CHAPTER - I

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1.1 INTRODUCTION

Gender differences in mathematical abilities continue to attract much research attention. History reveals that women’s education was started very late almost in all countries. In the United States, the founding of Harvard College in 1636 demonstrates that admission in this college was beyond the reach of women. In England, Oxford and Cambridge universities refused to admit women to full membership till 1919 and 1948 respectively. Herbert Spencer, a great Educationist, argued that the intellectual attributes of women developed differently in the course of evolution. Women were thus deficient in powers of abstract reasoning and in the most abstract of emotions, the sentiment of justice. Germany was also less favorable towards the education of women. In developing and under developed countries women’s education was not given due place till 1950. The proportion of girls opting for mathematics in school and college is still very low, particularly in India, before 1975, the proportion of female and male was 1 and 40.

In recent years, the importance of mathematical skills in the job market has attracted girls to opt for mathematics as one of the subjects of main study. Marrett and Gates (1983) found no gender differences in
Enrolment patterns in different schools seemed to vary more by school than by sex. Marret and Gates' results may be true for developed countries like the United States of America and United Kingdom. In India, the situation is quite different. English medium schools like Delhi public school, Mayo college, Ajmer, Scindia college, Gwalior, managed by private bodies and missionaries may have equal number of boys and girls studying mathematics. But the number of girls in other schools, particularly in the schools of rural areas or in semi urban areas, is very low. Cultural and social factors are highly responsible for the under representation of girls in mathematics. The second reason for under representation of girls may be male dominance. Charles Darwin, a renowned mathematician, admitted that his sister was brighter than he was (F. Darwin, 1929). Adele Galton tutored her famous brother Francis Galton (Pearson, 1914). But the names of Mesdames Darwin and Galton have not been given due place in the history of mathematicians. Women's achievements were defined in terms of motherhood and nurturance. Male mathematics teachers, parents and so called educated members of the Indian society still discourage girls from studying mathematics. Male mathematics teachers discourage girls in the classroom. A large section of the society considers girls a liability and boys an asset. Before and after school hours, girls are asked to help in domestic work by the parents. Generally, parents never disturb their sons while they are studying. Such discriminatory views of parents and male mathematics teachers demoralize girls.
Several brilliant women have done commendable work in mathematics. Shakuntala devi, a mathematics genius and a prodigy is an institution in herself. In Dallas, Texas, she calculated faster than the computer, the cube root of 188138517. Maria Gaetana Agnes of Italy is also a famous mathematician. She occupied for a time the chair of mathematician in the university of Bolongs. Her work in analytic geometry is well known. Barbara Holland was the youngest girl to take admission in the mathematics department of Melbourne University, Australia. She was invited especially by the Oxford University, London. These are some examples, which indicate that girls are not inferior by birth. They are equally talented.

The results of several surveys clearly indicate that the number of girls offering mathematics or mathematics related courses was less than boys up to 1970 in the developed countries. But Armstrong (1981) reported that the differences have diminished in recent years. In India, the number of girls offering mathematics at the intermediate and college level is increasing. Twenty years hence the ratio of boys and girls offering mathematics may be equal, but at present it is about 3:10. Katiyar (1979) reported insignificant differences between boys and girls studying advanced mathematics on the achievement test.

1.1.1 What is Mathematics?

Most commonly, Mathematics is called a science of logical reasoning. It always settles in the mind a habit of reasoning. The
reasoning in mathematics is of particular kind and possesses a number of characteristics such as simplicity, accuracy, certainty of results, originality, similarity to the reasoning of life and verification.

The word 'Mathematics' brings in our mind the numbers, the various calculations we do with number, geometrical shapes, graphs, equations etc. These are tools of mathematics. Mathematics is the thinking power based on all these tools. Even though, mathematics is involved in our daily life activities, it is a subject having logical structure. The chief aim of mathematics learning is to arrive at correct conclusion from a set of given conditions by making use of logical reasoning (Normha, 1983).

Many and varied are the definitions stated by great mathematicians, philosophers and others.

Mathematics is

- The study of quantity (Aristotle)
- A science of order and measure (Descartes)
- A science of self-evident things (Felix Klein)
- A subject identical with logic (B. Russell)
- A way to settle the mind; a habit of reasoning (Locke)
- A science which draws necessary conclusions (Benjamin pierce)
- The mirror of civilization (Hoben)
- Gate way and key to all sciences (Robert Becon).
- The basic fabric of our social order, (K.E. Brown)
• A natural science is a science only in so far as it is mathematical (Kant).
• Indispensable instrument of all physical research (Berthelot).
• Symbolic Logic is mathematics, mathematics is symbolic Logic, (C.J.Keyser).

Hermann Weyl, (1940) a great mathematician of our century, defines the mathematical way of thinking first as that form of reasoning through which mathematics penetrates into the sciences of the external world - Physics, Chemistry, Biology, Economics etc., and even into our everyday thoughts about human affairs, and secondly the form of reasoning which the mathematician, left to himself, applies in his own field.

Courant and Robbins define, "Mathematics as an expression of human mind, reflects the active will, the contemplative reason and the desire for aesthetic perfection. Its basic elements are logic and intuition, analysis and construction, generality and individuality".

Mathematics is universally practiced and applied by human beings and it is being and becoming part and parcel of our life. Mathematics as an expression of the human mind; reflects the active will, the contemplative reason, and the desire for aesthetic perfection. Its basic elements are logic and intuition, analysis and synthesis, generality and individuality. Without doubt, all mathematical development has its psychological roots in all practical requirements. But once started under
the pressure of necessary applications, it inevitably gains momentum in itself and transcends the confines of immediate utility. This trend from applied to theoretical science appears in ancient history as well as in many contributions to modern mathematics by engineers and physicists.

Mathematics is a very useful subject for most vocations and specified courses of higher learning. The duty of the school is to give the high school student, a broad view of what he is capable of achieving in future. He should get a broaden course, to be able to choose a suitable line, out of that. At the university level, most of physical and social sciences require the application of mathematics. Ignorance of mathematics will be a great handicap in the process of his studies, in many other subjects. No other subject can be a substitute for mathematics. As mathematics is a skill subject, proficiency in mathematics is essential to all.

1.1.2 Place of Mathematics in Schools

Mathematics is a basic in the curriculum, is heavily emphasized, along with reading, in state mandated testing. To have a good mathematics curriculum, carefully chosen objectives need to be in the offing and implemented in the instructional arena. These objectives need to stress a balance among cognitive, affective and psychomotor ends.

Mathematics is the noblest and the exact science developed by man. It is the basis of all scientific activities. No science is possible
without mathematics. It is the gateway and key to all sciences and the indispensable instrument for all scientific research.

The subject is highly useful from the practical point of view. It is indispensably important. With mathematics man makes superior adjustment with his quantitative environment. Human necessities are expressed measurable quantities. The whole commercial systems, industry and manufacture are based on mathematics. The entire atmosphere around us permeates with mathematics. Qualitative and quantitative aspects characterize every phenomenon; only mathematical treatment can help us to study the quantitative aspect in its turn aids qualitative grasp of the phenomena.

The whole commercial systems, industry and manufacture are based on mathematics. The entire atmosphere around us permeates with mathematics. It is the pivot of civilization from time immemorial.

A mathematics student develop his capacity to generalise from given statements, critical observance of facts, establishing relationship and to make distinction between the relevant and the irrelevant, concentration on problems, imagination for abstract ideas, functional thinking, systematic organisation and interpretation of data, reaching appropriate conclusions through accurate and logical reasoning, convergent and divergent thinking, symbolic expression and perseverance, self-confidence, self reliance, reverence for truth and traits like estimating and checking the results.
Thus mathematics helps the learner to discipline the mind and to cultivate valuable habits and attitude in him. Mathematics had been considered as a necessary part of general education. It is an essential subject in the curriculum of all high schools. Mathematics is taught in schools to attain the educational values of mathematics. The progress and the improvement of mathematics are linked to the prosperity of the state. It develops the power of reasoning and thinking which helps the students to be successful in all other subjects. In addition to the above values the other values are,

1. Development of Concentration
2. Development of self-reliance
3. Development of original thinking
4. Development of the habit of hard work
5. Development of art of economical living.

Teaching of mathematics should not merely aid to teach students the rules of thumb. The principal aim of mathematics teaching at all stages of education should be develop the creative ability of the student and to develop the mathematical way of thinking.

Shut out mathematics from daily life and all civilization comes to a stand still. In this world nobody can live without mathematics for a single day. Mathematics is intimately involved in every moment of everyone’s life. Right from human existence on this earth, it has been a faithful companion. the knowledge of this subject was born out of felt
needs of man. This knowledge is therefore indispensable. As the needs grow, the knowledge is bound to grow.

The reasoning in mathematics possesses the following characteristics.

1. Simplicity
2. Accuracy
3. Certainty of results
4. Originality
5. Similarity to the reasoning of life, and
6. Amount of reasoning.

Mathematics is necessary in everyday life and it is a tool in the hands of all people from a housewife to a scientist. It is necessary for every vocation.

Mathematics is a compulsory subject till the high school or X standard level. The Education Commission (1964 - 66), has pointed out, "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 the next two decades or so".

The National Policy on Education (1986) has also considered the importance of mathematics in general education, and suggests that, "Mathematics should be visualized as the vehicle to train a child to
think, reason, analyze and to articulate logically. Apart from being a specific subject, it should be treated as concomitant to any subject involving analysis and reasoning’.

The International Commission on Education for the 21st century of UNESCO has cited four levels of learning as the four pillars of education.

- Learning to KNOW for acquisition of broad knowledge.
- Learning to DO for skills and competence to earn
- Learning to LIVE TOGETHER for understanding others
- Learning to BE for life long learning, development of personality and self - actualization.

Learning of mathematics like many other disciplines belongs to the second category of learning to DO. (Parashar, 1999).

Mathematics represents a highly salient base. Students need to achieve well in mathematics to do well in school and society. The societal arena demands mathematics proficiency within students. (Marlow .E, 1990).

There is no denying the fact that mathematics had; has and will remain to have self-proven importance as a subject of study. Science and Economics, which have acquired a pivotal place in the world affairs today, cannot move a step forward without the help of mathematics. All over the world, mathematics is being accredited for the development of personalities, which affect societies, countries and the world as a whole.
in many ways. There is also a general opinion that teaching and learning of mathematics are to be given priority by each and every country. Throughout the ages, development of mathematics has been synonymous with the growth of civilization. Acquisition of 3R's has been the aim of education for quite a longtime.

However in India, which has given birth to a number of renowned mathematicians and a lot of mathematical knowledge, we observe a negative attitude prevailing towards teaching - learning of mathematics (Khosla, 1999)

The present world is in the process of technological revolution. Modern technological advances demand a variety of well-trained manpower of various grades, who can read, write, compute and have learnt how to learn. This social pressure ordains schools to prepare courses according to manpower needs. Success of any democratic government rests on the citizens who know problems and issues facing the nation. Education in India has undergone tremendous change during the last few decades. The science of mathematics is changing rapidly. Social and technical process depends more and more on up-to-date mathematics in an increasing range of professions. This is because mathematics is becoming a more flexible tool than it ever was in many fields of life and cultures old and new alike. The rapid speed of modernization in science, technology and even in sociology is due to the process of mathematisation.

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Under the pressure of modernisation, vocational training and higher education with over burdened mathematical topics, the pressure is transmitted to the lower levels of learning, even to the primary level. The School mathematics always lags behind at any point of time. Most of the pupils do not reach a desired level of mathematical thinking due to introduction of new and difficult topics. Much of effort is needed to see that the pupils, at the lower level of learning, continue their mathematical studies at desired level of performance. During the last three decades, there has been an explosion of knowledge in the world with tremendous development not only in the field of science, technology and electronics but also in commerce, industries etc. In all these developments, an increasing use of mathematics is evident.

To cope with the mathematical needs of all these developments in various fields, there has been expansion in the knowledge of mathematics. The horizons of mathematics have greatly expanded since the turn of the century. Many new topics relating to daily life problems have been included in the School syllabus, which did not find place previously. (Ediger, 2003).

1.1.3 Importance of Mathematics Education

Mathematics has not become important only today, but it kept its important place from the earliest time, and is perhaps the only subject which merits this distinction.
In earlier days, education was considered to be an ornament for the privileged class. The class, which had a lot of leisure pursued education as a pastime for the sake of culture. Mathematics was a must for them. Plato advocated the inclusion of mathematics because mathematical reasoning disciplines the mind. He wrote over the portals of his academy, 'Let no one ignorant of Geometry enter here'.

Where the class studied mathematics for disciplining their minds, the masses depended upon mathematics for its utility in everyday life. Everybody needs some knowledge of mathematics in one-way or the other. But it is felt that for an ordinary man, the knowledge acquired during the primary and secondary stages will suffice. Consequently, there is a controversy, over making it, optional or compulsory at the high/higher secondary stage.

Mathematics is a very useful subject for most vocations or specialised courses of higher learning. The duty of the school is to give to the high school student, a broad view of what he is capable of achieving in future. He should get a broader course, to be able to choose a suitable line, out of that. At the university level, most of physical and social sciences require the application of mathematics. To deprive the student, of the knowledge of this subject, at the high school stage, means narrowing the choice of vocation for him. Ignorance of mathematics will be a great handicap in the progress of his studies, in many other subjects. High/higher secondary school education will
remain incomplete and incomprehensive if, mathematics is excluded from it. No other subject can be a substitute for mathematics.

Nowadays, value of mathematics education has increased considerably, because of its applicability in diverse field of human activities pertaining to individual, demographic, Socio-economic planning and management, Geographical surveying, scientific, technological, environmental, biological, medical and hygienic problems etc. In fact, mathematics has the scope of its application whenever there are data and interventions of different variables/constraints/parameters to model the situation.

Mathematics like music and poetry is the creation of mind, the primary task of mathematics education is to extend mental horizon by representation and interpretation. Darwin said,' Every new body of discovery is mathematical in form'. Mathematics provides a convenient and accurate method of summarizing experience, for without some compactification device of formula. The mathematical formula is another way of expressing or communicating about all knowledge gained by practice, experiments and observations and perhaps then only can it be scientifically grasped: (Singh, V.P., 2001).

Mathematics, above all the other subjects, makes the students' lust for knowledge, fills him with a longing to fathom cause of events and to employ his own powers independently, it focuses faculties and concentrate them on a single point and thus awakens the spirit of
individual enquiry, self-confidence and joy of doing it. Mathematical studies are of immense benefit to student by habituating him to precision. In fact, definiteness of the subject is commonly admitted. Mathematics as an instrument of education strengthens the power of attention, develops the sense of order and faculty of construction and enables the mind to grasp the quantitative difference of physical phenomena. The motive for the study of mathematics is insight into the nature of universe and to develop observation, imagination and reason. The training which mathematics gives in working with symbols is an excellent preparation for other sciences (Salton, G.).

The knowledge of mathematics proceeds from concrete to abstract under the systematic framework, constituted by postulates, definitions, premises, logical connectives and rules. These provide an axiomatic basis to mathematics for carrying out deductions and generalization attributing rigour to it. Constant drilling of mental process along such mathematical process tend to settle a certain type of mental discipline where in consistencies, precision, accuracies and definiteness become the hallmark (Martiz, R.E.).

1.1.4 Nature of Mathematics

Mathematics: A process of generalisation, abstraction and symbolism. In the words of Pauling, D. (1989), Mathematics is a subject full of abstractions. To concrete the abstract ideas in the minds of the pupils is a difficult task. It has been widely suggested that there are

**Generalisation**

Generalisation is the process by which a mathematician passes from understanding one structure to understanding another structure, which subsumes the former as a part, or it is the statement that certain structures have a particular property, which can be extended to a finite or an infinite number of other structures.

**Abstraction**

Abstraction is the process of identifying the essential core in one or more mathematical structures by ignoring the superfluous details in some sense. Once this essential core has been studied to discover its mathematical properties, the results can be applied to any other structure, which has the same essential core. Mathematics is an abstract science, which investigates inductively, the conclusions implicit in the elementary conceptions of numerical and spatial relations. It is a systematic and organized science; it is a science of logical reasoning and it is also a language of mankind.
Symbolism

Symbolism is a way in which the processes like generalisation and abstraction can be carried out, using rules to manipulate, define symbols. Mathematical symbols, which include words, figures, special signs use to communicate message to other people and most of the educated people are familiar with these on worksheets or in text-books.

Jean Piaget and Bruner place emphasis on action on problem solving in learning and acknowledged the importance of representation for developing mathematical thinking.

Mathematics: ‘A LANGUAGE’ – EXPRESSION OF HUMAN MIND.

Mathematics is one of the languages of human life and certainly no more marvelous language was ever created by the mind of man. Mathematical language cuts short the lengthy statements through the symbols. It is free from verbosity. It helps the expression of ideas in an exact form. It enables us to understand and appreciate precision, brevity, sharpness, logic and beauty of mathematics.

Mathematics is an expression of the human mind, reflects the active will, the contemplative reason and the desire for aesthetic perfection. Its basic elements are logic and intuition; analysis and construction; generality and individuality. Teachers of mathematics who discuss their work with other people discover widespread misunderstanding of the nature of the subject. Mathematics means
profoundly different things to different people. For effective teaching, it is important to recognize and to appreciate these different aspects of mathematics.

Mathematics holds the mirror of civilization. It is not an exaggeration to say that the history of mathematics is the history of civilization. Mathematics can take pride in the fact that their science, more than any others, is an exact science and that hardly anything ever done in mathematics has proved to be useless. No one can deny the fact that, ‘Mathematics had, has and will remain to have self - proven importance as a subject of study’. Science and Economics which have acquired a pivotal place in world affairs today, cannot move a step forward without the help of mathematics.

1.1.5 Minimum competency in mathematics

Kumari,S. (2001) states that the minimum competency was defined as an attainment of those basic skills in mathematics which were needed by a student to function in adult society. However it was considered a relative term to be used in a specific situation because of changing need of the society and technology. The basic mathematical skills were identified by the National Council of Supervisors of Mathematics. (NCSM) as given below.

- Problem solving
- Applying mathematics to the everyday situation.
- Alertness to the reasonableness of results
• Estimation and approximation
• Appropriate computational skills
• Geometry
• Measurement
• Reading, interpreting and constructing table, charts and graphs
• Using mathematics to predict
• Computer literacy

Basic skills in mathematics cannot be created permanently because of the changing needs of society and is therefore subject to change.

To state minimal objectives and testing 'Michigan Accountability Model' was developed which consisted of the following six steps process.

• Defining goals
• Translating these goals into measurable student performance objectives
• Conducting needs assessment on the basis of objectives
• Analysing and developing delivery systems and instructional programmes that will help students reach the objectives
• Evaluating the programme to determine the extent to which they have helped the students attain the objectives
• Reviewing all the steps above and making recommendations for improvement
The United States of America has discontinued the minimum level of competency programme and now they have launched a mathematics programme that should lead to achieve professional standards. In other words, the present curriculum reform movements visualized as a movement which will ensure that all students have an opportunity to acquire a 'dynamic form of mathematical literacing' which enable them to participate as informed citizens and skilled workers in a rapidly changing technological society.

1.1.6 Aims and objectives of teaching mathematics

The main objectives of teaching mathematics in secondary schools, may be enumerated as follows:

1. To enable the students to cultivate a mathematical way of thinking (i.e.) in terms of carrying out experiences with numbers and geometric forms making hypothesis, verifying them with further observation and experiments, generalising them, trying to find proofs and making abstraction.

2. To enable students to learn the basic structures of mathematics through unifying concepts and to motivate learning structures through applications and concerns situations, and to stimulate the students to study mathematics on their own and to develop a taste and feeling for mathematics.

3. To enable students to qualify their experiences of the world around them and to understand the process of applying mathematics to real life problems.

4. To develop and present mathematics as a unified discipline.
According to Education Commission (1964 - 66) the objectives are as follows:

1. On the teaching of mathematics emphasis should be more on the understanding of basis principles than on mechanical teaching of mathematical computations.

2. The modernization of mathematics teaching is vital to any programme of reform in the school education.

3. Significantly flexibility should be provided in mathematics and in the methods of teaching to later to the special and varying needs of gifted individuals at all stages of school education. Objectives of teaching mathematics may be stated as follows.

   a. To correlate the study of mathematics to the real needs of life.

   b. To instill in the pupils at the power of discrimination and form the habit of independent thinking.

Conney, Davis and Henderson (1975) in the Dynamics of teaching secondary school mathematics give the following objectives of teaching mathematics.

1. To provide an adequate mathematics programme

2. To develop the mathematical potential of each student to the maximum.

3. We want students to have an enjoyable experience in learning mathematics.

4. Students should be able to prove theorems.
5. Our first objective to teach the mathematics is that each citizen must know to get along in our society.

Ved Prakash Gupta, Punjab Government College of physical education Patiala, Punjab, in his article published in “The mathematics education”, March 1973 quote some of powers that develop after the study of mathematics, they are i) power of concentration ii) power of mental reliance iii) will power iv) reasoning power.

According to Ved Prakash Gupta (1973), “Mathematics is taught to inculcate and develop particular attitudes traits and abilities towards life, a scientific out look on life, habits of exactness and perfection and traits and abilities like concentration, precision, persistence, patience to complete work to systematize senses of achievement creativity and originality”.

Smith (1928) elaborated seven reasons for teaching mathematics as under.

- Every educated person should know what mathematics means to society and to our race, what its greatest uses are:
- It has high value as a mental discipline
- It has intrinsic interest and value of its own - it has its own beauty and magic.
- It possess truth which, in an ever changing world, is eternal and enduring
- It enables us to understand our place in a world, which contains such contrasts as the infinite and infinitesimal.
• It came into being through the yearning to solve the mysteries of the universe and still works for us in that way.

• The history of mathematics is the history of human race

The Cockcroft Report (1982) places great emphasis on usefulness of mathematics education as

• of enabling each pupil to develop ... the mathematical skills and understanding required for adult life, for employment and for further study and training.

• of providing each pupil such mathematics as may be needed for his study of other subjects.

• of helping each pupil to develop... appreciation and enjoyment of mathematics itself and ... of the role which it has played and will continue to play both in the development of science and technology and of our civilization.

• above all, of making each pupil aware that mathematics provides him with a powerful means of communication.

Wain (1989) has given the variation on the main categories of reasons for teaching mathematics. The five reasons selected for consideration are listed below.

• Mathematics is useful

• Mathematics is important in our lives and its place needs to be understood

• Mathematics trains the mind
• Mathematics is a powerful means of communication
• Mathematics is enjoyable and has aesthetic value

Perry, (Ministry of Education, 1958) maintained that the study of mathematics began because it was useful, continues to be useful and is valuable to the world because of the usefulness of its results.

The NCTM (1989) suggested that we need mathematically literate workers and quotes the definition of mathematical expectations of new employees provided by Pollak:

• The ability to set up problems with the appropriate operations
• Knowledge of a variety of techniques to approach and work on problems
• Understanding of the underlying mathematical features of a problem
• The ability to see the applicability of mathematical ideas to common and complex problems
• Preparation of open problem situations, since most real problems are not well formulated.
• Belief in utility and value of mathematics

This is the foundation for an ambitious set of aims.

Scopes (1973) summed up the usefulness of mathematics as 1) Foundation for subsequent more advanced study of mathematics, and 2) Tools for other subjects. To some extent, new mathematics is inevitably built on mathematics learned previously, thus usefulness
cannot be defined as an internal requirements through the detail of any syllabus needs to be kept under constant review, for needs do change. He also states that 'Every student should be made aware of some of the major strands in the history of mathematics and how this has influenced the thought process of successive generations'. Aesthetic fascination of mathematics through the contemplation of shapes and patterns, the elegance of proof, the effective use of symbols and the unity of seemingly different branches of mathematics.

The mathematics education in schools has to address - generally consisting of three different but overlapping areas

- Preparing students for their private and social lives as individual citizens (Niss, 1989) what might be loosely termed as the everyday world.
- Preparing students for their working lives where in they may or may not use that mathematics and what is used may change markedly at different times in their careers, namely the world of work.
- Preparing students for their present and future academic lives, where they will meet and use mathematics in other subjects and be educated in mathematics itself, namely the academic world.

1.1.7 Psychology in teaching mathematics

An early pioneer, who stated measurable objectives and their use was B.F. Skinner.
a. Behaviorism in the mathematics curriculum

E.L. Thorndike (1874-1949) established foundational ideas for behaviorism as a psychology of learning during the early years of the 1900s. The Law of Effect has remained important by behaviourists, in numerous situations. Schedules of reinforcement may be in the offing as advocated by behaviorists. The schedules of reinforcement can be altered depending upon how frequently the pupil needs a reward to continue achieving more optimally. Presently, behaviourism emphasizes the writing of predetermined, precise objectives for pupils to achieve in mathematics.

Precise, measurably stated objectives and their use is the heart of behaviorism. These objectives are selected prior to their being implemented in the classroom. Behaviorism can be emphasized with stated mandated objectives in terms of core competencies and key skills.

Behaviorism emphasizes Instructional Management Systems (IMS) on the district level. The classroom teacher must emphasize each objective in teaching-learning situation. The mathematics teacher, without stated mandated objectives or IMS, may write and implement specific ends for student attainment.

Behaviorism, in its diverse manifestations, emphasizes that a student either does or does not achieve an objective as a result of
instruction. If an end is not attained, the mathematics teacher needs to try a different teaching strategy.

b. Humanism in mathematics curriculum

Humanism, is a psychology of learning, emphasizes students being heavily involved in determining objectives, learning opportunities and evaluation procedures. Each student is guided to attain self-realization. A.H. Maslow, humanist, psychologist, listed five sequential levels for individuals to move through to achieve realisation of the self. Humaneness is defined as students being able to decide from among alternatives which learning activities possess value and need to be completed satisfactorily. (Lish etal, (1983)

Humanism advocates an open ended mathematics curriculum. The following tenets of humanity are important to understand:

1. Pupil / teacher planning of the mathematics curriculum. Thus, there needs to be input from the pupil in terms of what is taught in the mathematics curriculum. With a learning centres approach, the pupil may sequentially select from the diverse tasks what to learn and what to omit, but still be profitably occupied continuously. As much as possible, there should be pupil directed learning. Pupils should have a voice in goal determination in the mathematics curriculum.

The learner is not to be left out of developing the mathematics curriculum. The attitudinal or affective dimension is very important to a
humanist. With much pupil input into the mathematics curriculum, humanists believe attitudes improve.

Robert Gagne (1985) is a leading psychologist of today who advocates both trends of behaviorism and cognitive psychology. He has been very strong in emphasizing that pupils experience quality sequence in learning. A major advantage in using Gagne's hierarchy of objectives psychology is that the mathematics teacher is attempting to develop quality sequence for pupil learning.

c. Constructivism

A relatively new concept of teaching and evaluation involves constructivism. Constructivism, among other things, involves appraising pupils within a contextual situation, not by external procedures (Ediger, 1988).

With constructivism, the mathematics teacher may appraise continuously as pupils are learning in mathematics. Whatever problems pupils reveal in achievement or lack there of can be monitored by the mathematics teacher. Then too, assistance may be given right away to the pupil experiencing a difficulty in mathematics. The every day evaluation results that the lay public hears little or nothing about comes to light and is indicated with constructivism as a concept in teaching and learning. Constructivism is:
1. pupil centered, in that the focus is upon the individual learner in determining how well/he she is doing.

2. sequential, in that the pupil is assisted when difficulties are faced at that specific moment.

3. continuous, in observing pupil achievement, not a one shot approach in appraising learner progress.

4. contextual and relates to what has happened previously in the ongoing lesson and unit of study.

5. emphasizes that the mathematics teacher is available at the time of need.

6. Personal, in that the appraisal is valid for a given pupil.

With constructivism, if a pupil does not understand place value such as ones, tens, and hundred, the teacher, at that specific time, may provide needed assistance. This situation is a motivator for each and every pupil in mathematics.

d. The structure of knowledge

The structure of knowledge approach, as identified by George Bruner and his associates emphasized that public school students utilize methods of learning utilized by mathematicians in the higher education level. An inductive procedure is then in evidence. Students are guided by the teacher to learn by discovery in moving from specific to the general to achieve structural ideas.
Relevant principles of learning from the psychology of education need to be implemented in teaching-learning situations. The teacher of mathematics must assist each student in an optimal manner.

In all kinds of psychomotor, affective and cognitive objectives being emphasized in teaching mathematics, the teacher needs to follow principles of learning from the psychology of education, including the following.

- Learning activities need to actively engage pupils. Pupils need to be wholeheartedly involved in ongoing lessons and units of study. The chances are a passive child will not learn much in mathematics.
- Pupils need to make sense of subject matter taught and learned. It wastes learner time if a lack of understanding result from the facts, concepts and generalizations being taught.
- Motivation is a powerful factor in learning with quality learning opportunities; pupils should feel energized to learn, to do, and to accomplish. Adequate motivation provides an inward desire for pupils to acquire mathematical leanings.
- Learning styles need to be stressed in teaching pupils. Thus selected pupils like to learn in collective situations where as others prefer individual endeavors.
- The teacher needs to select interesting activities to achieve objectives. This is important in order to secure pupil attention in the lesson presentation.
• Individual differences need adequate provision since pupils differ from each other in talents and abilities. Each pupil needs to achieve as optimally as possible in the curriculum.

• A variety of appraisal procedures need to be used to ascertain pupil achievement. Achievement in cognitive, affective and psychomotor objectives, need to be evaluated in terms of quality criteria.

1.1.8 Psychology of Learning in Mathematics

Mathematics often becomes a subject matter area where students separate themselves from the challenge of learning.

According to Edison (1988), first of all to have the student and mathematics become united and not separated; challenging learning activities need to be in the offing. Securing student attention is vital. Set establishment is a necessity. The student needs to attend the material and methods of presentation. Time on task is salient. The opportunities to learn may well be accepted by the student due to his/her inherent interests. The teacher must have as an affective objective for students to attain the interest to learn, to achieve, to grow and to develop in mathematics.

Second, the mathematics teacher needs to guide student to perceive purpose in goal attainment. Purpose in mathematics achievement emphasizes, students accepting relevant reasons for learning. If students perceive reasons for acquiring vital facts, concepts
and generalizations, increased energy levels for achievements will be in evidence.

Third, rational balance needs to be emphasized among knowledge, skills and attitudinal objectives. Knowledge goals, which emphasize vital subject matter for student achievement should be selected carefully by teachers. Skills aims stress students engaging in higher levels of cognition such as critical and creative thinking, problem solving, applying knowledge, hypothesizing and synthesizing. Attitudinal goals advocate students developing positive feelings, values and beliefs pertaining to mathematics. Quality attitudes affect student progress in achieving knowledge and skill goals.

Fourth, the mathematics teacher needs to provide for individual differences. Students differ from one another in capacity, interests and skills. Quality sequence to assist each student to achieve optimally should then be in evidence. Providing for individual differences as a concept, which mathematics teachers need to understand and implement.

Fifth, appropriate sequence in achieving objectives needs to be in the offing. With quality sequence, students experience continuous optimal process. Each learner is achieving as much as abilities and efforts permit. A psychological mathematics curriculum may be in evidence. A learning center's procedure may well stress a psychological mathematics curriculum. Here, each student makes sequential choice in
terms of tasks to pursue from the diverse centres. A logical mathematics curriculum emphasizes predetermined measurably stated objectives for a student attainment. The objectives are written prior to instruction and arranged for students to achieve in an order determined by the teacher.

Sixth, procedures in teaching mathematics should stress moving from the simple to complex in terms of student achievement objectives.

Seventh, subject matter achieved by students should be meaningful with meaning attached to content acquired; students understand that which is being taught. Meaningful subject matter makes sense to learners.

Eighth, students should be ready for each new sequential step of learning. With readiness, students possess needed prerequisites and background information to understand the new learning's being presented by the teachers. Readiness for achieving new facts, concepts and generalizations indicates the learner can achieve with effort put forth. Readiness is a powerful factor in learning. With inherent readiness, the learner can benefit optimally the ordered objectives.

Diagnosis of learner difficulty in mathematics needs adequate emphasis. Students with teacher guidance need to determine specifically where the former reveals problems in mathematics. After diagnosis, remedial teaching needs to be in evidence.
Students should be guided to develop feelings of appreciation towards mathematics. Appreciation for mathematics emphasizes its practical dimension, as well as its structure and order. Students need to appreciate the many opportunities of studying mathematics.

**1.1.8 (a) How to facilitate students learning in mathematics**

A mathematics teacher has to guide and direct students learning and for this purpose he/she may take cognizance of the points stated below while planning and transacting mathematics on his/her class (Lalit Kumar suggest that:

- Make students’ attitudes favourable towards mathematics.
- Arrange diagnostic and remedial classes.
- Determine the objectives in behavioural terms and applying objective based evaluation.
- Manage the amount, kind and distribution of practice.
- Find the learner’s difficulty
- Increase the participation of the students
- Provide planned assignments.
- Suggest few ways for self- study.
- Provide opportunity for self activity

The teacher influences the pace of learning of the students to a large extent. Besides the above mentioned strategies a teacher may, therefore also adopt other techniques, especially for the brighter students for learning concepts of mathematics and in acquiring desired
skills. This can be accomplished by developing a healthy relationship between himself and pupils, through proper motivation, by providing suitable environment, by providing opportunity for transfer of learning by meeting the psychological needs of the students, by recognizing individual differences, by providing opportunities for creative expression, by using appropriate methods, strategies and skills of teaching, by dividing the learning materials into small steps and the like.

1.1.8 (b) Mathematics and theories of learning

Shulman (1970) claimed that mathematics instruction has been quite sensitive to shifts in psychological theories, but also that mathematics educators have shown themselves, especially adapt at taking hold of conveniently available psychological theories to buttress previously held instructional proclivities.

Dienes (1960) proposed a theory of mathematics learning consisting of four principles namely

- The dynamic principle
- The constructive principle
- The mathematical variability principle and
- The perceptual variability principle

The theory of meaningful learning proposed by Ausubel (1968) was a process through which new knowledge was absorbed by connecting it to some existing relevant aspect of the individual's knowledge structure. If there are no relevant concepts already in the
mind to which new knowledge could be linked, the knowledge would have to be learned by rote and stored in an arbitrary and disconnected manner. If new knowledge was assimilated within the existing knowledge structure as a related unit, and if appropriate modification of prior knowledge took place, the result was meaningful learning. It was therefore not necessary for all, or perhaps even much knowledge to be acquired by a process of relevant existing ideas, and this might not only be more economical (in terms of time taken) than own discovery, it might be more efficient in terms of quality and breadth of learning. Discovery learning would be necessary with very young children, and at this stage of life the emphasis would need to be an encouraging concept formation rather than teaching for concept acquisition. But once a rich structure of knowledge has been learned the most efficient way to proceed would be by exposition Discovery methods might occasionally be appropriate, but meaningful learning would be effective.

Much of our everyday knowledge is learnt directly from our environment, and the concepts involved are not very abstract. The particular problem (but also the power) of mathematics lies in its great abstractness and generality, achieved by successive generations of particularly intelligent individuals each of whom has been abstracting from, or generalizing, concepts of earlier generations. The present-day learner has to process not raw data but the data-processing systems of existing mathematics. This is not only an immeasurable advantage, in that an able student can acquire in years ideas, which took centuries of
past effort to develop; it also exposes the learner to a particular hazard. Mathematics cannot be learnt directly from the everyday environment, but only indirectly from other mathematicians, in conjunction with one’s own reflective intelligence. At best, this makes on largely dependent on teachers (including possibility of acquiring a life long fear and dislike of mathematics.

Though the first principles of the learning of mathematics are straightforward, it is the communicator of mathematical ideas, and not the recipient, who most needs to know them. And though they are simple enough in themselves, their mathematical applications involve much hard thinking.

Learning styles probably differ by gender, but research results vary widely (Belenty et. al., 1986; Philbin et.al., 1995; Sadler, Smith, 1999). Men are more abstract learners, women have more anxiety about study success; men are more intuitive; women are more analytical; women more organized, men more undirected. Overall picture suggests that women and men learn differently.

1.1.9 Mathematical abilities

Mathematical ability is the ability to solve various sorts of problems, which are generally determined by many conditions, and thus mathematical ability can be defined as the ‘ability to understand the nature of mathematical problems, its symbols, methods and proofs, to learn them, to retain in the memory and to reproduce them etc.’
definition has got a growing interest when the person is working in the problems of mathematics education. It is hard to find a field of knowledge to which mathematics would not be related. The development of the sciences has been characterised recently by a tendency for them to become more mathematical and finally depending upon mathematical abilities.

Mathematical ability was defined by Krutetskii as “Individual psychological characteristics that answer the requirements of school mathematical activity and that influence success in the creative mastery of mathematics as a school subject in particular a relatively rapid, easy and thorough mastery of knowledge, skills and habits in mathematics”.

Some writers are of the view that ability in mathematics is not always inherent in persons having high intelligence. So many scholars have proved that even persons of low intelligence can understand mathematics as much as others. The difference between mathematical thinking and mathematical ability is the same as between natural experiment and school application.

According to Rastogi, Mathematical abilities as identified from mathematical thoughts are,

1. An ability to formalise mathematical material, to isolate the type from content, to abstract from concrete numerical relationships and spatial forms and to operate with formal structure.
2. An ability to generalize mathematical material, to detect what is of chief importance, abstracting from the irrelevant and to see what is common in the externally different problems.

3. An ability to operate with numerals and other symbols.

4. An ability for sequential, properly segmented logical reasoning which may result in the need for proof, substantiation and deductions.

5. An ability to shorten the reasoning process, to think in curtained structure.

6. An ability to reverse a mental process.

7. Flexibility of thought, an ability to switch from one mental operation to another, freedom from the binding influence of the common place. This characteristic of thinking is important for the creative work of a mathematician.

8. A mathematical memory, it can be assumed that its characteristics also arise from the specific features of the mathematical sciences. This is a memory for generalizations, formalized structures and logical schemes.

9. An ability for spatial concepts, which is directly related to the presence of a branch of mathematics such as geometry (especially the geometry in the space).

   Ability can be judged only when the student is busy in solving the problems. Without being in a dynamic state and by using only one level of achievement, it is hard to evaluate ability. Abilities can be judged only when we have found out how quickly and easily one progress in his mastery of the appropriate habits. Experimental problems are not used.
generally for selecting mentally gifted or mentally inferior pupils, but for a study of ability.

It is the fact that success in performing a mathematical activity requires a certain combination of personality traits. Some abilities, without being combined with an appropriate orientation of personality or of its emotional volitional sphere, cannot in themselves result in high achievement, even when they are of a high level.

Syadam and weaver (1977) reflect on characteristics of good problem - solvers in mathematics as

1. Ability to estimate and analyze
2. Ability to visualize and interpret quantities and relationships
3. Ability to understand mathematical terms and concepts
4. Ability to note likeness, differences and analogies
5. Ability to select correct procedures and data
6. Ability to note irrelevant detail
7. Ability to generalize on the basis of few examples
8. Ability to switch methods readily
9. Higher scores for self- esteem and lower scores for text anxiety

Syadam and weaver also noted that ‘more impulsive student are often poor problem solvers, while more reflective students are likely to be good problem solvers’.

A major study on mathematical ability in pupils was carried out by Krutetskii (1976). The origins of mathematical ability as seen by
This can be also used in the selection of the personal in some specific categories of jobs, with requires a certain level of numerical ability. This would be a reliable instrument in assisting the youth to prepare for the future. It will be a light-house to the ship traveling in a stormy night.

Like the linguistic abilities, mathematical ability is also very complex. From the early stages of childhood, the learning of mathematics begins to simplify the complexity of learning. Since knowledge of computation plays a major role in all business activities, this reasoning power is essential.

But numerical ability should not be confused with the mathematical ability. Numerical ability is fundamental, where as, the mathematical ability is a learned factor. Numerical ability may create interest in mathematics, but it cannot be equated with the other. One cannot deny the fact that both are inter dependent.

Numerical ability does not mean “numerical fighting ability” but an intelligent grasp of number relations and the ability to deal with arithmetical situations with proper comprehension and practical significance.

Learning mathematics is a process. It is achieved not in any single way but through a variety of activities and is approached through a variety of oneness; reading; listening; asking questions; working with material objects, writing, drawing, comparing, interpreting, analyzing,
Reasoning is an implicit act. It is regarded as the highest form of thinking. It is a complex mental process that needs a well organised brain. It also requires deliberate efforts on the part of the individual who reasons.

1.1.9 (c) Blocks to Mathematical reasoning and abilities

Blocks to mathematical reasoning ability and understanding. The following are identical as block to:

i) Emphasis on memorization and drill at the expense of understanding and thinking.

ii) Lack of concrete experiences in situations to help the learners to develop meaningful concepts.

iii) Poor understanding on the part of teachers, resulting in poor instruction.

iv) Fear and dislike developed towards the subject.

v) Children who are not physically, mentally or emotionally ready.

vi) Lack of understanding of important mathematical terms.

vii) Pupils see little reason for learning mathematics.

viii) Poor reputation of the subject

1.1.10 Domain Specific Knowledge

Kuhn, Garcia - Mila, Zohar and Anderson proposed that children’s domain-specific knowledge is acquired and organized using theories that children have about their domain. The development of these theories is believed to be dependent on children’s ability to reflect on their cognitive process and states. Thus, according to Kuhn et. al’s
perspective, children's developing understanding of mathematics should be tied to reflective, meta cognitive knowledge about mathematics. There is evidence that metacognitive knowledge is selected to good performance in mathematics.

Teaching children to use elaborative, integrative or specific strategies and related meta cognitive knowledge will result in improved mathematics achievement and retention. In the case of mathematical strategies, children who possess specific strategy knowledge will be better be able to use mathematics strategies.

Fennema and Peterson suggested that one way girls differ from boys is that girls do mathematics in a note fashion and boys are autonomous in their mathematics. Children who reflect on their strategy use and mathematics knowledge will be autonomous in their mathematics. In contrast, children who see mathematics as note application of procedures may see no need to reflect on their mathematics. If this is true then the difference should be evident in the types of strategies and the net of cognitive Knowledge girls and boys use in problem solving.

Girls' rote approach to mathematics would result in the use of strategies that are algorithmic and may result, if, the superior calculation documented by Armstrong and Marshall, but girls would not be able to move from rote procedures and superior calculation skills to good problem solving skills. They would not reflect on what, why, and
how they solve mathematical problems. In contrast, if boys are more independent in their approach to mathematics, they should reflect more on their mathematics and this reflection should result in the use of more complex strategies, related metacognitive knowledge about strategies and subsequently better problem-solving skills.

1.1.10(a) Domain Preference

Both high and moderate achievers tend to prefer science to mathematics. In fact, moderate achievers do not experience significant levels of nervousness when explaining science answers to the class. Both math and science classes should include discussions of stereotypes about mathematics and science achievement, strategy use, everyday applications of domain knowledge and careers. In this way direct antecedents to math anxiety can be addressed, namely performance expectancies and perceived task value. Also, schools could attempt to use more cross-curricular projects that blur the distinction between mathematics and science, perhaps enhancing students' enjoyment of mathematics. And finally, moderately achieving students should be encouraged to use presentation style components in science project since this is a task promoting lower levels of anxiety for them.

1.1.11(a) Cognition Based Learning of Mathematics

Learning is psychological in nature therefore learning of mathematics, like any other subject can be facilitated by the recent developments in the field of cognitive psychology. Cognition can be
simply defined as the 'act of knowing'. The analysis of this act and its components is the core of our attempts to understand the mind, its development and its functioning. The models of the mind, created by psychologists, have separated the act of knowing into its component processes. Cognitive psychology has given new meanings to different concepts in education and learning is one of them. Initially cognitive science was a science more of knowing than of learning and it was generally found that studies on cognitive expertise did not translate directly into successful instruction. Later, the stress of researches shifted to learning. Recent developments in the field of cognitive psychology view learning as cognitive change. The restructuring of a person's prior knowledge is now acknowledged as a more appropriate way of thinking about meaningful learning. (Shah et al, 1996)

Cognition means becoming aware of something and understanding it, for example, calculus is a branch of mathematics. Also cognitive monitoring refers to regulating one's own use of knowledge and cognitive strategies in achieving learning goals (Flavell, 1979).

**Cognitive Development**

Characteristics of human intellectual functioning such as, thinking, planning, knowing, relating, classifying, creating and problem solving have been traditionally labeled as cognitive process. More recent views have broadened this characterization to include attention, perception, memory, imagery and motor learning among others. These
processes are not solely intellectual but are clearly influenced by or under the control of higher order intellectual processes. Further, affective factors of life are linked through attitudes, beliefs, judgements and values, with the cognitive apparatus and therefore cannot be excluded from a consideration of cognitive influences.

1.1.11(b) Cognitive objectives in mathematics

Each cognitive objective needs to be chosen carefully in mathematics. Quality sequence begins in the preschool years and goes throughout higher education. Thinking skills are vital in mathematics. The foundations for, meaningful mathematics learning must begin early in the child’s life. Logical thinking needs adequate emphasis in mathematics. Logical thinking transfers in sequence to all branches of mathematics.

Critical thinking is salient in that pupils need to be able to analyze mathematical subject matter. Inherent in critical thinking is creative thought within the framework of critical and creative thinking, problem solving is vital as well as useful. Subject matter is used creatively as needed to solve problems. Being able to estimate well and check the estimation correctly is a vital skill. Estimating in mathematics is a highly useful and important skill in everyday life. Ability to estimate well in terms of time, distance, volume and area. A practical use of estimation must be stressed.
1.1.11(c) Cognition and its relation to Affect

Problem solving is clearly a cognitive activity. Because there is no established catalogue of the cognitive processes that are most important in problem solving; memory and representation processes, role of consciousness, role of meta cognition and the role of automaticity are identified as major categories that are relevant to affective issue.

Mandler (1984) noted that 'we have little data regarding affective influences on storage and retrieval process' Bower (1984) reports that mood (affect) can influence memory process.

Northan (1981) lists the study of consciousness as 1 of 12 important topics for cognitive science research. Mandler (1975) argues that the concept of consciousness is needed to account for important aspects of human information processing. Rigney (1980) discusses aspects of consciousness that seem especially relevant to affect issues in problem solving.

Kilpatrick (1985) has also explored the concept of consciousness in his stimulating paper presented at the Fifth International Congress on Mathematical Education. He suggests that we need to help students analyse how consciousness operates and how they can manage their own mental resources. He refers to this as meta cognition. Meta cognition is important to success in problem solving, in which the solver must make decision about which strategy to apply and how long to keep
on trying it before stopping and selecting a new strategy (Silver, 1982, Schoenfeld, 1983).

Automaticity is normally a part of cognitive theories (Resnick & Ford, 1981; Schiffni & Dumais, 1981), but the processing of affective information related to mathematics is also done automatically, in large part. Students who get frustrated by a non-routine problem for example, will often first quit, they assume, without really thinking about it, that frustration is a signal to go and get help, rather than a normal part of problem solving.

1.1.12 Affect and Affective Domain

Affect has been used by psychologists in a variety of ways. (Benner, 1985; Clark & Fiske, 1982; Corsini, 1984; Mandler 1984). According to Encyclopedia of Psychology, affect refers to 'a wide range of concepts and phenomena including feelings, emotions, moods motivation, and certain drives, instincts. (Corsini, 1984). Using this definition, examples of affect would be anger, joy, fear, pride, hate and anxiety. Affect is also sometimes used loosely as a synonym for feeling, emotion and mood.

Kahn and Weiss (1973) firmly established the centrality of affective education, covering a full range of possibilities including learner and teacher characteristics, classroom climate, instructional strategies and the nature of the curriculum. Finally it was becoming clearer that planned or not education is affective. Theleis (1960) was early to
perceive its significance, affirming a view of education as an inquiry involving all human dynamics.

Simon (1982) distinguishes among several aspects of affect. He uses affect as a generic term and describes its main forms as 'emotion', 'mood' and 'valuation'. Affect has also been used, particularly among educators, as a blanket term to describe attitudes, appreciation, tastes and preferences, emotions, feelings and values.

The use of affect stems partly from the description of the affective domain by Krathwohl, Bloom and Maria (1964) in Taxonomy of Educational Objective. The affective domain, Krathwohl et al conceptualized the affective domain on the dimension of internalization or intensity of a broad set of constructs but did not distinguish carefully among these constructs. Other educators have consciously decided to use affective as a general term for beliefs, attitudes, and emotions. Fennema, for example, uses the term affective variables because the early work on attitude towards mathematics was not careful about the definition or measurement of attitudes and she prefers to avoid the norms used at that time. Psychologist often uses the term affect to indicate hot, gut level emotional reactions. It is often used by educators to mean a wide variety of beliefs, attitudes and emotions ranging from cold to hot.
1.1.12 (a) Affective Objective Mathematics

Affective objectives are minimised in teaching due to the inability to accurately measure if these kinds of objective, have been achieved by pupils. Teacher, through daily observation, may notice the quality of attitudes possessed by pupils. Growth is a desire to achieve more optimally in mathematics, as an attitude, provides opportunities for pupils to attain vital facts, concepts, and generalizations in mathematics. These learning need to be reflected upon and communicated to others in an atmosphere of respect.

Neat, legible and accurate writing is necessary when communicating mathematical ideas in writing. Communication skills are important in mathematics, including the ability and desire to convey ideas orally. Processes and procedures in mathematics need to be conveyed which are meaningful to other pupils, the teacher and parents in the home setting. Wanting to communicate clearly and accurately provides opportunities to develop thinking abilities Each learning obtained provides a foundation of achieving increasingly more complex ideas. It takes understanding and quality attitudes to attach meaning to vital subject matter. The pupil needs to have an inward desire to learn and achieve. Quality attitudes then in the affective dimension aid people to achieve and accomplish. Having good attitudes go a long way in doing well in a developmental mathematics curriculum.
Heak (1972) enumerates four basic tenets
(1) education of affects 2) experiential learning 3) learning as
organismic experience and 4) nurturance of our social being. Rossiler
(1976) lists five maxims i) develop the whole person, 2) treat students
as persons 3) foster interaction that leads to self actualization 4) know
your-self as teacher and 5) do not teach by formula. Affective education
can be consider as process of becoming; and a description of variety of
programmes that facilitate this process can serve as a more realistic

1.1.12 (b) Affect and Learning

Affect is the learnt investigated aspect of human problem solving.
The term 'affect' has meant many things to many people, acquiring
interpretation that range from 'hot' to 'cold'. At the hot end, affect is
used co extensively with the word emotion implying an intensity
dimension; at the cold end, it is often used without passion, referring to
preferences, likes and dislikes and choices. Emotion is not only
anecdotally and phenomenally part of human thought and action; there
is now a burgeoning body of evidence 'that emotional states interact in
important ways with traditional cognitive functions'. Isen's (1982) work
has shown that positive feelings determine the accessibility of mental
contents in the process of decision making, serve as retrieval cues, and
influence problem – solving strategies.
There are two different views of emotional phenomena. One view is that emotions are discrete pattern of behaviour, experience and neural activity. The second approach is cognitive and constructivist, which considers emotional experience (and behaviour) to be the result of cognitive analyses and physiological (autonomic nervous system) response. (Averill, 1980; Lazurus, Kanner & Folkman, 1980; Mandler, 1984).

We frequently react affectively to events, before experiencing a more 'analytic' knowledge of the event, speaks to the ubiquity of affective and evolitional construction and intentions. We live in a world of value and affect, and the themes that determine our conscious constructions often require an affective content.

1.1.12 (c) Role of Affect in Mathematical Problem Solving

When students are given a non routine mathematical problem to solve, their reactions often include a lot of emotion. If they work on the problem over an extended period of time, the emotional responses frequently become quite intense: Many students will begin to work on a problem with some enthusiasm, treating it like a puzzle or game. After sometime the reactions become more negative. Students who have a plan to solve the problem may get struck trying to carry out the plan. They often become quite tense. They may try to implement the same plan repeatedly, getting more frustrated with each unsuccessful attempt. If the students obtain solution to the problem, they express
feelings of satisfaction, even joy. If they do not reach a solution, they may angrily insist on help so that they can reduce their frustration.

Given the intensity of the emotional responses to problem-solving assignments, it is a bit surprising that research on mathematical problem solving has not looked into affective issues more seriously. Since the appearance of ‘An agenda for Action’ (National Council of Teachers of Mathematics, 1980) and its recommendation for greater emphasis in problem solving, a substantial amount of effort has gone into research and related development of materials to teach problem solving at all ages and all ability levels. (Shufelt, 1983).

1.1.12 (d) Curriculum Development and Affect

Materials designed to teach problem solving mention the importance of attitude and motivation, but they do not address affective issues in a systematic way. Some problem solving books for secondary school students (eg., Adams, 1980; Whimbey & Lochhead, 1982) include discussions on confidence and persistence, but place little emphasis on such topics. Some books do provide thoughtful and direct discussions of affect issues in problem solving. Mason, Barton and Stacey (1982), for example, address in detail the difficulties involved in getting ‘struck’ when trying to solve a problem. The authors give students ways to deal with their feelings of frustration when they are struck and suggest useful heuristics that will help the students to moving ageing. Burton (1984) provides some information on the
philosophy and experience that influenced their work. Researchers and developers agree that affective issues are important in problem solving; however, little has been done to incorporate affective concerns in a systematic way in either research or curriculum development.

1.1.13 Psychomotor Objective in Mathematics

Ample and meticulous attention must be given to psychomotor objectives in the mathematics curriculum. These kinds of objectives, emphasize pupils applying what has been learned. When application is made, pupils practice what has been learned previously. Retention of learning is improved upon, when facts, concepts and generalizations are used by pupils. Using that which has been learned also makes it possible for review and practice to take place in a meaningful way.

Making application mean using what has been learned in a new process, skill or practical situation. There are a plethora of situation in which previously achieved ideas in mathematics are used.

The following are few suggested learning opportunities.
- Making mathematical models.
- Constructing items where mathematics is used in an ongoing unit of study.
- Dramatizing mathematical situation.
- Drawing diverse geometrical figures to show design and spatial relations.
- Modeling a process or procedure to share with others.
In every day life, pupils need to use what has been learned in mathematics applied to practical situation.

1.2 GENDER DIFFERENCES

Since the publication of the volume on sex differences edited by Maccoby (1966), it has been popular to look for Sex differences. Indeed, in some studies only sex differences were found. But simply finding a difference between males and females, however, has no inherent values. As in any area of research, the study of sex differences should be guided by some underlying theory. Too often such research has been a theoretical one.

The topic of sex difference has been of interest to researchers and educators for sometime until recently, however, sex differences received only secondary attention, as a factor that might affect experimental findings in the focal areas of research. Maccoby’s volume directed attention to the issue of sex differences itself and inaugurated sex difference as a valid filed of psychological inquiry. Concurrent social change, particularly women’s movement, stimulated interest in the field, and over the past 15 years, research in male-female difference has proliferated. The women’s movement also influenced direction of sex differences research. Early work tended to focus on areas in which males seemed to excel, female performance, if it was even examined, was treated essentially as an interesting deviation from an established male norm. Currently however these same areas of male proficiency are
being reexamined to see what the findings say about girls and women. Many of the researches in the field are women, and their interests are reflected in the emphasis on female abilities that is beginning to emerge. The new emphasis indicates a desire to understand what implications sex differences have for female psychology and development. Beginning in 1960, a series of articles criticized these practices that encouraged the analysis of sex differences. Carlson, 1971; Carlson and Carlson, 1960; Harris 1972; Signorella, Vegiga & Mitchell, 1981 analyzed over 200 articles appearing in the major social, personality and developmental journal during the years 1968 – 1970 and 1975-76. Their objective was to discover whether or not any change in the treatment of sex differences had occurred. In comparing the two time periods, they found that:

- There was no overall increase in consideration of sex differences in either hypothesis or analyses.
- Both male and female authors had improved in specifying the sex of their subjects and in including both males and females as subjects.
- Female authors more than male authors were likely to use both male and female subjects.
- Female authors have increased their routine analysis of sex differences even when they failed to provide a theoretical justification.
Status of Research

There have been many studies of sex related differences in mathematics (Stafford, 1972; Sherman, 1977; Fennema, 1974; Fennama and Sherman, 1977; Aiken, 1971). As reported in a review of 38 students by Fennama 1974, no significant differences were found between boy’s and girl’s mathematics achievement before or during elementary years. If apparent in upper elementary and early high school years, any differences were between levels of cognitive tasks. Boys have favoured when the tasks were at higher cognitive levels and girls were favourable when the tasks were at lower cognitive levels. Data from the National Assessment of Education Progress (NAEP, 1975) indicate that neither sex has a clear advantage in computational ability.

Researches in sex differences had three broad categorical variables such as biological, cognitive and psychosocial and studied the differences in these.

Biological differences

Boys and girls differ in terms of several biological characteristics. Most basic is the chromosomal difference. Sex hormones differ even prenatally and there is evidence that prenatal hormones are related to differential brain organization causing sex differences in behaviours. Sex differences in brain organization, particularly in terms of extent of lateralization of function between the hemispheres. While there is evidence that the brains of male and female rats differ anatomically,
research evidence shows that human brain is overwhelmingly behavioural and therefore is a subject to the biases that are linked to sexually different socialization. Sex differences influence sensitivity, scant attention, size and strength, tactile sensitivity and odor perception. Gender differences in mathematical problem solving is not biologically primary. Unlikely there is anything like a ‘male math gene’ or gender differences due to the reproductive strategies or the associated division of labour.

**Cognitive Differences**

Maccoby and Jacklin (1974) concluded that sex differences were well established in the three cognitive constructs. Mathematical performance, verbal ability and spatial visualization ability. These differences appeared fairly consistently by early adolescence. Fennema, (1977) has challenged the view that sex differences in mathematics performance exist, once differential course taking on the part of the boys and girls is accounted.

Benbow and Stanley (1980) argue that course taking alone cannot account for sex difference because they find more boys than girls among the mathematically precocious prior to ages when mathematics courses become elective. Although Benbow and Stanley argue that their data support a genetic explanation, they fail to consider experimental factors other than course taking that might explain sex difference in mathematics performance. Pearsons (1981) for example finds that
parental expectations exert powerful influence on the mathematical performance of boys versus girls.

**Psychosocial differences**

The area of psychosocial difference is large, complex and difficult to divide into separate and definable aspects. Psychosocial sex differences influence in empathy, confidence in task performance, self esteem, aggression altruism, close contact with attachment to objects, anxiety, their surrogates influence ability and conformity.

**Contemporary Issues**

Although girls consistently receive better grades than boys throughout in elementary and secondary schools, their grades on standardized achievement tests do not reflect academic superiority. Achievement disparities between the sexes have been most striking in mathematics and science. In preschool and elementary school years girls' achievement scores in Mathematics and Science are approximately equal to those of boys. However, many studies have shown a consistent increase in boy's superiority in Mathematics and science in early adolescence (Maccabi and Jacklin, 1974). For example, NAEP, The National Assessment of Educational Progress study conducted in 1977-78 indicated that males excelled in problem solving in Mathematics at both the seventh grade and twelfth grade levels (NAEP, 1979 b).
Many differences have been put to explain these disparities and controversy is on going, some researchers have claimed that males achieve higher mathematics and science scores because of socialization; these areas are stereotyped as male domains. Boys are more likely to regard mathematics and science as important to future careers and they are more likely to elect advanced mathematics & science course. A less popular explanation suggests that there may be biological differences in these areas whichever explanation one accepts, it is clear that science and especially math are 'critical filters' that deprive females of equal access to occupations, including medicines, architecture, engineering, computer science and many other technical fields.

There are occupational as well as achievemental costs that appear to be related to sex stereotyping and socialization. When elementary school girls were asked to describe what they wanted to do when they grow up, they were able to identify only a limited number of career options. The majority identified only two careers. Teaching and nursing. In contrast, boys at these grade levels were able to identify many more potential occupations. Looft (1971), Howley (1971), found that during high school many women exhibited a decline in career commitment; this decline is related to their feeling that men disapproved of a woman's using her intelligence.

Since most sex differences in achievement are not exhibited during the pre school and elementary years, it seems reasonable to conclude that socialization in school and society contributes significantly
to these disparities. Researchers have conducted studies of various aspects of social policy & practices, and they have disclosed bias in textbooks, enrolment patterns, teacher-student interaction, counseling and employment in educational institutions.

1.2.1 Sex differences in intellectual ability

During the nineteenth and twentieth centuries, a great deal of research was carried out with the expressed aim of revealing the nature of differences in intellectual abilities existed and were motivated to provide an appropriate explanation for them.

Darwin (1871), considered that, 'intellectually, males attained higher excellence than females in whatever they undertook, whether requiring deep thought, reason, or imagination or merely the use of senses and hands! His explanation for the evolutionary origins of male superior intellectual power was based on the contentious belief that man had always provided for, and defended, women. Nineteenth century woman was depicted by male scientists as biologically vulnerable, she was also genteel, unimaginative, perceptive, modest, emotional, coy, dependent and above all maternal." Shields (1978).

1.2.2 Under representation of women in Mathematics

Women have been under represented in mathematics for many years, but now the times are changing. In an interview, Nobel Laureate Isidor I Rabi (1987) spoke of how many women were in Science and
mathematics today and said, "I wonder, how much longer, it will be that, we will refer to a female mathematician rather than just saying mathematician".

Why, many women dropout of, or lose interest in mathematics courses? The result of research in this area find one consistently recurring observation, ‘Many more women, than men see mathematics as neither relevant to their interests and experiences nor useful to them in their future lives and careers’.

1.2.3 Why do boys opt mathematics

Boys often opt for mathematics, because it is expected of them and not because they enjoy the subject. Society always appears to have conveyed the message that mathematics is a male subject and that certain other subjects are female subjects. Girls tend to underestimate their potential, while, boys tend to overestimate. Boys display confidence about their ability in mathematics which is sometimes not justifiable, whilst girls perhaps with better results, display unjustifiable anxiety.

Mathematics is considered to be a high status subject, particularly by boys, but this does not of itself imply liking. The attitude of many girls to mathematics appeared to deteriorate steadily through the years of secondary schooling, alongside the growth of self-consciousness about errors and difficulties.
Another related hypothesis concerns student's perceptions of the value of certain subjects for themselves and their future lives. Boys tend to see mathematics as important for their future careers, whereas these are of less value for girls' lives and careers. Such perception affects the performance of the pupils and their potential learning is either limited or enhanced depending on their view of the appropriateness of the activities they are expected to engage with.

One can assess the degree to which students subscribe to traditional ideas about the role of mathematics in men's and women's lives by asking them questions directly relevant to the problem. This was done in the SIMS by asking boys and girls to respond to four statements and to rate their answers.

The four statements were:

1. Men make better scientists and engineers than women.
2. Boys have more natural ability in mathematics than girls.
3. Boys need to know more mathematics than girls.
4. A woman needs a career just as much as a man does.

It was found that expectations and beliefs of the learner and of the wider society have a bearing on achievement (Leder, 1986).

In some societies, being males or females decide largely, what kind of life, the individual leads. So education is expected to prepare girls to be womanly and boys to be manly. It must prepare them to do...
the kind of work thought suitable for their sex and develop in them differing behaviours and emotions. Other societies do not make such an effort to differentiate, they accept that females can do the same kind of work, have much the same attitudes and behave in similar ways. Is different education for boys and girls infact necessary because differences are inborn?

1.2.4 Are there important innate sex differences in abilities, attitudes, emotions?

At various times, people have believed the following differences as based on inborn characteristics.

1. Women are less intelligent than men. Women are less capable (because of general, physical fragility), of studying at high intellectual levels.
2. Men are good at mathematics and physical sciences, women at languages and verbal performances. Objective intelligent testing does not support that females are less intelligent.

Admittedly, much depends on the construction of the tests, some questions may be better answered by boys or by girls, and such questions would often be discarded from the final version of a test; for this reason. Different scales may have to be used for boys and girls. For example, about the age 11, girls tend to do better in some verbal reasoning tests. So when such tests were used for secondary school selection, two different set of norms were to be used. On the other
hand, boys may do better some kinds of intelligence test which include spatial ability. More often males score extremely high or low on some intelligence tests. Hence it can't be concluded that one sex is more intelligent than the other.

As for the supposed inability of women or girls to cope with serious study, this has been proved by experience that it has not prevented girls from achieving, on average, as well as boys, if not better, in secondary school work. Women's success in higher education also disproves the assumption.

International studies in many countries have indicated male superiority in mathematics and most branches in physical sciences and females superiority in language reading and comprehension. But there are factors affecting these differences, for example, the kind of school teaching received, options in the curriculum, popular attitude toward subjects, vocational prospects etc. The levels of achievement of either sex do not reach a 'ceiling' predetermined by sex alone.

Teaching methods used in mathematics can also create barriers to women's participation. We know that women express much less preference, than men, for competitive or individual approaches to learning, and a greater preference for a co-operative mode. The traditional style of mathematics teaching is authoritarian and teacher-centred and tends to encourage a competitive atmosphere. The confident, assertive student thrives in such a class-room, while the more
reticent, and less confident are disadvantaged. There is an abundance of research results showing that women are more likely to come in to the latter category.

There might be other difficulties for girls created by the school government. Most mathematics teachers are men. Some books have been written by women. Many others, perhaps, because they themselves were males have placed mathematics within contexts, which were of much greater interests to males than to females.

1.2.5 Perpetuating cycles of attitudes

The under representation of girls and women 'in mathematics' and science is well documented, as the historical, cultural and educational forces which combine to discourage women from continuing with these subjects. The attitude that 'girls don't need mathematics' has resulted in large numbers of adult women who having failed in mathematics in the past, have very little confidence in their ability. This attitude often conveyed to their daughters, thus, perpetuating the cycles. Even today, girls, at schools continue to solicit subject with primarily humanities or commercial bias, to the exclusion of mathematics and sciences.

Researches have shown that girls achieve more in mathematics in a single sex school, than they do in a mixed school. Boys, on the other hand, tend to perform better in a mixed school, than in a single sex school. 'Sex differences possibly due to biological constraints are
dwarfed by the far greater pressures imposed by social and cultural stereo-types about cognitive skills and occupation.'

1.2.6 Achievement behaviour as a function of gender differences

It is found that females will forego the satisfaction of achievement needs to attain social outcomes presumably reflects gender differences in value orientation. On the other hand, females are socialized to be primarily 'socially oriented' while males are socialized to be primarily 'achievement oriented' (Maccoby & Jackhin, 1974).

According to Harner's theory, females who perform poorly in competition strive to win, but are inhibited by unconscious conflict and the attendant anxiety about sciences. According to strategic performance depression theory, however, such females knowingly elect not to try to their full capacities, and should feel reasonably satisfied upon failing, since unlike male, they simply do not value winning as much as social success.

1.2.7 Preference and attitude towards mathematics

Hudson (1966) drew attention to the possibility that a liking for mathematics stemmed from preferred styles of study. The fact that mathematics provides a 'beautiful safe heavens from the fear and anxieties of life' (Caldwell, 1972) is attractive to some. At the same time, private emotional reaction to the beauty or elegance of mathematical ideas and results is not ruled out. Rinsell (1983) showed
that 'Pupils often perceive the mathematics classroom as being a place for competition, which is attractive to some and not to others'.

1.2.8 Gender inequality and bias

In the last three decades, inquiry into the basis of gender inequality has evoked interest in the theoretical framework for interpreting distinctions between the sexes and has spurred research activity. It has challenged the very root of scientific inquiry in the social and biological sciences. The problem of bias has been of concern to every level of analysis, yet there is little argument even about what constitutes bias.

Cultural assumptions about the inevitability of differences between the sexes have persuaded observers, both within and outside the scientific community that a person’s sex status account for his or her behaviour and attitudes.

Many feminist writers adhere to the difference model, specifying distinct attributes for each sex, in attitudes and behaviour and in emotion and cognition. They claim that women, in contrast to men, are more ‘caring’; more attuned to personal relationships, less concerned about success; more oriented to home. Many scholars claim that women have different values and even a different culture.
1.2.9 **Gender differences in the development of the mathematical skills**

Gender differences in the development of mathematical skills and knowledge are also believed to emerge as functions of the different experiences of girls and boys in-group settings and under peer influences in the classroom and neighbourhood. Peers contribute to emerging gender differences even though children spend considerable time learning in the company of classmates. Boys tend to dominate in the classroom as a function of their interactions with classmates and teachers and their approaches to mathematics may become the preferred strategies in the classroom as a result of this dominance. Boy's dominance in the class room and their preference for competition may push them to acquire more complex strategies and metacognition. In contrast, girls are more concerned with pleasing teachers and are dependent on teachers for feedback. Such dependence on teachers as helpers is hypothesized to lead to a rote approach to mathematics but not the development of more and complex strategies like metacognition.

1.2.10 **Potential causes for Gender differences in Mathematical Problem Solving Ability**

In cognitive style, males advantage in visuospatial skills and in different types of psychometric tests of spatial ability such as three dimensional rotations of images; judging relative distance and relative velocity of moving objects are most pronounced during adolescence but also found early in elementary school years.
Potential causes for gender differences in mathematical problem solving include three psychological influences. Historical trends, perceived usefulness and competence of mathematics and classroom experiences.

**Historical trends**

Magnitude of gender differences in mathematical difference has declined over the last several decades.

**Perceived usefulness and competence**

Male students consistently perceive mathematics as being a useful skill, appears to be related to long term carrier goals. Women are much less likely to enter mathematics-intensive professions. Many girls do not believe that working in these areas will be especially interesting. Perceived mathematical competence includes two factors.

- One’s performance in relation to peers - better performance.
- Higher perceived competence individuality; the skill that is relatively better among oneself will be perceived more competent, disregard of the level compared with others.
- Male feel better about their mathematical competence.
- Perceived mathematical ability affects performance, performance again affect perceived ability.
Class room experience

Leinhard, 1979, reports that girls need more individual time in reading instructions, while boys need more mathematics instruction time.

1.2.12 Present status of gender differences

The traditional assumptions that there are basic and universal differences between the sexes are now being challenged. New techniques show that 'Cognitive differences between men and women are disappearing' (Fein Gold, 1988)

Epstein, (1988) reports, 'I have found that most distinction believed to peculiar to either sex are deceptive'. Some distinctions seem to hold overtime because considerable social effort is exerted to insure that they do not diminish. The social control of law, social policy, etiquette and convention act as powerful mechanism by which gender distinctions conform to cultural expectations.

In the last decade; Government policy makers have been forced to recognize this as a problem and have began to put money to schemes encouraging women and girls to mathematics and science areas.

1.2.13 Future Research Trends

Until recently most of the research on sex differences has focused on understanding male superiority or advantage. Some recent
perspectives and theories, however, suggest that this research may be entering a new phase: one in which researchers focus on understanding female behavior apart from male behaviour. The distinction between the two approaches is subtle but significant. Past research has been able to tell us how and why females differ from men on male-oriented behaviours. For example, the research on sex differences in spatial or mathematical performance has been able to tell us how and why females differ from men on male-oriented behaviours. For example, the research on sex differences in spatial or mathematical performance has established that when differences occur, males are likely to outperform females. In addition, we have information about factors that influence these sex differences. But such research provides information only about constructs that are salient to males. Such results say little about females, except what they do not do and perhaps why. The areas of female excellence and interest remain largely unexplored.

The work of Gilligan (1977, 1979) suggests a new focus for research efforts. She points out that the major theories of development are andocentric. The constructs of cognitive and moral development articulated and assessed by Piaget (1965 [1932]) and Kohlberg (1976) are better able to explain the development of boys than that of girls, at least by adolescence. In contrast, ego development, as articulated and assessed by Loevinger (1976), is more likely to be appropriate for females than males. This distinction in the approaches of Piaget and Kohlberg as compared with Loevinger derives from the understanding
that these scholars have of the nature of human development. Surely girls, just as boys, develop cognition and moral understanding. But abstract conceptualization may be more salient to boys than girls. Similarly, interpersonal comprehension may be more salient to girls than boys. The significance of the differences in these approaches is only beginning to be articulated and understood.

Hauser, (1980) suggests that an interpersonally oriented construct such as ego development shows sex differences in favour of females.

Chodorow’s work (1978) describes the development of girls from the psychosocial perspective within psychoanalytic theory. Her perspective is distinct from that of Freud (e.g., 1961[1905]) in that Chodorow articulates the processes that might affect female development, whereas Freud best described male development. Although many have criticized psychoanalytic theory for its failure to account for female development, little previous work has provided coherent alternative perspectives.

These new conceptualizations are important for two reasons. First, they hold promise of stimulating work on the unique aspects of female behavior and development, in contrast to the sex differences studied in previous research, which examined how and why females were not like males. Second, these perspectives may identify the areas
of strength in females, so that we can understand why males differ from females in some respects.

The difficult but exciting challenge for research is that sex roles and sex differences are changing, because of the social and legal changes.

1.3 BACKGROUND OF THE STUDY

Currently there is a big movement in India to try to address the issues of gender equity. Affective action in favour of women is now being practiced in both the private and public sector as well as in educational institutions. Inspite of efforts to afford both female and male students, equal opportunity in education, it has been alleged that this is not being extended to or achieved in practice for all the subjects in the curriculum and to mathematics in particular. In India, mathematics is a compulsory subject from class I to class X and so the number of girls studying the subject at school level is more or less the same as that of boys. As Toole (1993) noted, research on gender related issues has moved onto a search for explanations of observed differences in performance in mathematics between girls and boys. It is on line with their quest to find explanations for the observed poor performance and high dropout rate of boys at the secondary level, that the current study focussed on investigating the aspects of students’ mathematical abilities.
In attempting to explain the male advantage, some research teams have looked at biological differences between the sexes, focussing on harmones (Broverman et. al. 1968), Genes (Bock and Kolakoswki, 1973) and brain organization (Waber, 1979). Other research teams have proposed theoretical models which include a number of factors such as the curriculum, the situation, the environment and participation in mathematics-related science courses (Eccles, 1985, Fennema, 1985, Leder 1982, 1986). The literature on sex differences has also considered the possibility that male mathematical superiority is due to psychosocial processes such as stereotyped sex-role identifications. (Alken, 1976, Becker, 1981, Baston, 1986, Walder and Walkerdis, 1985) and social reinforcement contingencies (Fox et. al. 1979). It should be stressed that some research has also shown that gender-related differences in achievement vary considerably both within and among countries (Schildkamp Kundiger, 1982).

1.4 STATEMENT OF THE PROBLEM

GENDER DIFFERENCES IN MATHEMATICAL ABILITY AMONG HIGH SCHOOL STUDENTS IN SALEM.

1.5 NEED AND SIGNIFICANCE OF THE STUDY

Mathematics play an important role in our daily lives and thorough grounding in it is essential for all boys and girls during their education and training. Although Mathematics is a compulsory subject upto the age 15+ or 16+ in Indian schools, it does not follow, all the
pupils actively participate in the learning of Mathematics. Mathematics is the subject in which the contribution of women is to the barest minimum.

The issue of sex differences in Mathematical problem solving has been raised often, especially in the popular press. For example, in 1980, 'Newsweek' run a story entitled, "Do males have a math gene?" and the same week, 'Time' devoted a page to "The gender factor in Math". Inspite of the occasionally intense public attention and strong opinions sometimes given in popular publications, it is possible to examine sex differences issue from a scientific point of view. In particular, two related questions can be raised:

1. Are there sex differences in children’s scores on test of Mathematical ability and achievement?
2. If so, why are the differences?

The present study is an attempt to find out the possible answers to the cited questions in the Indian context and high school students.

As the investigator is a Mathematics educator, she got interested to find out the possible reasons among the high school students, if there exists, any gender differences in Mathematical abilities.

The research is restricted to VI standard and IX standard students, because at these two levels; the students enter into the middle and high school levels respectively. At these stages; the gender differences in Mathematical abilities are to be analysed. Hence the apt
1.6 SCOPE AND LIMITATIONS OF THE STUDY

The present study will reveal the gender differences in mathematical ability in cognitive, affective and psychomotor outcomes. The study will also focus few factors that lead to the gender differences. The study will throw light on the interactive effect of ability in one domain of learning on the other. As the study is at the school level, the results will be of much help for the society at large to improve the ability in mathematics among students, irrespective of gender.

The study was restricted to VI standard and IX standard only. The samples were drawn only from Salem educational district. Only seven independent variables were taken into consideration, viz., gender, type of school, management of school, locality, medium of instruction, birth order and class of study.

In the cognitive constructs i) achievement in Mathematics, ii) achievement in different subject areas, iii) achievement in components of cognitive domain such as knowledge, understanding and application iv) spatial visualization and logical reasoning were the dependent variables selected.

In the affective outcomes, i) the value for the power of mathematics ii) Attitude towards mathematics and iii) Attributional styles were the three dependent variables selected. In the psychomotor
domain, the skills in i) drawing mathematical figures ii) preparing mathematical models were the two dependent variables selected.

The question papers on cognitive constructs and psychomotor domain and the attributional style questionnaire were prepared and standardized by the investigator. The other two tools were standardized tools.

1.7 SUMMARY

The first chapter ‘Conceptual Frame Work’ elaborately presented the theoretical background of the present study. The next chapter will focus on ‘Review of Related Literature’.