CHAPTER - I

INTRODUCTION AND CONCEPTUAL FRAMEWORK

1.1. INTRODUCTION

“The destiny of India is now being shaped in the class room”. One of the assertions of Kothari Commission finds ample use by all who want to talk or write on education. The statement throws light on the importance of the place called “Class room” in a formal system of education. It is really the place where the matured personality of the teacher influences the unshaped personality of the students. Clearly speaking, the way by which the teacher student interaction that flourishes in the classroom decides the expected bahavioural outcome. Even for class room teaching proper teacher students interaction is much expected to bring the expected behavioural outcome in teaching.

Many students have different opinions about the subject of mathematics. Students need to be engaged in the lesson through discussion, group work and less chalk and talk from the teacher. All teachers have different teaching styles and approaches to making sure their students are participating and learning the subject. But the teacher’s education background, personality, social background, experiences in the field, or mastery of the skill may affect his or her teaching methods in the math classroom. When students are learning math, the teacher’s teaching method is a crucial factor to how much the student would understand and retain the material. Teachers appear to lecture and use teacher directed instruction more frequently than using student centered methods to instruct math (McKinney et al., 2009). They also found that many teachers spend more time on teaching basic computational skills rather than engaging the students in mathematically rich problem-solving experiences. Furthermore, in high poverty schools, teachers
implement the “pedagogy of poverty” when they teach their students. The “pedagogy of poverty” is a curriculum that follows a fixed sequence, concentrates on just teaching the students basic skills without enough emphasis on problem solving and reasoning.

1.2. EDUCATION

Education is a process of human enlightenment and empowerment for the achievement of a better and higher quality of life. A sound and effective system of education results in the enfoldment of learner’s potentialities, enlargement of their competencies and transformation of their interests, attitudes and values. According to Dewey (1976), "Education is a form of production like a factory and it has three elements: raw materials (people) tools (Teaching methods) and product (changed behaviours)". Education is fundamentally concerned with the enhancement of quality of life both the individual and the society level. Armstrong et.al. (1985) quotes President John, F. Kennedy's message to the congress, "Education is the key stone and the arch of freedom and progress. Nothing has contributed more to the enlargement of this nation's strength and opportunities than our traditional system of free universal, elementary and secondary education coupled with widespread availability of college education".

Education is the aggregate of all processes by means of which a person develops abilities, attitudes and other forms of behaviour of positive value in the society in which the person lives. The goal of education is to shape people so that they develop integral, multi-faceted personalities and are able to carry out fully their social role by developing their intellectual, physical and spiritual capacities and encouraging a more elevated level of human feeling an aesthetic taste thus turning the ideological principles into personal connections and habits of every day behaviour.
According to Aristotle, "Education is the apprenticeship of life. It is only through virtue of education that man is able to command respect in society, influence, social ways and become the harbinger of change". Education is an effective tool not only to measure the perceptible change on the learners but also to assess the teaching learning process and which should contribute to the improvement of teaching and learning process. Thus the basic task of education should be the development of the individual and the characteristics which make a person to live effectively in a complex society.

1.3. IMPORTANCE OF EDUCATION

Education is the process of instruction aimed at the all round development of boys and girls. Education dispels ignorance. It is the only wealth that cannot be robbed. Learning includes the moral value and the improvement of character and the methods to increase the strength of mind. Our school is a good example of this; all are the recipients of sacred and precious values imparted regularly by our teachers. A good moral based education is also a must. Students want an education by which character is forced, strength of mind and knowledge increases and makes him independent. This is for them to keep forever. This kind of teaching received in our schools and they have every confidence to say that along with prosperity they will also have character due to the quality of education received.

This importance of education is basically for two reasons. The first is that the training of a human mind is not complete without education. Education makes man a right thinker. It tells man how to think and how to make decisions. The second reason for the importance of education is that only through the attainment of education; man is enabled to receive all necessary information regarding the present.
According to Common Wealth Report (1974); The goals of education are:

- Exaltation of human personality of self-realization.
- Self expression of unfolding of the self.
- Developing problem solving activity.
- Providing one with a harmonious experience and developing the all round growth of an individual.

The characteristics of quality presented in this document, whether they indicate strengths or weaknesses, have been identified from the investigator’s observation of practice in schools. The characteristics are not intended to constitute a definitive or exhaustive set of indicators, nor are they intended to be used as a checklist of unrelated items. They are intended, rather, to offer a framework within which groups of teachers might reflect on the effectiveness of teaching and learning in mathematics within their school.

The characteristics should be interpreted within the context of the Programmes Of Study (POS) for mathematics, for key stages 1, 2 and 3/4, as appropriate, and the associated Attainment Targets (ATs) in the Northern Ireland Curriculum (NIC). While separate specifications for Processes in Mathematics, Number, Algebra, Measures, Shape and Space, and Handling Data are set out in the POS, the POS emphasize that teaching should help pupils to understand inter-relationships within and between different areas of mathematics.

The POS also emphasize that processes in mathematics should pervade the entire mathematics programme and that pupils should learn and use mathematics both within mathematics lessons and in other subjects and aspects of the curriculum. Not only should pupils be developing mathematical understanding, skills and
knowledge but also progressing in their ability and confidence to use and apply mathematics in a variety of contexts and problems and to communicate and reason mathematically. These key requirements have clear implications for classroom practice and for teachers’ evaluation of their pupils’ learning and achievement in mathematics.

1.4. TEACHING AND LEARNING

1.4.1. Teaching

Teaching is the process of providing situations in which learning takes place, in other words, arranging situations in which the things to be learnt are brought to the attention of the learner, their interest in development, desire around, conviction created, action promoted and satisfaction ensured.

- The ultimate purpose of teaching is not merely to inform pupil but to transform them, to bring about the desired change in their behaviour.
- If the learner has not learnt, the teacher has not taught.
- Teaching is not filling a bucket, it is lighting a lamp.
- Teaching is an intentional or purposeful process, not drift, if it is done by plan, not by trial or error.
- Effective teaching is done according to design, not drift; it is done by plan not by trial or error.
- Good teaching, therefore, requires careful planning of content, procedure, methods and techniques.
- Good teaching is essentially good communication and good communication requires sympathetic sharing, and clear explaining.

Since different teaching methods inculcate different outcomes there is a need to study the effect of the different teaching methods on students.
1.4.2. Learning

By this learning process the learner experiences change in his or her behaviour through his own efforts. Learning occurs within the learner. People learn through the experiences that are through their activating. The teacher should provide such experiences to the learners that they may change their behaviour in the desired direction. Any change of behaviour which takes place as a result of experience may be called learning. Learning can take place only when the learner reacts to what he sees, hears and feels. In other words, the learner has to be active in order to learn. Teachers should provide some activity related to the topics on the day as planned in the course outline, in which the learner can react in a desired way. The situation created by the teacher to make the learner active must be very carefully planned to bring specific change in his behaviour.

Principles of Learning

1. Learning is facilitated when a new behaviour contributes in satisfying the needs on the part of the learner.

2. Learning should be meaningful. The student must be helped in understanding why he is learning the new behaviour and should also be made aware of the general pattern of knowledge.

3. Learning is facilitated when two or more senses are used at a time by the learners.

4. Effect of senses on learning the researches show that one learn 1 percent through taste, 1.5 percent through touch, 3.5 percent through sound, 11 percent through hearing and 53 percent through sight.

5. Learners possess the ability to retain.
6. Learning is effective when the learners participate actively. This demands that the teacher should help the learners to set goals and to maintain an active attack on the problems which act as a block in achieving goals.

7. Learning is facilitated when the learners are ready to learn. Before teaching the new behaviour the teacher should prepare the learners and draw their attention to the topic to be learnt.

1.5. THE QUALITY OF TEACHING AND LEARNING

Teaching and learning are at the heart of a school’s work. The relationship between teaching and learning is a complex one but the quality of teaching bears directly on the effectiveness of pupils’ learning. The following lines highlight important aspects of teaching and learning: relationships, responses, teaching, the assessment of the pupils’ work and planning. It is possible that all the characteristics of high quality outlined in some of these sections will be present in a single mathematics lesson: it is more likely that they will be observed over a number of lessons and in a variety of classes; equally, the shortcomings identified below may be present in a single mathematics lesson, or may be observed in a sequence of lessons and in a variety of classes.

No two individuals are alike. Some may be bright, others average and some others dull. Since man is a product of heredity and environment, the answer lies with either of these factors or with both. According to I.P. Guilford "General mental ability as measured by intelligence test and the primary abilities taken separately, show development with age during childhood and youth and decline after passing middle age. There is some sex difference some favouring males and some females. A balance would probably show that the two sexes are equal for general abilities". In
1920 E.L. Thorndike coined the definition of intelligence in his book Animal Intelligence "Ability to make good responses is rated by the capacity to deal effectively with novel situations of an abstract, mechanical or social nature".

Intellectual or mental development is an important aspect of growth, embracing the various mental abilities; mental development includes such abilities as attending, perceiving, observing, imagining, thinking, solving problems and growth of intelligence as well as of language. These abilities grow and mature with age. In spite of general pattern of mental development, each individual grows and matures with age. The various mental abilities are inter-related and develop as a whole. They are inter-dependent; moreover, mental development is a continuous process. The factors that affect mental development include maturation, learning and education. Mental development is a function of the nervous system especially of the brain.

1.6. TEACHING AND LEARNING IN MATHEMATICS

Learning skills and remembering facts in mathematics are important but they are only the means to an end. Facts and skills are not important in themselves. They are important when one need them to solve a problem. Students will remember facts and skills easily when they use them to solve real problems. As well as using mathematics to solve real life problems, students should also be taught about the different parts of mathematics, and how they fit together.

Mathematics can be taught using a step-by-step approach to a topic but it is important to show that many topics are linked. It is also important to show students that mathematics is done all over the world. Although In India may have a different syllabus, there are many topics that are taught all over the world. Some of these are:
i. number systems and place value
ii. arithmetic
iii. algebra
iv. geometry
v. statistics
vi. trigonometry
vii. probability
viii. graphs
ix. measurement

1.7. MATHEMATICS AS A SIGNIFICANT SUBJECT

The most important and crucial stage of school education is the higher secondary level. This is the transition level from a generalized curriculum to a discipline based curriculum. In order to pursue their career in basic sciences and professional courses, students take up mathematics as one of the subjects. Mathematics is considered to be the queen and servant of all sciences. To provide sufficient background to meet the challenges of academic and professional streams, this subject could be studied through different teaching methods to understand the concepts which is more important than memorizing.

Hence it is intended to make the students understand the subject thoroughly so that they can put forth their ideas clearly, in order to make the learning and application to be more interesting. Due importance has been given to develop in the students, experimental and observation skills. Their learning experience would make them to appreciate the role of mathematics towards the improvement of them in future.
Mathematics is derived from Greek words ‘Manthanein’ which means ‘learning’ and ‘Techne’ which means ‘an art of technique’. Therefore mathematics means the art of learning related to disciplines or faculties.

The dictionary meaning of mathematics is that it is either the science of number and space or the science of measurement, quantity and magnitude. Mathematics is, thus, defined as the science of quantity, measurement and spatial relations. It is a systematized and organized branch of science. It deals with quantitative facts, relationships as well as with problems involving space and form.

According to J.B. Shaw, “Mathematics is engaged in fact in the profound study of art and the expression of beauty”.

According to Lindsay, “Mathematics is the language of physical sciences and certainly no more marvelous language was created by the mind”.

According to Aristotle “Mathematics is the study of quantity”.

According to Gauss “Mathematics is the queen of sciences”.

Websters’ New world Dictionary (1973) defines mathematics as the “science dealing with quantities, forms etc and their relationships by the use of numbers and symbols”. (Anice James, 2006, P1-2).

1.8. THE IMPORTANCE OF MATHEMATICS

Mathematics is a way of organising our experience of the world. It enriches our understanding and enables us to communicate and make sense of our experiences. It also gives us enjoyment. By doing mathematics one can solve a range of practical tasks and real-life problems. One uses it in many areas of our lives. In mathematics, one use ordinary language and the special language of mathematics. One needs to teach students to use both these languages. One can work on problems within mathematics and one can work on problems that use mathematics as a tool,
like problems in science and geography. Mathematics can describe and explain but it can also predict what might happen. That is why mathematics is important.

Mathematics is a science of calculation, a science of space and numbers and a science of measurement, magnitude and direction. In fact, the meaning of the word mathematics is ‘The science in which calculations are prime”. In this way, on the basis of these assumptions of mathematics, one can say that mathematics is the science of numbers, word, sign, etc, with which one can know about magnitude, direction and space.

Mathematics is an important subject in school curriculum. It is more closely related to our daily life as compared to other subjects. Except the mother tongue, there is no other subject, more closely related to the daily life as Mathematics. Mathematics is considered as father of science. In present days mathematics has been given an important place in school curriculum. In order to give an important place in curriculum, a particular subject must possess the following views.

- Utility of particular subject in daily life.
- Whether the subject is helpful in the development of mental discipline or not.
- Mathematics, thus, has the quality to be given important in school curriculum.

1.9. AIMS AND OBJECTIVES OF TEACHING MATHEMATICS

- To enable the child to understand the use of numbers and quantities related to their daily life.
- To enable the child to solve mathematical problems of daily life.
- To create a suitable type of discipline in the mind of the child.
- To familiarize child with the latest mathematical knowledge to fulfil the existing needs of the society.
➢ To give the knowledge about the broad objective of teaching mathematics such as knowledge, understanding, application, etc.
➢ To develop, in the child, fundamental skills and process of mathematics.
➢ To develop, in the child, a sense of appreciation of cultural arts.
➢ To prepare the child for elementary as well as higher education in science, engineering etc.
➢ To develop the habit of concentration, self-confidence, self-reliance and discovery.
➢ To develop, in the child, the mental powers like thinking, reasoning, etc.
➢ To develop scientific and realistic attitude towards life.
➢ To give practical knowledge of mathematics to face the day-to-day problems.
➢ To prepare the child for technical professions such as those of accounts, audits, bankers, surveyors, cashiers, scientists, architects and mathematics teachers.
➢ To bring an all-round and harmonious development of the personality of the child.
➢ To develop the sense of appreciation of mathematical knowledge and contribution of mathematicians.
➢ To develop the skill to use the modern mathematical device like computers.
➢ To develop the abilities of analysis, synthesis, reasoning, computation, etc.
➢ To develop interest in mathematics.

**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 to all round development. Therefore, values reflect one’s personal attitudes, judgments, decisions, choices, behavior, relationships, dreams and vision. Napoleon 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 values as given in the following figure.

**Figure showing values of teaching mathematics**

![Diagram showing values of teaching mathematics]

**Objectives of Teaching Mathematics**

(i). **Knowledge**: The pupil acquires knowledge of terms, concepts, symbols, definitions, principles processes and formulae of mathematics at the secondary stage.
(ii). **Understanding:** The pupil develops understanding of terms, concepts, symbols, definitions, processes and formulae of mathematics at the secondary stage.

(iii). **Application:** The pupil applies his or her knowledge and understanding of mathematics to unfamiliar situation.

(iv). **Skill:** To acquire skills of computation, drawing geometrical figures and reading tables, charts, graphs.

**1.10. PROBLEMS IN MATHEMATICS TEACHING**

Any analysis of mathematics education in our schools will identify a range of issues as problematic. The teachers can structure our understanding of these issues around the following four problems which one deems to be the core areas of concern;

1. A sense of fear and failure regarding mathematics among a majority of children,
2. A curriculum that disappoints both a talented minority as well as the non-participating majority at the same time,
3. Crude methods of assessment that encourage perception of mathematics as mechanical computation, and
4. Lack of teacher preparation and support in the teaching of mathematics.

Each of these can and need to be expanded on, since they concern the curricular framework in essential ways.

**1.11. IMPROVE THE QUALITY OF MATHEMATICS TEACHING**

Mathematics education has gained significant momentum as a national priority and important focus of school reform (National Mathematics Advisory Panel, 2008). In the United States, student achievement in mathematics, although improving, remains alarmingly low in comparison with other nations. Only 32 percent of eighth
graders scored “proficient” on the U.S. National Assessment of Educational Progress in 2007. Moreover, achievement gaps persist between Caucasian students and students of color, with 42 percent of Caucasian students in eighth grade scoring “proficient” in mathematics, as compared with 11 percent of African American and 15 percent of Hispanic students (NAEP, 2007).

Central to raising student achievement in mathematics is improving the quality of mathematics teaching. Students who receive high-quality instruction experience greater and more persistent achievement gains than their peers who receive lower-quality instruction. Rivkin et al. found that students who were taught by a highly effective teacher achieved a gain of 1.5 grade equivalents during a single academic year, whereas students enrolled in classes taught by ineffective teachers gained only 0.5 grade equivalents in the same year. Moreover, the effects of high-quality instruction on the academic achievement of disadvantaged students are substantial enough to counteract the host of familial and social conditions often found to impede student achievement (Rivkin et al., 2005). To put it differently, teachers are critical determinants of student learning and educational progress and thus must be well trained to use effective teaching practices.

1.12. TEACHER EFFECTIVENESS

The term teacher effectiveness is very ambiguous and it is difficult to define. It is a relative term. It consists of two words. Teacher and effectiveness. It will be used to refer to the results which a teacher gets or to the amount of progress the pupils education makes. One implication of this definition is that teacher effectiveness cannot be defined, and can be assessed, in terms of behaviour of pupils, not the behaviour of teachers.
Teacher effectiveness will be regarded not as a stable characteristic of the teacher as an individual but as a product of the interaction between certain teacher characteristics and other factors that vary according to the situation in which the teacher works. The effective teachers can teach using different methods of teaching, using variety of audio-visual aids and applying unconventional techniques. Effective teaching is also called “Teacher effectiveness”, "Criteria for Competence" and "Ability to Teach".

Achievement is one of the most important concepts for the classroom teachers. Achievement means the academic status of a child in different school subjects at any particular time. Achievement test as the name signifies are employed for measuring the amount of success or achievement of individual in a specific field or area of accomplishment. In the school situations an achievement test is used as a tool for measuring the nature and extent of students learning in a particular subject or a group of subjects. How far a particular student has been able to learn and acquire or has been benefited from the learning experience given to him is ascertained with the help of their tests.

Therefore achievement tests are essentially past oriented. They give evidence of what has been learned or acquired by an individual by testing his present ability. Achievement test generally solve three purposes. The purpose of a survey test is to supply information as to the extent to which the pupils have met the established norms. Such a test comprises of items that include learning materials covered in a particular subject field or subject limit. Such tests are prepared to assess the attainment or understanding in a given field of knowledge or skill.

Diagnostic test is administered to discover the respective strength and weaknesses of individual learners in a subject area or unit. Such test provides
information about pupil’s deficiencies and point the way for remedial work. They also diagnose the problems in the teaching learning process. Prognostic test determine a pupil's or a class readiness for beginning or advanced learning in specific subject areas. They predict future success of an individual or class super states. Achievement tests give better differential predictions of success in specific subject.

The existing teaching methods which are largely based on rote memory, lectures and reproduction should be replaced by new teaching methods which awaken curiosity, encourage self-study habits and promote problem solving skills. It is necessary to recognize the importance of problem solving exercises and seminars, discussions in the case of science subjects and case studies, tutorials and seminars in the case of social science. Therefore, adequate time is explicitly allocated in the time table for tutorials, seminars, self-study sessions etc. It is suggested that a formal lecturing should not constitute more than two kinds of the teaching learning situations.

1.12.1 Teacher

Today our great and pressing need is for great teachers. Our greatest need at the moment is not for more and better information, it is far more and better dissemination of the information already have, it is to hold the student, to prevent him from becoming a drop out, a welfare recipient. For every student that fails or drops out, for every teacher and society as a whole has failed just that much. These are the days of educational decisions. The educationists succeed or fail in the first great opportunity that society has given us to prove the cause of education for the 21st century. It reminds us of the great eradicator who said, "I educate my students for the future, the future is where I plan to spend the rest of my life".
1.12.2. Role of a Teacher

The different roles of a teacher are:

1. Interest in the overall welfare of the student.

2. Possessing skill in using teaching aids.

3. Using as many teaching aids as possible.

4. Keeping personal contact with every student in the class.

5. Maintaining a democratic atmosphere in the class.


7. Developing a syllabus.

8. Evaluating the answer papers within reasonable time.

9. Evaluating the progress of the student continuously.

10. Evaluating one's own progress in teaching.

Definitions and views expressed by various educationalists on teacher are given below.

**Good (1959)**

The teacher is a person employed in an official capacity for the purpose of guiding and directing learning experiences of pupils in an educational institution, whether public or private.

**Humayun Kabir**

Without good teachers, even the best of the system is bound to fail, with good teachers, even the defects of a system can be largely overcome.

**S. Radhakrishnan**

A good teacher must know how to arouse the interest of the pupil in the field of study for which she is responsible. She must herself be a master in the
field and be in touch with the latest development in her subject. She must herself be a fellow traveler in the exciting pursuit of knowledge.

University Education Commission Report (1948) says that the right kind of teacher is one who possesses a vivid awareness of her mission. She loves not only her subject, but also loves those whom she teaches.

The National Commission on School Teachers (1983-1985) has described the role of the teacher in the context of the present needs of India as:

"The teacher must actively and feelingly associate herself as an essential and responsible partner in the great tasks which face the nation. The teacher will indeed prepare students for examinations and open to them the world of knowledge. But, these well counts for little unless she has helped them to become persons of character. There is the personal aspect of character building to develop qualities like honesty and integrity and there is the social aspect which defines natural character such character identification must not be based on cultural and religious traditions of any one group but must find acceptance by all sections of the people”.

The place of the teacher in the society is of vital importance. Teacher acts as the pivot for the transmission of intellectual and technical skills from generation to generation. Teacher is the destiny of the nation. This place a special responsibility on teachers at all levels of education.

1.13. CHARACTERISTICS OF MATHEMATICS TEACHER

A – Teacher designs learning opportunities that allow students to participate in empowering activities in which they understand that learning is a process and mistakes are a natural part of the learning. The teacher:
1. designs learning opportunities that allow students to participate in relevant activities.

2. establishes a learning environment so that students will realize learning is a process and mistakes are a natural part of learning.

3. models the characteristics of a lifelong learner in his/her instruction by asking guiding questions of self and students.

B – Teacher links concepts and key ideas to students’ prior experiences and understandings, uses multiple representations, examples and explanations. The teacher:

1. demonstrates how the big ideas in mathematics are connected.

2. uses multiple representations, relevant examples and clear explanations to enhance student learning.

C – Teacher incorporates student experiences, interests and real-life situations in instruction.

D – Teacher selects and utilizes a variety of technology that support student learning.

E – Teacher effectively incorporates 21st Century Learning Skills that prepare students to meet future challenges.

F – Teacher works with other teachers to make connections between and among disciplines. The teacher:

1. poses real-world problems involving other disciplines for students to solve by applying mathematical reasoning.
G – Teacher makes lesson connections to community, society, and current events.

The teacher:

1. poses real-world problems involving community, society and current events for students to solve by applying mathematical reasoning.

1.14. INADEQUATE TEACHER PREPARATION IN MATHEMATICS

More so than any other content discipline, mathematics education relies very heavily on the preparation that the teacher has, in her own understanding of mathematics, of the nature of mathematics, and in her bag of pedagogic techniques. Textbook-centered pedagogy dulls the teacher’s own mathematics activity. At two ends of the spectrum, mathematics teaching poses special problems. At the primary level, most teachers assume that they know all the mathematics needed, and in the absence of any specific pedagogic training, simply try and uncritically reproduce the techniques they experienced in their school days. Often this ends up perpetuating problems across time and space.

At the secondary and higher secondary level, some teachers face a different situation. The syllabi have considerably changed since their school days and in the absence of systematic and continuing education programmes for teachers, their fundamentals in many concept areas are not strong. This encourages reliance on ‘notes’ available in the market, offering little breadth or depth for the students.

While inadequate teacher preparation and support acts negatively on all of school mathematics, at the primary stage, its main consequence is this: mathematics pedagogy rarely resonates with the findings of children’s psychology. At the upper primary stage, when the language of abstractions is formalized in algebra, inadequate teacher preparation reflects as inability to link formal mathematics with
experiential learning. Later on, it reflects as incapacity to offer connections within mathematics or across subject areas to applications in the sciences, thus depriving students of important motivation and appreciation.

One summarise what one believe to be the central directions for action towards our stated vision. The teachers, can group them again into four central themes:

1. Shifting the focus of mathematics education from achieving ‘narrow’ goals to ‘higher’ goals,
2. Engaging every student with a sense of success, while at the same time offering conceptual challenges to the emerging mathematician,
3. Changing modes of assessment to examine students’ mathematisation abilities rather than procedural knowledge,
4. Enriching teachers with a variety of mathematical resources.

In school mathematics, certainly emphasis does need to be attached to factual knowledge, procedural fluency and conceptual understanding. New knowledge is to be constructed from experience and prior knowledge using conceptual elements. However, invariably, emphasis on procedure gains ascendancy at the cost of conceptual understanding as well as construction of knowledge based on experience. This can be seen as a central cause for the fear of mathematics in children.

Arithmetic and algebra a consolidation of basic concepts and skills learnt at primary school is necessary from several points of view. For one thing, ensuring numeracy in all children is an important aspect of universalization of elementary education. Secondly, moving from number sense to number patterns, seeing relationships between numbers and looking for patterns in the relationships
bring useful life skills to children. Ideas of prime numbers, odd and even numbers, tests of divisibility etc. offer scope for such exploration.

Algebraic notation, introduced at this stage, is best seen as a compact language, a means of succinct expression. Use of variables, setting up and solving linear equations, identities and factoring are means by which students gain fluency in using the new language. The use of arithmetic and algebra in solving real problems of importance to daily life can be emphasized. However, engaging children’s interest and offering a sense of success in solving such problems is essential.

1.15. A METHOD OF INVESTIGATING MATHEMATICS

Many teachers show students how to do some mathematics and then ask them to practice it. Another very different approach is possible. Teachers can set students a challenge which leads them to discover and practice some new mathematics for themselves. The job for the teacher is to find the right challenges for students. The challenges need to be matched to the ability of the pupils.

The key point about investigations is that students are encouraged to make their own decisions about:

i. where to start
ii. how to deal with the challenge
iii. what mathematics they need to use
iv. how they can communicate this mathematics
v. how to describe what they have discovered.

The teachers can say that investigations are open because they leave many choices open to the student. This section looks at some of the mathematical
topics which can be investigated from a simple starting point. It also gives guidance on how to invent starting points for investigations.

1.16. INSTRUCTIONAL METHODS FOR TEACHING MATHEMATICS

“All-encompassing recommendations that instruction should be entirely “student centered” or “teacher directed” are not supported by research. High quality research does not support the exclusive use of either approach”.


“The Panel recommends regular use of formative assessment, particularly for students in the elementary grades…for struggling students, frequent (e.g., weekly or biweekly) use of these assessments appears optimal, so that instruction can be adapted based on student progress”.


The Panel recommends that students with learning disabilities and other students with learning problems receive, on a regular basis, some explicit systematic instruction that includes opportunities for students to ask and answer questions and think aloud about the decisions they make while solving problems. This kind of instruction should not comprise all mathematics instruction students receive.


Theories of mathematical learning suggest that the nature of classroom activities, or “tasks,” affects students’ abilities to learn mathematics with understanding. Hiebert and Carpenter (1992) contend that the structure and depth of knowledge depends on learners’ prior knowledge and their ability to access it and connect complex mathematical ideas to one another within a broader network of understanding. Students with connected knowledge structures are better equipped to engage in reasoning and problem solving and better primed to transfer learning and
adapt understandings to new contexts. Therefore, the mathematical tasks in which students engage should facilitate and support students’ conceptual understanding of mathematics, fostering deep connections among mathematical ideas.

Rather, knowledge of mathematics for teaching is embedded in the practice of teaching mathematics: in mathematics, how teachers hold knowledge may matter more than how much knowledge they hold. In other words, teaching quality might not relate so much to performance on standard tests of mathematics achievement as it does to whether teachers’ knowledge is procedural or conceptual, whether it is connected to big ideas or small bits, or whether it is compressed or conceptually unpacked student learning might result not only from teachers’ content knowledge but also from the interplay between teachers’ knowledge of students, their learning, and strategies for improving that learning.

Refinements in conceptualizing knowledge of mathematics for teaching are currently underway. Hill and her colleagues have developed a conception of “knowledge of content and students”, which is one component of pedagogical content knowledge yet differs from “knowledge of content and teaching” and “knowledge of curriculum” (Hill, Ball, and Schilling, 2008, p. 377).

1.17. INNOVATIVE TEACHING METHODS

Teacher's main job lies to teach. There is a single method or the methods of teaching science which could suit in all the situations. All the teachers are different. No two children are alike. Teachers differ in personality; children differ from family to family and from locality to locality even in respect of their mental and physical development. Thus a teaching method is largely governed by these three factors viz: environment, teacher and pupil. It will be advisable to lay down a series
of methods of science teaching, so that the teachers could select from them according to their need.

Method is a style of the presentation of content in classroom. The following are the innovative methods that can be used to make teaching-learning process of mathematics effective.

**Inductive-Deductive Method**

It is a combination of inductive and deductive method. Inductive method is to move from specific examples to generalization and deductive method is to move from generalization to specific examples. In classroom usually the instructions directly start with the abstract concepts and are being taught in a way that does not bring understanding on the part of majority of the students. Formulas, theorems, examples, results are derived, proved and used. But teacher needs to start with specific examples and concrete things and then move to generalizations and abstract things. Then teacher again needs to show how generalization can be derived and it holds true through specific examples. This method will help students for better understanding; students don’t have to cram the things and will have long lasting effect.

Example: Pythagoras Theorem - In a right-angle D ABC right angled at B, \(2AB + 2BC = 2AC\) (Considering right angle triangles of different measurement leading to generalization and then establishing it through the theoretical proof).

**Analytic-Synthetic Method**

It is a combination of Analytic and Synthetic method. Analytic is breaking down and moving from unknown to known and Synthetic is putting together known bits of information and moving from known to unknown. These methods are basically used in proving the results and solving sums. In textbooks mostly synthetic
method is used, to prove something unknown one start with a certain known thing, but that leaves doubt in mind of students why one have started with that step and using this particular known thing. So teacher has to use combination in order to explain and relate each step logically.

**Problem-Solving Method**

This method aims at presenting the knowledge to be learnt in the form of a problem. It begins with a problematic situation and consists of continuous meaningful well-integrated activity. Choose a problem that uses the knowledge that students already have i.e. you as a teacher should be able to give them the problem and engage them without spending time in going over the things that you think they should know. After students have struggled with the problem to get solution, have them share their solutions. This method will help them in developing divergent thinking.

Example: Put a problem of finding the amount of water in a given container instead of deriving the formula of volume (cylinder filled with water).

**Play-Way Method**

This method consists of the activities that include a sort of fun or play and give joy to the students. Students don’t realize that they are learning but in a way they are gaining knowledge through participating in different activities. This method helps to develop interest in mathematics, motivates students to learn more and reduces the abstract nature of the subject to some extent.

Example: Mathematical games and puzzles.

**Laboratory Method**

Laboratory method is based on the principles of “learning by doing” and “learning by observation” and proceeding from concrete to abstract. Students do
not just listen to the information given but do something practically also. Principles have to be discovered, generalized and established by the students in this method. Students learn through hands on experience. This method leads the student to discover mathematical facts. After discovering something by his own efforts, the student starts taking pride in his achievement, it gives him happiness, mental satisfaction and encourages him towards further achievement.

Example: Making and observing models, paper folding, paper cutting and construction work in geometry.

**1.18. DIFFERENT TEACHING METHODS IN MATHEMATICS**

The different ways one can teach a topic in the classroom. Young people learn things in many different ways. They don’t always learn best by sitting and listening to the teacher. Students can learn by:

i. practicing skills on their own

ii. discussing mathematics with each other

iii. playing mathematical games

iv. doing puzzles

v. doing practical work

vi. solving problems

vii. finding things out for themselves.

In the classroom, students need opportunities to use different ways of learning. Using a range of different ways of learning has the following benefits:

i. it motivates students

ii. it improves their learning skills

iii. it provides variety

iv. it enables them to learn things more quickly.
The investigator looks at the following teaching methods in a traditional classroom:

1. Presentation and explanation by the teacher
2. Consolidation and practice
3. Games
4. Practical works
5. Problems and puzzles
6. Investigating mathematics

For example, to solve the design problem, our students need to:

1) **Do estimations**
   - (i) of the height of the people who will use the shelter
   - (ii) of the floor area of the shelter

2) **Calculate area**
   - (i) of the floor of different shelter designs such as rectangles, squares, regular and irregular polygons, triangles, circles.

3) **Understand inverse proportion**
   - (i) for example, if the height of the shelter increases, the floor area decreases.

4) **Make scale drawings of different possible shelters**
   - (i) based only on a few certain dimensions like length of one or two sides, radius.

5) **Use Pythagoras’ Theorem and trigonometry**
   - (i) to calculate the dimensions of the other parts of the shelter such as lengths of other sides and angles.
1.18.1 Conventional Method

This is one of the most popular methods of teaching in our schools. This is a teacher structured method, and the students are just passive listeners most of the time. Very few teachers allow questions during the lecture, though some of them give some time to their students to ask questions after the lecture. Many students forget their questions by the time the lecture is over and so their questions remain unanswered. Teachers talk most of the time without using any teaching aid though some of them use blackboard. For them the lecture method is talk and chalk method. Sometimes the backbenchers cannot even read what is written on the blackboard. Students take notes of the lecture and slow writers miss many points.

Advantages

i. It is quick, and a lot of knowledge can be imparted in quite a lesser time.

ii. It is highly efficient if teacher teaches in a systematic and logical manner.

iii. It is convenient and easy and a teacher is free to develop his own style of teaching.

Disadvantages

- Student’s involvement and participation is nil or quite less.
- Student’s previous knowledge or entry behaviours are not usually taken into consideration.
- Developing scientific skills are neglected.
- Teacher needs a lot of prior knowledge to prepare a lecture.

1.18.2 Co-operative Learning Method

Cooperative learning method is an educational approach which aims to organize classroom activities into academic and social learning experiences. There is much more to cooperative learning than merely arranging students into groups, and it
has been described as “structuring positive interdependence”. Students must work in groups to complete tasks collectively toward academic goals. Unlike individual learning, which can be competitive in nature, students learning cooperatively can capitalize on one another’s resources and skills (asking one another for information, evaluating one another’s ideas, monitoring one another’s work, etc.). Furthermore, the teacher’s role changes from giving information to facilitating students’ learning. Everyone succeeds when the group succeeds. Ross and Smyth (1995) describe successful cooperative learning tasks as intellectually demanding, creative, open-ended, and involve higher order thinking tasks. Five essential elements are identified for the successful incorporation of cooperative learning in the classroom. The first and most important element is positive interdependence. The second element is individual and group accountability. The third element is (face to face) promotive interaction. The fourth element is teaching the students the required interpersonal and small group skills. The fifth element is group processing.

Brown and Ciuffetelli Parker (2009) and Siltala (2010) discuss the 5 basic and essential elements to cooperative learning:

1. Positive interdependence
   1. Students must fully participate and put forth effort within their group.
   2. Each group member has a task or role or responsibility therefore must believe that they are responsible for their learning and that of their group.

2. Face-to-face promotive interaction
   1. Members promote each other's success.
2. Students explain to one another what they have or are learning and assist one another with understanding and completion of assignments.

3. Individual and group accountability
   1. Each student must demonstrate mastery of the content being studied.
   2. Each student is accountable for their learning and work, therefore eliminating “social loafing”.

4. Social skills
   1. Social skills that must be taught in order for successful cooperative learning to occur.
   2. Skills include effective communication, interpersonal and group skills.
      1. Leadership
      2. Decision-making
      3. Trust-building
      4. Friendship- development
      5. Communication
      6. Conflict-management skills

5. Group processing
   1. Every so often groups must assess their effectiveness and decide how it can be improved.

   In order for student achievement to improve considerably, two characteristics must be present:

   1. When designing cooperative learning tasks and reward structures, individual responsibility and accountability must be identified. Individuals must know
exactly what their responsibilities are and that they are accountable to the group in order to reach their goal.

2. All group members must be involved in order for the group to complete the task. In order for this to occur each member must have a task that they are responsible for which cannot be completed by any other group member.

Techniques of Cooperative Learning Method

There are a great number of cooperative learning techniques available. Some cooperative learning techniques utilize student pairing, while others utilize small groups of four or five students. Hundreds of techniques have been created into structures to use in any content area. Among the easy to implement structures are Think-Pair-Share, Think-Pair-Write, variations of Round Robin, and the Reciprocal Teaching Technique. A well-known cooperative learning technique is the Jigsaw, Jigsaw II and Reverse Jigsaw.

i) Think Pair Share

Originally developed by Frank T. Lyman (1981), Think-Pair-Share allows for students to contemplate a posed question or problem silently. The student may write down thoughts or simply just brainstorm in his or her head. When prompted, the student pairs up with a peer and discuss his or her idea(s) and then listen to the ideas of his or her partner. Following pair dialogue, the teacher solicits responses from the whole group. When teachers use this technique they don’t have to worry about students not volunteering because each student will already have an idea in their heads, therefore, the teacher can call on anyone and increase discussion productivity.
ii) Jigsaw

Students are members of two groups: home group and expert group. In the heterogeneous home group, students are each assigned a different topic. Once a topic has been identified, students leave the home group and group with the other students with their assigned topic. In the new group, students learn the material together before returning to their home group. Once back in their home group, each student is accountable for teaching his or her assigned topic.

iii) Jigsaw II

Jigsaw II is Robert Slavin's (1980) variation of Jigsaw in which members of the home group are assigned the same material, but focus on separate portions of the material. Each member must become an "expert" on his or her assigned portion and teach the other members of the home group.

iv) Reverse Jigsaw

This variation was created by Timothy Hedeen (2003). It differs from the original Jigsaw during the teaching portion of the activity. In the Reverse Jigsaw technique, students in the expert groups teach the whole class rather than return to their home groups to teach the content.

v) Reciprocal Teaching

Brown and Paliscar (1982) developed reciprocal teaching. It is a cooperative technique that allows for student pairs to participate in a dialogue about text. Partners take turns reading and asking questions of each other, receiving immediate feedback. Such a model allows for students to use important metacognitive techniques such as clarifying, questioning, predicting, and summarizing. It embraces the idea that students can effectively learn from each other.
vi) The Williams

Students collaborate to answer a big question that is the learning objective. Each group has differentiated questions that increase in cognitive ability to allow students to progress and meet the learning objective.

vii) STAD (or Student-Teams-Achievement Divisions)

Students are placed in small groups (or teams). The class in its entirety is presented with a lesson and the students are subsequently tested. Individuals are graded on the team's performance. Although the tests are taken individually, students are encouraged to work together to improve the overall performance of the group.

1.18.3. Multimedia Learning Method

Multimedia integrates video, animation, audio, graphics, and test resources to develop effective presentations. It allows sort out the information, analyse and make meaning for conceptualization and applications which is suitable for individual learners. Only limited studies have been undertaken on multimedia learning particularly for mathematics. Multimedia is characterized by the presence of text, pictures, graphics, sound, animation and video; some or all of which are organized into some coherent program. A primary application of the interactive multimedia for instruction is in an instructional situation where the learners is given control so that he or she may review the material at his or her own pace and in keeping with his or own individual interests, needs, and cognitive processes.

“Mathematics is an expression of the human mind reflects that active will, the contemplative reason, and the desire aesthetic perfection is its basic elements are logic intuit analysis and construction generally and individually”.

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Multimedia enables the students learn reading autonomously. Critical reading can be taught through multimedia applications. Sometimes, reading on the lines, reading between the lines and ‘reading beyond the lines’ is demanded. Sound is never far from reading, and hence both in oral and silent reading, we do often move our lips and perhaps the tongue and other sub-vocal mechanisms. What one see by eye is to be converted into some sound values (Crystal, 1987: 210). At the most basic level, reading is sometimes thought to consist of translating symbols on a page, or nowadays on a computer screen, into sounds, in what is sometimes referred to as ‘barking print’ (Fairbrain & Fairbrain, 2002: 18).

With the introduction of technology, specifically multimedia technology into the classroom environment, the delivery of the information becomes a new phenomenon (Vanaja M. 2007). The use of technology and multimedia will clearly reinforce and strengthen the traditional ICP and change the roles of the instructors and students. Now, the teacher becomes the director of the knowledge access process and will make a difference in the integration of the media into this process. Thus multimedia means a combination of more than one medium in a single communication for the same purpose. Navigational links can be added to the instructional content to enable the student to interact and to move around the content with ease in the way he or she likes best (Saxena, Mishra, & Mohanty, 2006). They allow students to progress at their own pace and work individually or problem solve in a group. So, the students learn independently at their own pace which is called self learning. The multimedia package provides the self learning strategy in the educational field (Jonassen, et. al, 1999).

Multimedia package used in the classroom for teaching learning process have a wide significance to the learners as well as teachers. It provides a
good motivating force to the students. Verbalism both printed and spoken does not prove much effective in the process of teaching and learning. Raymond Wyman (1967) says, we (teacher) tell students and one provide them with written material so much of the time. Words are wonderful. They are easily produced, reproduced, stored and transported but the excessive use of words can result in serious problem, chiefly, the problem of verbalism (using or adopting words of phases without considering what they mean) and forgetting. The multimedia package helps in solving the problem of verbalism by providing picture, animation, video etc in teaching and learning. It arouses the interest of learners and helps the teachers to explain the concepts easily. Hence, in the present study, the investigators developed the multimedia package in teaching mathematics among higher secondary students.

1.19. ARRANGEMENT OF DISSERTATION

The dissertation is presented in five chapters. The first chapter gives the background of the study. The study of the related literature is discussed in the second chapter. The third chapter gives details about the methodology followed, the sample selected, the tool used, the statistical technique applied and the delimitations fixed. The analysis of the data, interpretation of the result the findings and the conclusion drawn are discussed in the fourth chapter. The last chapter as well as the fifth summaries the whole matter. The recommendations as the educational implications and the suggestion for further research are also given in the fifth chapter. The books and websites referred are listed and given under “Bibliography”. The copies of the tools used in this study are given in the appendix.