and computers.
- To understand the culture, social development and civilization
- To understand the natural phenomena clearly
- To develop self-confidence, self-reliance& patience
- To apply mathematical concepts and principle in a new situation.
- To apply mathematics knowledge and skills in the working place
- To apply mathematics knowledge in the other school subjects
- To enable the pupils to appreciate the subject of mathematics in Engineering and technology
- To find the alternate methods while solving a problem
- To develop the skill to express mathematical thoughts clearly and accurately.
- Develop a positive attitude towards learning Mathematics
- Perform Mathematical operations and manipulations with confidence speed and accuracy
- Think precisely, logically and critically in any situation
- To recognize that mathematics is a powerful and fundamental tool of science with limitless applications.
- To develop willingness to work collaborates.
- To collect, organize, analyze and interpret data and make conclusions and predictions from its results.
- To enjoy mathematics and develop patience and persistence when solving problems.
- To Develop Mathematical curiosity and use inductive and deductive reasoning when solving problems.
- To recognize patterns
- Use appropriate mathematical language in both oral and written explanations,
- To inculcate the habit of hard work, patience, self-confidence, regularity etc.
- To prepare students to college level.
- All round development of the student for improvement of his personality.
- To develop moral values of the pupil.
- The real aim of teaching mathematics is to develop power, not knowledge. The knowledge acquired through reasoning becomes power, which helps in discovering new facts.
- To develop logical and critical thinking.

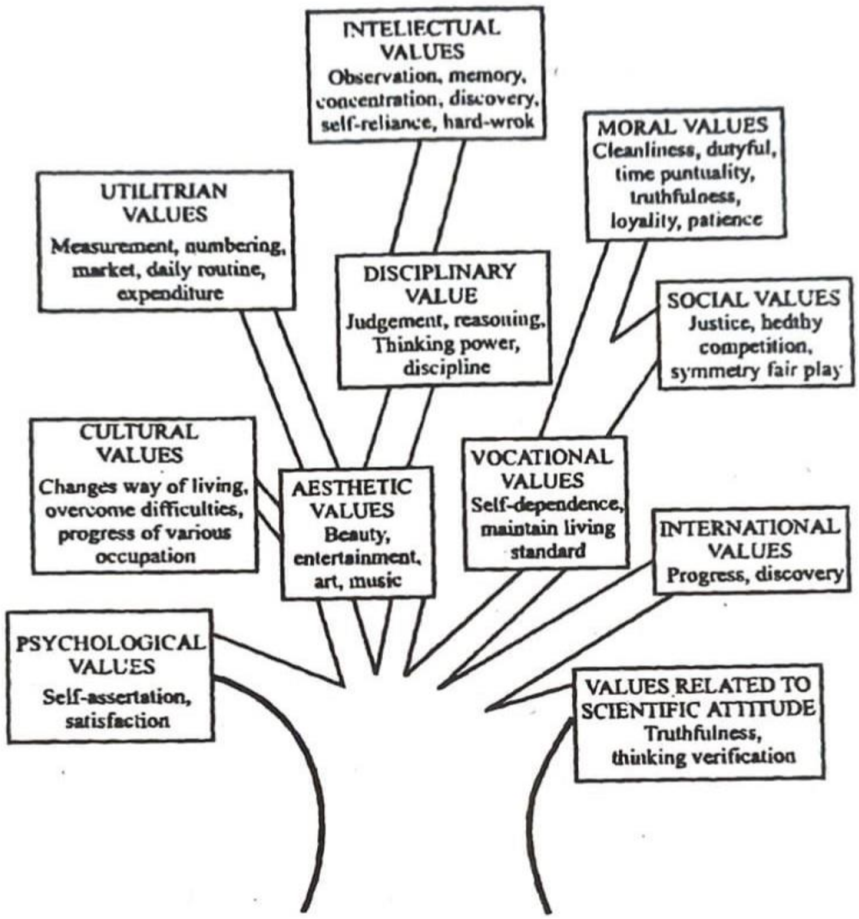
- To exhibit how mathematics is related with other school subjects.

- To develop various skills like accuracy, neatness in drawing geometrical figures.

1.7 Values of Teaching Mathematics

Values are regarded as desirable, important and are held in high esteem by the people who live in a particular society. Thus, values give meaning and strength to a person's character by occupying a central place in his life. Values are the guiding principles of life which are conducive to all round development. Therefore, values reflect one's personal attitudes judgments, decisions, choices, behaviour, relationships, dreams and vision. Napolean also remarked that the progress and improvements, of mathematics is linked to the prosperity of the state. Therefore, mathematics plays an important role in the progress of Society. Mathematics teaching has the following values.

Tree showing Values of Mathematics Teaching



The various values of Mathematics teaching can be explained as follows—

1. Intellectual Values - Mathematics teaching is very important for intellectual development. There is no other subject in the curriculum like mathematics which makes student's brain active. Problem-solving helps us in development of mental faculties. Mental work is needed for solving mathematical problem. As a child, faces a mathematical problem his brain becomes active in solving that problem. Each problem of Mathematics possesses such a sequence which is necessary for constructive and creative process. In this way, all mental abilities of child are developed through mathematics.

Throwing light on intellectual values of mathematics, a great educationist, Plato has said, "Mathematics is the subject which provides an opportunity for training the mind, to close thinking, stirring up a sleeping and unstructured spirit."

World is filled of broad knowledge which is increasing day by day. It is not so important to achieve knowledge but to learn how to achieve knowledge is more important so that knowledge can be more useful and important. Knowledge can be important for a person only when he can utilize the knowledge according to his needs and it depends upon mental abilities of an individual.

According to professor Schultze, "Mathematics is primarily taught on account of the mental training, it affords and only secondarily on account of the knowledge of facts, it imparts."

In this way, the study of mathematics helps to develop all the mental abilities of students. It provides all the opportunity to the students to develop their observation power, logical power, memory, concentration, originality, power of discovery, thinking power, reasoning power, self-reliance and hard work etc.

2. Utilitarian or Practical Value - Our daily life and behaviour is totally dependent on mathematics. We need mathematics in order to classify and to understand every fact. We need its knowledge in our daily routine, house, outside, market, income-expenditure etc. In the absence of mathematical knowledge, a person can neither treat his family well nor can he face his social duties. In this way every aspect of our life is concerned with the application of mathematics.

Our daily routine, measures and calculations all are dependent on it. Before sleeping and after awakening, mathematics is must for us. When we have to awaken? When we have to sleep? When we have to work? etc., all these evidences are related to it. Even all-natural phenomena are based on mathematical principles.

Each and every person of society needs mathematical knowledge either he is accepted personality or rejected one. It is not that mathematical knowledge is needed only by engineers, doctors, traders, businessmen etc. but also it is needed to smallest citizen of society, such as labourers, workers, drivers, coolies' salesmen, vendors etc. In this context Young, J.W.A. said that, "Wherever we turn in these days of iron, steam and electricity we find that mathematics has been the pioneer. Were its backbone removed, our material civilization would inevitably collapse." Moreover, it is also required to study other school subjects, especially, science subjects. Generally, it is said that the child gets high achievement in mathematics also keeps high.

Achievement in physics because physics also involves various types of calculations like maths. All scientific inventions and instruments which have made our daily life so easy smooth and happy are available only by mathematics. In this support **Bacon** has also remarked that

"Mathematics is the gate way and key of all the sciences."

Hence in the age of science and information technology the knowledge of mathematics is very much essential and useful.

3.Disciplinary Value - Mathematics is not meant only for development of mental abilities but also to develop their personality with some qualities like concentration, truthfulness, seriousness etc. That is why the disciplinary value of Mathematics is also important. A person who is gaining mathematical knowledge is not in favour of working against the rules of under sentimental situations. A child judges about his good or bad with the help of his reasoning power, wisdom, patience, and self-confidence.

Mathematics is the only subject whose knowledge develops the habit of hard work, concentration, well organized and clearity in the students. These are such conditions which enable the students of mathematics to lead seriously, wisdomful, and disciplined life. In this context **Locke** says," **Mathematics is a way to settle in the minds of children, a habit of reasoning."**

Mathematical knowledge is exact, real and pure so that a special kind of discipline develops in the child's mind. Its facts are real and definite. Discipline is the only necessary requirement in order to use the acquired knowledge. It develops thinking and reasoning power and demands less from memory.

4. Moral Value - Morality is the important phase of life which is most effected by time, person, situation and place. Mathematical knowledge is helpful in character and personality development. It develops all those qualities which a person of strong character must possess.

Child develops qualities of cleanliness, reality, punctuality, truthfulness, honesty, loyalty, justice, dutifulness, self-control, self-reliance, self-confidence, patience, listens to others and respect them etc. through the study of mathematics. In this way mathematics leads to character development and moral development. It deprives off the feelings of jealous, hate etc.

Explaining the moral value of mathematics **Dutton** has said,**" Mathematics does furnish the power for deliberate thought and accurate statements and to speak the truth. Gossip, flattery, slander, deceit all speak from a mind that has not been trained by Mathematics."** Thus mathematics is the only subject which really gives the training of self-control to the child and gives advance knowledge.

4. Social Value - Man is a social animal and human life depends upon the co-operation of each other. In order to live a social life, each other. In order to live a social life, its knowledge is

needed because the give and take process, business and industry depends upon the knowledge of mathematics.

The change in the social structure with regards to modern facilities like mode of transport, means of communication and progress in the field of science and technology is due to mathematics only. Ideal education is that which helps to make a child a qualified and useful citizen of society from the beginning. **Napolean** has accepted the social value of mathematics and said that, **"The progress and improvements of mathematics are linked to the prosperity of the state."**

In this way mathematics has played an important role in not only understanding the progress of society but also to develop the society. At present our social structure seems to beso scientific and systematic its credit goes to mathematics. In its deficiency, the entire social system will be disturbed.

5. Cultural Value - The culture of every nation or society has its unique characteristics. It has its own importance. Each nation or society reflects its culture by its living standards rituals, artistic progress, economic, social, and political aspects etc. The history of mathematics presents the image of culture of different nations. The person is said to be cultured if one is well educated and have refined manners of dealing. The person becomes critical observer, logical thinker and proper knowledge of mathematics changes the mind of the person. Thus the person becomes more cultured with the proper knowledge of mathematics. The famous mathematician **Hogben** has remarked that **"Mathematics is the mirror of civilization."** In fact mathematical knowledge is indispensable and changes the way of one are living.

Mathematics not only familiarizes us with culture and civilization but also helps in preventing, promoting cultural heritage and transmitting it to future generations. Through the application of scientific and mathematical discoveries, our culture and civilization is undergoing constant change. The welfare of our civilization is now almost wholly-dependent upon scientific as well as mathematical progress. It affects view of life and way of living as a result of which it also effects our philosophy of life. Hence the teaching of mathematics plays a vital role in developing our cultural heritage. **Young, J.W.** has also remarked that, **"whenever we turn in these days of iron, steam, and electricity we find that mathematics has been the pioneer. Were its backbone removed, our material civilization would inevitably collapse. Hence mathematics shapes culture as a playback pioneer and has played an important role in bringing him to such an advanced stage of development."**

6. Aesthetic Value - Mathematics is just like a song, beautiful, an art, music and a means of gaining pleasure for those who studies and likes it. But only few people who have not yet studied it have made a belief that mathematics is a dull and boring subject. One gets pleasure in solving mathematical problems, especially when he get the correct answers to his problems. At that moment every child feels pleasure, satisfaction, confidence and self-reliance. Perhaps this is the

reason that Pythagoras gave scarification of 100 oxen, when he discovered his theorem. **Keats**has well remarked that **"Truth is beauty."**Thus, whenever a mathematician discovers something new with the help of mathematical laws, facts, theorems and principles, a sense of joy is developed in his mind. He realises the aesthetic aspect of his findings or research. So, the child gets encouragement, satisfaction and happiness in attaining remarkable achievements. Indeed, a sense of appreciation is developed in the mind of the child.

If mathematics is considered as the creator and nurturer of all arts then it might not be wrong because in the development of all arts such as drawing, painting, art of sculpture, fine art, music, dance etc. mathematics plays an important role. **Lebnitz** has also said that **"Music is a modern hidden exercise in arithmetic of a mind unconscious of dealing with numbers."**

Moreover, day-to-day changes; beautiful, and latest designs of our clothes, beautiful gardens, lawns, even flower pots etc., all these follow the mathematical rules in one or the other way. Various mathematical puzzles and riddles not only entertain the mind of the child but they also produce a sense of joy and appreciation amongst the children. Infact in the mind of the child a feeling of appreciation of mathematical knowledge is developed.

7. Vocational Value - The main aim of education is to help the children to earn their living and to make them self-dependent. To achieve such aim, mathematics is the most important subject than any other. At present the vocational value of engineering, technology, management, information technology has become more important and prestigious or reputed. The knowledge and training of these vocations is possible only through mathematics. Almost each and every vocation needs the knowledge of mathematics. Even to learn different vocations related to different branches of science require the knowledge of mathematics. Moreover, mathematics plays a very important role in different vocations.

For example

- An architect cannot become a god designer without the knowledge of geometrical drawing and measurement.
- Official work requires the knowledge of mathematics.
- To become an engineer, accountant, banker etc., there is need of mathematical knowledge.
- Similarly to understand different sciences, knowledge of mathematics is must.

Therefore, it can be said that each and every person needs mathematical knowledge for the earning and to maintain his living standard.

8. Psychological Value - Mathematics education is also useful from the point of view of psychological aspects. Mathematics fulfils the psychological needs of the children. In mathematics emphasis is given on operations and drill work so that its knowledge becomes more solid as well as durable. The teaching of mathematics follows the various laws and principles of psychology. For example, the child acquires knowledge on the various principles of psychology such as-learning by doing, learning through experiences and problem-solving, etc. Through its

knowledge the child develops and satisfies his desires, creative and constructive tendencies, self-satisfaction, self-assertion etc.

9. Value Related to Scientific Attitude - The knowledge of mathematics trains the children in attempting the problems according to a definite and distinct procedure which may be called as the scientific method. Generally scientific method involves the following steps

* Identification of the problem.
* Defining the problem.
*Collection of data/information regarding the problem.
* Drawing conclusions.
* Verification of the results

` Thus we can reach to the depth of the problem and then select the most appropriate solution to the problem. Scientific attitude involves open-mindness, critical observation, suspended judgment, free from superstition and false belief etc. Thus, the training which a child receives in studying mathematica can be applied to solve the problems arising in new situations.

10. International Value - Mathematics not only gives the knowledge about the nation and its background but also gives a message of nationality. The progress in the field of mathematics is neither the achievement of a single person, nation, society, cast or religion followers only nor it is the property of a particular nation. Any invention of a nation when crosses its boundaries, it reaches to its international value. This is the reason of the progress in the field of science and mathematics. Now a days it is the requirement of the time that all the scientists, mathematicians, educationists and researchers of the world should work as an integrated nation. These all facts reflect the international value of teaching mathematics.

Hence it is quite clear from the above discussion that mathematics which is so valuable, important, psychologically based and so closely connected with our day-to-day life, is justified to be included in the school curriculum.

1.8 Aim and Objectives of Mathematics

1.8.1 Aim of teaching Mathematics

To teach any subject, it is the primary fact to know the teachers and students, what is the purpose of teaching and what are the uses of teaching. We use the term 'aims' to mean the broad goals which our educational system (the whole of the Indian society involved) embraces and which we are expected to attain. The aims of education are based on philosophical and socio – psychological aspects of society and culture. Thus, we may mention the aims of teaching mathematics as under:

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

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

- To develop thinking and reasoning power of the students.
- To prepare sound foundation needed for various vocations, Mathematics is needed in various professions such as those of engineers, bankers, scientists, accountants, statisticians etc.
- To prepare the child for further learning in mathematics and related fields. School mathematics should also aim at preparing him for higher learning in mathematics.
- To develop in the child desirable habits and attitudes like habit of hard work, self – reliance, concentration and discovery.
- To give the child an insight into the relationship of different topics and branches of the subject.
- To give the child to understand popular literature. He should be so prepared that the finds no handicap in mathematical terms and concepts used in various journals, magazines, newspapers etc.
- To teach the child the art of economic and creative learning.
- To develop in the child rational and scientific attitude towards life.

1.8.2 Objectives of teaching Mathematics

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

Knowledge objectives

Though mathematics, a pupil

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

Skill objectives

Mathematics develops the following skills:

- The child learns to express thoughts clearly and accurately.
- He learns to perform calculations orally.
- He develops the ability to organise and interpret the given data.
- He learns to reach accurate conclusions by accurate and logic reasoning.
- He develops speed and accuracy in solving problems.
- He develops the skill to draw accurate geometrical figures.
- He develops the ability to use mathematical apparatus and tools skilfully.

Appreciation Objectives The child learns to appreciate:

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

Attitude Objectives
Mathematics helps in the development of following attitudes:

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

1.8.3 Difference between Aims and Objectives

Aims and Objectives may be comparing on the basis of following points –

Aims	Objectives
1.Aims are very broad and comprehensive.	1. Objectives are narrower and specific.
2. Philosophy, sociology is main source of aims.	2. Psychology is the main source of objectives.
3. They are not definite and clear.	3. They are definite and clear.
4. They are difficult to achieve.	4. They can be achieved conveniently
5. Long-time duration is needed in order to achieve aims.	5. They need short duration. That is, in the period of class room teaching.
6. They are subjective.	6. They are objective.
7. These cannot be evaluated.	7. These can be evaluated.
8. These include objectives.	8. Objectives are a part of aims.
9. They are related with the whole education system and whole curriculum.	9. These are related with the teaching and any specific topic.
10. It is the responsibility of school, society and	10. Generally teacher is only responsible.

nation to achieve them.	
11. These are theoretical and indirect.	11. Objectives are direct and concerned with the teaching.
12. Aims are formal.	12. These are functional and informative.

1.8.4 Instructional Objectives

It is practically impossible to know all the aims of mathematics education within the framework of curriculum, for they involve a total programme of education encompassing even out of classroom experience. The part of aim that can be achieved with in an objective. While aims give directions to education objectives are directed towards the aims. Aims are divided into some definite, functional and workable units which is called objectives. Thus, objectives are part of aim.

Aims are general and long-term goals and may be common to more than one subject. Objectives are specific, immediate and attainable goals, specific to one subject, precise and clearly defined and may be achieved in a period of 40- or 45-minutes duration. Objectives are directly related with the learning process.

1.8.4.1 General Instructional Objectives

Non observable behaviour of the student is called general instructional objectives. The statement of such objectives contains verbs like knows, understands etc. Acquisition of knowledge or understanding by the student cannot be observed by the teacher and therefore, they are not observable behaviour. Examples:

- The pupil acquires knowledge of mathematical terms, facts and concepts.
- The pupil understands the meaning of mathematical terms, facts and concepts.
- The pupil applies mathematical principles of new situations.

1.8.4.2 Specific instructional objectives

Precise and measurable behaviours of a student are called specific instructional objectives. These objectives contain an action verb. In the statements like the pupil states the properties of a rhombus or the pupil explains the mathematical statement, states, explains by the student are observable behaviours. Examples

- The pupil recalls definition of Mathematics.
- The pupil recognizes mathematical symbol.
- The pupil lists the properties of a geometrical figure.
- The pupil gives reason for mathematical concepts.

1.8.5 Behavioural objectives

Defining the objectives in behavioural terms, it would be clear that what changes are to be brought by pre – determined objectives and "in which areas these changes are to be brought?" Specification of objectives in a task of teaching and learning may prove more effective and purposeful if they are translated into behavioural language.

While writing objectives in behavioural terms following point should be kept in mind –

1. Nature of objectives: Knowledge, Comprehension, application etc.
2. Area or domain of the behaviour: Cognitive, affective and psychomotor.
3. Specific Content areas in which behavioural changes are planned to be brought about related with the topic.

We can say that behaviour is a specification of objective expressed in terms of what the child does. The criteria for judging the validity of behaviour are as follows:

- It should flow from the objective
- It should be expressed in terms of what the child can do after the objective has been attained by him.
- It should make explicit and idea which is implicit in the objective.

1.8.6 Need and Importance of Instructional Objectives

The need and importance for writing objectives is given below:

- The teacher gets help in selecting teaching strategies.
- It helps in making certain and specific teaching activities.
- Teacher gets help in selecting questions for evaluation.
- It helps in selecting questions for evaluation.
- It helps in selecting Audio – Visual Aids for effective teaching.
- With the help of writing objectives in behavioural terms learning – experiences can be determined and measured.
- A balance between teaching and learning can be determined.
- It helps in advance study.
- It indicates the desired / expected behaviour of the child.
- It helps in managing examination for the achievement of objectives.
- It helps in the measurement of performance and other activities of the child.
- The teaching and learning process can be made objective centred.
- It helps teacher and children both in differentiating amongst various behaviours.

1.8.7 Writing objectives for different mathematics Topics

To write objectives for a particular mathematics topic, first write the General Instructional objectives and then specific instructional objectives.

1. Std: 8 **Topic: Congruent Triangles**

Objectives of Teaching

General Objectives: Students

1. Knows the conditions (knowledge) for the two triangles to be congruent.
2. Understands the conditions for the two triangles to be congruent.
3. Using knowledge and understanding solves a problem in a new situation.
4. Learns the skill to cut congruent triangles in paper.
5. Approaches the congruent triangles with a scientific attitude.
6. Solves the problem with interest.

Specific objectives: Student

1. Recalls the triangles on the basis of angles.
2. Recalls the triangles on the basis of sides.
3. States the difference between the concepts of side – side – side and side – Angle – side triangles.
4. Applies the skill to verify two triangles to be congruent.
5. Explains with reason that the two triangles are congruent.
6. Uses symbols for verbal form.
7. Analyses the problem.
8. Evaluates the result.
9. Appreciates the congruent pattern.
10. Cuts right angles and equilateral triangles in colour papers for Annual day of the school.

2. Std: 10 **Topic: Volume of the Cone**

Educational Objectives

General Objectives: Students

Knows the method of finding volume of the cone.

1. Understands the method of finding volume of the cone.

2. Using knowledge and understanding solves a problem in a new situation.

3. Obtain the skill to find volume of the cone shaped things.

4. Approaches the various aspects of the problem with a scientific attitude.

5. Solves the problem with interest.

Specific objectives: Student

1. Recalls the volume of the cylinder.
2. Recalls the properties of a right-angled triangle.
3. Finds the relationship between the volumes of cylinder and cone having same radius and height.
4. Gives examples of cone shaped things.
5. Analyses the sufficiency of the data to solve a problem.
6. Solves the problem in an appropriate way and find its solution.
7. Verifies the result.
8. Draws the cone accurately.
9. Does written calculations with speed and accuracy.
10. Finds, volume of the cone shaped water tank.

3. Std: 8 **Topic: Drawing rhombus**

Educational Objectives

General Objectives: Students

1. Knows the method of drawing rhombus.
2. Understands the method of drawing rhombus.
3. Using knowledge and understanding solves a problem in a new situation.
4. Obtains the skill of draw rhombus type figures.
5. Draws the rhombus with a scientific approach.
6. Draws the rhombus with interest.

Specific objectives: Student

1. Recalls the method of forming quadrilateral.
2. Recalls the properties of rhombus.
3. Differentiates between square and rhombus.
4. Draws rough figure with the help of given data.
5. Analyses what is given? and what isasked? in a problem.
6. Draws the rhombus accurately in order.
7. Uses appropriate geometrical instruments.
8. Measures with speed and accuracy.
9. Obtains the skill to use instruments needed to draw rhombus.
10. Finds area of the rhombus accurately.

4. Std: 8 **Topic: Real numbers Four properties of Addition and Subtraction of rational numbers**

Educational Objectives

General Objectives: Students

1. Knows four properties of addition and subtraction of rational numbers.
2. Understands four properties of addition and subtraction of rational numbers.
3. Using knowledge and understanding solves a problem in a new situation.
4. Analysis the closure property, associative property in respect of addition and subtraction of rational numbers.
5. Improves computation skill.
6. Solves the problem with interest.

Specific objectives: Student

1. Recalls the rational numbers.
2. Recalls the rational numbers between of any two rational numbers.
3. Explains that if we add or subtract any two rational numbers, again we get a rational number.
4. Differentiates between additive identity and subtractive identity.
5. Obtains skill to tell additive inverse of any rational number.
6. Obtains skill to tell subtraction inverse of any rational number.
7. Verifies the results.
8. Does calculations speed and accuracy.
9. Analysis the various components of a given problem
10. Solves the problem in an appropriate way and get the result.

5. Std: 9 **Topic: Algebra – Factorization**

Educational Objectives

General Objectives: Students

1. Knows the method of factorization.
2. Understands the method of factorization.
3. Using knowledge and understanding solves a problem in a new situation.
4. Obtains the skill to factorize algebraic equation.
5. Analysis various methods of factorization with a scientific approach.
6. Solves the given problem with interest.

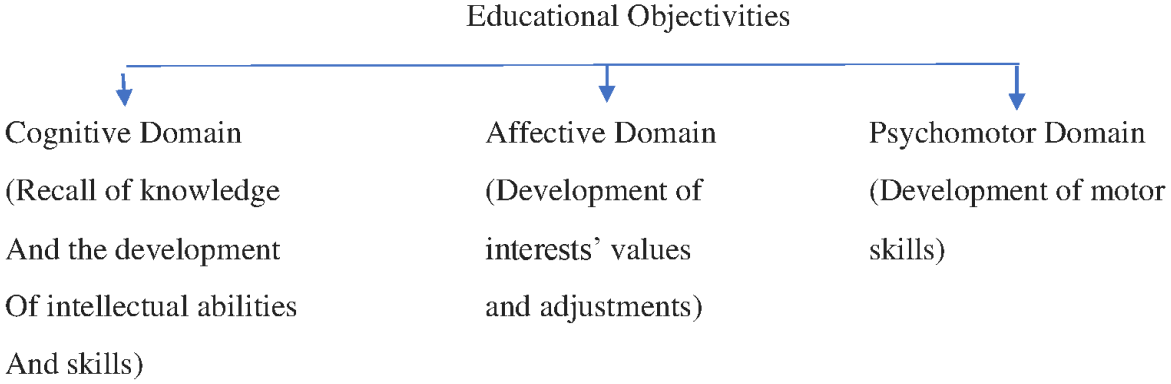
Specific objectives: Student

1. Recalls the coefficient of x^2, coefficient of x constant in an equation.
2. Recalls the method of factorization of integers.

3. Finds the relationship from the given data.
4. Compares the terms of the given polynomial.
5. Analyses the problem and solve using appropriate method.
6. Obtains skill in grouping terms of the polynomial.
7. Analyses the polynomial and obtain the skill of finding general factors.
8. Solves the problem using short cuts.
9. Analyses all the aspects of the problem.
10. Solves the problem in an appropriate method and gets the result.

1.9 Blooms Taxonomy of Educational Objectives

To define understand and classify the educational objectives American educationalist Benjamin S. Bloom and his associates at the University of Chicago divide it into three domains i.e., cognitive, affective and psycho-motor and explains clearly to the teachers.



In each domain, objectives are hierarchical order starting from easy to difficult. Hence this arrangement is called "Taxonomy of Educational objectives".

1. Classification of cognitive domain or objectives by Bloom (1956)
2. Affective Domain by Krathwaohl(1964)
3. Psychomotor Domain by Dave (1970).

Dr.Bloom concentrated on the study of cognitive Domain. He assumed that in thinking about a problem of hierarchy of cognitive process is involved. While teaching, a teacher follows his historical order. This classification of objectives is known as "Taxonomy of educational objectives" or "Blooms Taxonomy" of objectives.

1) Cognitive Domain

Cognitive domain includes those objectives which deal the recall or recognition of knowledge and the development of intellectual abilities and skills. This domain consists of six parts and arranged in a hierarchical order, in increasing levels of difficulty (from lower to upper)

Pedagogy of Mathematics

Knowledge forms the basis for all cognitive objectives and all other objectives are not possible without knowledge. Similarly if one is able to apply knowledge in a new situation, if can be inferred that he has to achieve lower levels of objectives namely knowledge and comprehension clearly. Thus a higher level objective subsumes to lower ones.

While teaching mathematics for Secondary and Higher Secondary students give priority to the first three objectives of cognitive domain namely knowledge, comprehension and application. The remaining three objectives Analysis, Synthesis and Evaluation may be trained to them according to their maturity of mind.

Knowledge:

The objective is to remember and recall or recognize the already learnt information and acquire more and more knowledge.

Comprehension:

Objective at this level requires learners to understand the knowledge without any doubt. He should have ability to arrange data in order.

Application:

Objective at this level requires students to apply already learnt knowledge to new and unfamiliar situations. Think critically in depth.

Analysis:

Objective at this level requires the learners, to attain the ability to break up a given communication into parts to understand it better.

Synthesis:

Synthesis is just opposite to Analysis. The ability to draw upon elements from various sources and put them together to produce a new structure. This objective gives divergent thinking and creativity.

Evaluation:

This is a highest objective of cognitive domain. The ability to make judgments about something for given purpose. Judgment can be both quantitative or qualitative.

Cognitive Domain GIOs and SIOs

General Instructional Objectives	**Specific Instructional Objectives**
Knowledge:	**Student**
Student knows the mathematical symbols, concepts, definitions, formulas, and statements etc. of mathematical subject.	1.Recalls the mathematical formulas, concepts and statements. 2.Recognises what he learned.
Comprehension:	**Student**
Student Understand the mathematical symbols, concepts, definitions, formulas, statements	**1.** Give examples **2.** Give reasons **3.** Compares **4.** Differentiates **5.** Classifies **6.** Relates **7.** Detect errors and rectify **8.** Using symbols **9.** Explains **10.** Evaluate the result
Application:	**Student**
Using mathematics knowledge and comprehension to solve the problem in a new situation	**1.** Examine what is given in the problem? What is need? 2.Examine the sufficiency of the data. 3.Select appropriate formula. 4.Solve the problem in an appropriate method. 5.Applying alternate method. 6.Verifying the result**.**

Analysis:	**Student**
Break up a given mathematics statement into small meaningful parts.	1.Understand the meaning of the hypothesis 2.Form the given data draw conclusion. 3.Identify motives / causes for the mathematical concepts.
Synthesis:	**Student**
Putting elements from various sources and put them together to produce a new structure.	**1.** Solves the problem. **2.** Develops the idea in advance. **3.** Compile, generate, create mathematical concepts.
Evaluation:	**Student**
Evaluating qualitative or quantitative judgement for mathematics elements or methods.	**1.**Evaluates the solution of a given problem. 2.Assess defend mathematical concepts. 3.Review / Criticise mathematical statements.

2) Affective Domain

Affective Domain includes the development of feelings of the educational and social attitudes and to increase the emotional objectives.

Receiving:

This is the first step for the learner to learn what the teacher teaches. Listen attentively to a particular phenomenon or stimuli.

Responding (Interest):

This is also called interest objective. Pupil is sufficiently motivated to attend actively. Interest in mathematics lends the student to select a vocation throughout his life. Interest can be developed in solving puzzles, reading mathematical books and journals etc.

Valuing:

It means individual's own valuing or assessment of thing, phenomena or behaviour. It is also called attitude. Development of proper attitude in mathematics is one of the major objectives of teaching mathematics.

Organisation:

The objective brings together different values, resolving conflicts among them, starting to build an internally consistent value system.

Characterisation:

It means to hold a value system that controls his behaviour and characteristic of his life style. Teaching of maths should include the formation of good habits, socially desirable and acceptable.

Affective Domain GIOs and SIOs

General Instructional Objectives	**Specific Instructional Objectives**
Receiving:	**Student**
Students listens attentively what the teacher teaches.	1.Identifies 2.Asks 3.Points out errors boldly
Responding Student develops interest in mathematics. Studentactivelyparticipates in class activities.	Student **1.** Reads books of mathematics. **2.** Solves mathematics puzzles. **3.** Writes activities on mathematics for school **4.** Gives short cuts for solving problems. **5.** Does problems apart from syllabus. **6.** Gains mathematics knowledge more than thesyllabus. **7.** Participates in mathematics club activities. **8.** Participates in class discussions

Appreciates: Student Student appreciates mathematics for its use in daily life.	1. Solves the problems of other subjects using mathematics. 2. Appreciates the symmetrical pattern of figures seen in his daily life.
Scientific Attitude	**Student**
Student develops scientific attitude through the study of mathematics.	1.Accepts mathematical statements only when logically proved. 2.Examines all aspect of a problem.
Valuing (Attitude)	**Student**
Student attaches to a particular object, phenomena or behaviour	1. Explains 2. Proposes 3. Differentiates 4. Explains 5. Initiates

3) Psychomotor Domain

Dave's psychomotor domain (1970) is probably the most commonly referenced and used psychomotor domain interpretation. Dave's five levels of motor skills represent different degrees of competence in performing a skill. It captures the levels of competence in the stages of learning from initial exposure to final mastery. Imitation is the simplest level while Naturalization is the most complex level.

1. Imitation

Imitation involves the ability to learn and pattern your behaviour after someone else. The learner observes a skill and attempts to repeat it, or sees a finished product and attempts to replicate it while attending to an exemplar. At this level, the performance may be of low quality.

2. Manipulation

Manipulation involves the ability to perform certain tasks by memory or following instructions. The learner performs the skill or produces the product in a recognizable fashion by following general instructions rather than observation.

3. Precision

Precision involves the ability to perform certain tasks with some level of expertise and without help or intervention from others. The learner independently performs the skill or produces the product, with accuracy, proportion, and exactness; at an expert level. At this level, the performance becomes more exact and redefined.

4. Articulation

Articulation involves the ability to adapt and integrate multiple actions to develop methods to meet varying and novel requirements. The learner modifies the skill or the product to fit new situations; combines more than one skill in sequence with harmony and consistency.

5. Naturalization

Naturalization is the ability to perform actions in an automatic, intuitive or unconscious way. The learner accomplishes one or more skills with ease and makes the skill automatic with limited physical or mental exertion. At this level, the performance has become second – nature or natural, without needing to think much about it.

Psychomotor Domain GIOs and SIOs

General Instructional Objectives	**Specific Instructional Objectives**
Imitation:	**Student**
Student performs a skill while observing a demonstrator.	1..Attempts 2.Copies 3. Imitates 4. Mimics 5. Follows 6. Repeats 7.Duplicates 8.Replicates 9.Reproduces
Manipulation	Student
Student follows instructions to build a model	1. Acts 2. Executes 3. Performs 4. Completes 5. Accomplishes
Precision	Student
Student performs a skill or task without assistance	1. Accurates 2. Demonstrates 3. Calibrates
Articulation	Student
Student combines a series of skills or activities to meet a novel requirement.	1. Adapts 2. Constructs 3. Combines 4. Creates 5. Formulates 6. Modifies
Naturalization	Student
Student achieves highest level of proficiency	1. Creates 2. Designs 3. Develops 4. Invents

Skill to be developed in Mathematics

In Mathematics the following skills may be developed. Some of these skills are not purely psychomotor; they have to be integrated with the classes of objectives under cognitive domain.

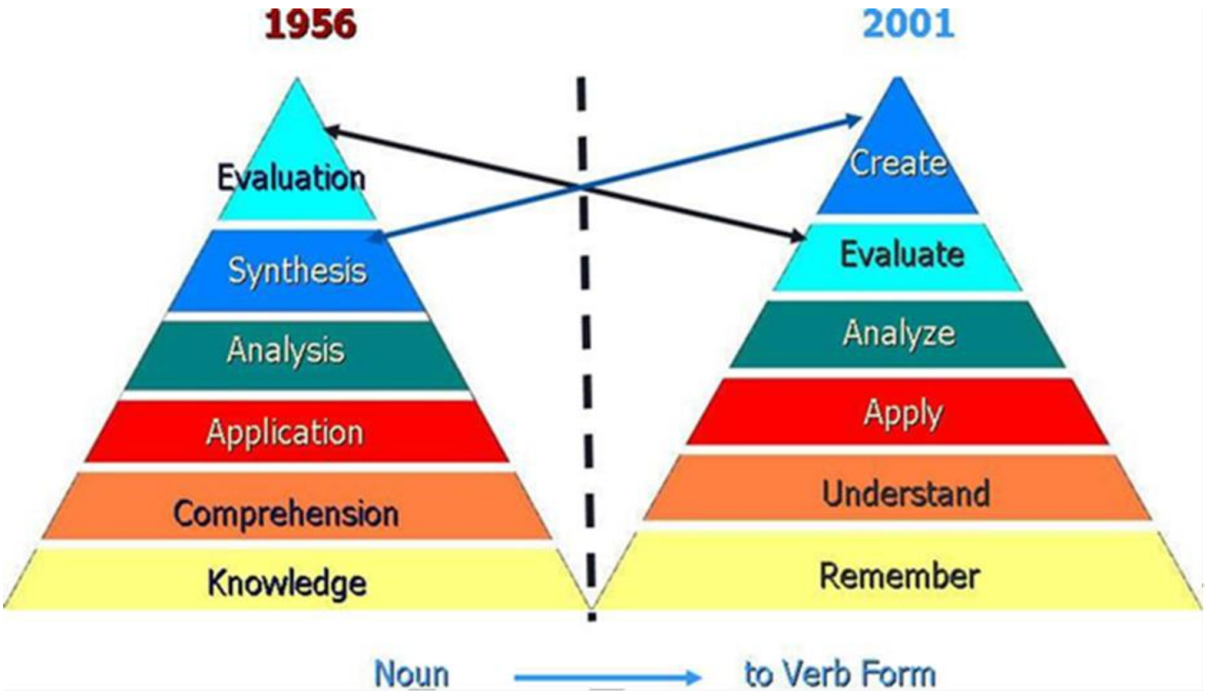
- Skill of drawing figures
- Skill of drawing graphs
- Skill of reading tables
- Skill of computation

General Instructional Objectives	Specific Instructional Objectives
Student develops skill in drawing geometrical figures.	**Student** 1. Draws rough figure with given data. 2. Selects appropriate geometrical instruments. 3. Draws geometrical figures with given measurements. 4. Draws neatly and accurately. 5. Measures with speed and accuracy.
Student develops skill in drawing graphs.	**Student** 1. Selects appropriate scale. Plots the point neatly and accurately. Draws the graph neatly and accurately. Interprets the graph correctly.
Student develops skill in reading table.	**Student** 1. Reads the mathematical table correctly. 2. Reads to table with speed and accuracy.
Student develops skill in computation.	**Student** 1. Does oral sums with speed and accuracy. 2. Does written calculations with speed and accuracy. 3. Does written calculations neatly.

1.10 Revised Bloom's taxonomy

The following chart includes the two primary existing *taxonomies of cognition.* Please note inthe table below, the one on the left, entitled Bloom's, is based on the original work of Benjamin Bloom and others as they attempted in 1956 to define the functions of thought, coming to know,or cognition.This taxonomyis almost 60 years old. The taxonomy on the right is the more recent adaptation and is the redefined work of Bloom in 2000-01. That one is labeled

Anderson and Krathwohl. The group redefining Bloom's original concepts, worked from 1995-2000. Asindicated above, this group was assembled by Lorin Anderson and David Krathwohl and included people with expertise in the areas of cognitive psychology, curriculum and instruction ,and educational testing, measurement, and assessment.



Remembering:

The knowledge category was renamed as remembering. Knowledge is an outcome or product of thinking and not a form of thinking. Hence the word knowledge was inappropriate to describe a category of thinking and was replaced with the word remembering.

Remembering is recalling information. This objective is to recognizing, listing, and describing, naming, finding, already learned information.

Understanding:

Objective at this level requires learners to understand the knowledge without any doubt.

He should have knowledge to interpret, explain, classify and summarize.

Applying:

Objective at this level requires the learners to apply information in another familiar situation and executing in a best way.

Analyzing:

Objective at this level requires the learners to attain the ability to break up a given information into parts to explore understanding and relationships between them.

Evaluating:

The ability to make judgments about a decision or course of action. Judgment can be both quantitative and qualitative.

Creating:

By putting elements together from various sources to form the ability to generate new ideas, products or ways of viewing thing in a different way. Design, plan, produce, invent new things and objects is the objective at this level.

1.11 Interrelating among the domains

The new adaptation also took intoconsiderationmanyofBloom'sownconcernsandcriticismsofhis originaltaxonomy.

Bloom's Taxonomy	Revised Bloom's Taxonomy
1. **Knowledge:** Remembering or retrieving previously learned material. Examples of verbs that relate to this function is: Know, identify, relate, list, define,recall, memorize, repeat,record, recognize, acquire.	1. **Remembering:** Recognizing or recalling knowledge from Memory. Remembering is when memory is used to produce or retrieve definitions, facts, or lists, or to recite previously learned Information.
2. **Comprehension:** The ability to grasp or construct meaning from material. Examples of verbs that relate to this function are: restate, locate, report, recognize, explain, express, identify, discuss, describe, discuss, review, infer, illustrate, interpret, draw, represent, differentiate, and conclude.	2. **Understanding:** Constructing meaning from different types of functions be they written or graphic messages or activities like interpret, exemplify, classify, summarize,compare, or explain.
3. **Application:** The ability to use learned material, or to implement material in new and concrete situations. Examples of verbs that relate to this function are: apply, relate, develop, translate, use, operate, organize, restructure, interpret, demonstrate, illustrate, practice, calculate, show, exhibit, dramatize.	**Applying:** Carrying out or using a procedure through Executing, or implementing. Applying relates to or refers to situations where learned material is used through products like models, presentations, interviews or simulations.
4. **Analysis:** The ability to break down or distinguish the parts of material into its components so that its organizational structure may be better understood. Examples of verbs that relate to this function are: analyze, compare,	**4. Analyzing:** Breaking materials or concepts into parts, determining how the parts relate to one another or how they interrelate, or how the parts relate to an overall structure or purpose. Mental actions included in this function are

inquire,examine,contrast,categorize,differentiate,contrast,investigate,detect,survey,classify,deduce,experiment,scrutinize, discover,inspect,dissect,discriminate, andseparate.	differentiating, organizing, and attributing, as well as being able to distinguish between the components or parts. When one is analyzing, he/she can illustrate this mental function by creating spreadsheets, surveys, charts, or diagrams, or graphic representations.
Synthesis: The ability to put parts together to form a coherent or unique whole. Examples of verbs that standards relate to this function re:compose,produce,design,assemble,create,prepare,predict, modify,tell,plan,invent,formulate,collect, setup,generalize, document,combine, relate,propose,develop,arrange,construct, organize,originate,derive,write,propose	Evaluating: Making judgments based on criteria and new through checking and critiquing.Critiques, recommendations, and reports are some of the products that can be created to Demonstrate the processes of evaluation. In the newer taxonomy, evaluating comes before creating as it is often a necessary part of the precursory behavior before one creates something.
Evaluation: The ability to judge, check, and even critique the value of material for a given purpose. Examples of verbs that relate to this function are: judge,assess, compare, evaluate, conclude, measure,deduce, argue,decide, choose, rate, select, estimate,validate,consider, appraise, value,criticize, infer.	**Creating:** Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing. Creating requires users to put parts together in a new way, or synthesize parts into something new and different creating a new form or product. This process is the most difficult mental function in the new taxonomy.

1.12 Correlation between Subjects

According to Webster's new dictionary of English language correlation means "The act of correlating or the state of being correlated or mutual relation of two or more things or parts". Thus, the word correlation means the reciprocal relationship between various subjects of the curriculum.

1.11.1 Definition

Ferguson: "Correlation is concerned with describing the degree of relation between variables". Lathrop: "Correlation indicates joint relationship between two variables".

1.11.2 Correlation of Mathematics with other subjects

Mathematics: with its special features and looks have wider applications in daily life and other fields of study. This facilitates the correlation of mathematics with other fields and disciplines. A teacher of mathematics with knowledge of the correlation of mathematics can

enhance the effectiveness of his/ her instructional process by relating it to other areas of interest.

1. Mathematics and Sciences:

Mathematics is the pivot of all Sciences. It has been very well said that mathematics is a science of all sciences and art of all arts. In this respect "Roger Bawn" has remarked that, "Mathematics is the gateway and key of all Sciences." The correlations of mathematics with different branches of science is as follows -

i. Mathematics and Physics:

Mathematics and Physics are very closely related and has a very well established correlation. Each rule and principle in Physics takes mathematical form and Mathematics gives final shapes to the rules, laws and Principles of Physics.

For examples

- The laws of motion, friction, expansion of solids, liquid pressure are dependent on mathematics.
- The measurement unit in Physics is employed as frequently as in Mathematics.
- The coefficient of linear expansion of deferent metals, cubical expansion of liquids, Charles law of expansion of gases, conversion of scales. Principle of working of lenders is based on mathematical knowledge.

Mathematics and Chemistry:

Mathematics and Chemistry are also correlated. All the chemical combinations and their equations are based on Mathematics.

For example –

- The formation of various compounds like H_2S. The formation of H_2S gas is possible only when two atoms of hydrogen are combined with one atom of sulphur without this mathematical ratio and proportion, preparation of H_2S is not possible.
- In the estimation of elements of organic compound, the use of percentage, ratio and proportion is needed.
- Molecular weight & number of organic compound is based on Mathematics.
- Balancing of chemical equations and other calculation work is also based on Mathematical knowledge.

Mathematics with Biology:

A biologist must have the sufficient knowledge of mathematics to understand its branches like; biophysics and bio-chemistry.

For example -

- The caloric and nutritive values of food articles are based on mathematics.
- The rate of respiration, transpiration, supply of water in connection to all living bodies is related mathematics.
- Number of bones, organs etc., it is also mathematical.
- Mathematics can acquire knowledge of heredity growth, nutrition, maturation, etc.
- Study of living cells, composition of blood, age and category of plants, animals is possible through mathematical knowledge.

2. Mathematics with History:

The knowledge of history helps in understanding the historical development of mathematics. Similarly mathematical knowledge is applied in history to know dates, time, days etc. of various historical events. Thus the correlation between history and mathematics is reciprocal.

3. Mathematics with Geography:

The knowledge of mathematics is also applicable to the study of geography, For example- shape and size of earth, area, distance of places, height and distance, temperature longitude, time etc., all are based on mathematical calculation. Similarly, to study the rivers, canals, mountains, population, climate, depth, drawing of graphs and figures, moment of winds, falling of rainsetc. in all these, mathematical plays a prominent role. Hence the geological and geographical studies are not possible without the proper application of mathematics.

4. Language and Literature

Language is the vehicle for communication and mathematics cannot be learned without the use of language. Though mathematics has its own language of symbols, they become more clear, meaningful and operational only when they are clearly explained in clear simple language. Certain mathematical concepts, especially abstract concepts can be learned only in the form of verbal statements known as definitions. Such definitions become specific and concise when stated in simple, clear language. In turn, mathematics helps the students to learn the language with clarity and exactness. The logical thinking and reasoning that the students develop through the study of mathematics can be applied to learn the language, especially in the usage of grammar and organizing ideas logically and precisely.

1.13 Conclusion

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