CHAPTER 1

INTRODUCTION

1.1 AN OUTLINE OF THE SUBJECT:

Mathematics has always been an integral part of any school curriculum. The study of this subject is a continuous process, which is carried onwards to higher levels. It does not remain confined to itself but also plays a role in the development of other disciplines. It is a fundamental building block that helps in structuring thoughts in a logical order. Mathematics taught in schools is crucial to higher order learning. A lot of importance has been given to the subject from time immemorial, and it has acquired even greater importance today with its linkage to various fields of physical and social science.

Indeed from the very beginning of their education children start with both language and numerical skills. The rationale for teaching and learning mathematics is manifold. First is obviously the usefulness of mathematics where it can be used as a tool in various other activities. This is followed by the argument that studying mathematics for its own sake develops discipline of thought and logical reasoning. Still further are the arguments by learned scholars for the intellectual and aesthetic satisfaction that can be derived from mathematics. In India the practice of mathematics education was a well established phenomenon. It is a highly revered subject in Indian culture and is viewed as a measure of one’s intellectual ability. Arithmetic and astronomy were core components of the course of study. With the arrival of the British, the system of education underwent a major change. The present system of education was introduced and founded by the British in the 20th century, by
the recommendations of Macaulay. Not much was done for the general advancement of science and technology. (Bhatacharya S P, 1995) However; much of the curriculum development in mathematics has taken place during the past forty years. This is because of the new technological revolution which has an impact on society as great as the industrial revolution.

School mathematics is basic to undergraduate, postgraduate and research mathematics; it is also fundamental for the growth of science and technology in the country. (Kapur J N, 1967). One cannot do without the use of basic processes of mathematics in daily life. The knowledge of its fundamental processes and the skill to use them are the preliminary requirements of a human being these days. Due to its very nature mathematics also develops reasoning and thinking powers. (Sidhu K S, 1990). Mathematics, when taught well, is a subject of beauty and elegance, exciting in its logic and coherence. It trains the mind to be analytic providing the foundation for intelligent and precise thinking.

Its usefulness makes mathematics a necessary subject at school level. In post-independent India, great emphasis has been placed on mathematics teaching and learning. In 1937, when Gandhiji propounded the idea of basic education, the Zakir Husain committee was appointed to elaborate on this idea. It recommended, “Knowledge of mathematics is an essential part of any curriculum. Every child is expected to work out the ordinary calculations required in the course of his craft work or his personal and community concerns and activities.” The Secondary Education Commission appointed in 1952 also emphasized the need for mathematics as a compulsory subject in the schools. The Indian Education Commission has known as the Kothari Commission (1964-1966) recommended mathematics as a compulsory subject for students at school level. It 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.’ Even today the above statement holds true, in spite of the different changes in the content matter of mathematics taught over the past decades. The effectiveness of mathematics as a compulsory subject remains constant. The Commission points out that, ‘In the teaching of mathematics emphasis should be more on the understanding of basic principles than on the mechanical teaching of mathematical computations’. The National Policy on Education 1986 went on to state 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 a concomitant to any subject involving analysis and reasoning.

Starting from the elementary concepts of addition, multiplication, subtraction and division school level mathematics prepares the preliminary ground for higher level studies in the same subject. The National Curriculum Framework for School Education (NCFSE-2000) has reiterated that the study of mathematics contributes in the development of precision, rational and analytical thinking, reasoning and aesthetic sense among children. The new National Curriculum Framework (NCF 2005) also places due emphasis on mathematics. Succeeding in mathematics should be the right of every child. It is recommended that mathematics should enhance the child’s ability to think and reason, visualize and handle abstractions and formulate and solve problems. Continuity from one level to the next, inter-disciplinary and thematic linkages between topics listed for different school subjects, linkage between school and college syllabi are some major considerations of the new NCF-2005. A high-
quality mathematics program is essential for all students and provides every student with the opportunity to choose among the full range of future career paths.

As such the importance of a sound foundation in mathematics cannot be underestimated. The pivotal role of mathematics is seen as a subject essential for later learning and later life yet difficult for most pupils to master at the school stage. (The International Encyclopedia of Education). There is a definite lacking among the majority of the school children in the proper understanding of the subject. This becomes a handicap as they go on to pursue the subject at the college level. The difficulty arises because mathematics is a continuous discipline requiring sound knowledge of basic concepts.

In extreme cases this non-understanding manifests itself as “Mathematics Phobia”. It is a matter of concern that the maximum failures in board examinations are in Mathematics and English. The way the students learn school mathematics and the habits they form now will to some extent, determine the future pattern of intellectual activity of the country. The problems in school mathematics should therefore be of vital concern not only to professional mathematicians but also to everybody interested in the future of the nation. (Kapur J N, 1967).

Mathematics is the key to opportunity. No longer just the language of science, mathematics now contributes in direct and fundamental ways to business, finance, health and defense all of which go towards the development of a country. So no matter what the career option of a student is, the mathematics learned at school will be integrated into his or her daily life. The mathematics learnt in schools should transform students to become “mathematical problem solvers,” an outcome that moves beyond the traditional goal of getting correct answers to arithmetic exercises. (Seeley C, P Harold, 2004). Students should emerge from mathematics classes with an
appreciation for when and how the application of mathematics in their daily or personal lives is warranted, and with a willingness to think mathematically in relevant situations. Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge. It is more useful to know how to mathematise than to know a lot of mathematics. (Wheeler David, 1982).

For this the mathematics curriculum should be one which gives students ample scope in terms of problems from real life starting with simple counting and measurement to applications in business, science and daily life. Mathematics projects which are purposeful and a mathematics laboratory can promote learning of both skills and concepts.

Mathematics, when taught well, is a subject of beauty and elegance, exciting in its logic and coherence. It trains the mind to be analytic providing the foundation for intelligent and precise thinking. Research in mathematics education has shown that to teach well, substantial mathematical understanding is necessary; even to teach whole-number arithmetic. Prospective teachers need a solid understanding of mathematics so that they can teach it as a coherent, reasoned activity and communicate its elegance and power.

In the developing world, there is diversity in the level of mathematics education among countries. Each country has a different cross-cultural heritage, different medium of instruction, different level of teacher training and in fact different socio-economic positions. In most of the developing world today, the mathematics education system was deeply imbedded in the cultural and colonial heritage of the past. For example in Malaysia, Singapore, India and Hong Kong, adopted the British System, the Philippines adopted the American system while Vietnam and Cambodia
adopted the French system and so on (Nebres B F, 1995). However, most countries today had revised and developed their own curriculum, albeit some of the contents are still the replica of the Western curriculum. The only variation is often reflected by the difference in socio-cultural landscape. In the Indian context, there is a further centrality of concern which has an impact on all areas of school education, namely that of universalisation of schooling. This has important implications for the discussion on curriculum, especially mathematics. Schooling is a legal right, and mathematics being a compulsory subject of study, access to quality mathematics education is every child’s right. The curriculum should thus create learning environments which will help students to enjoy and appreciate the value of mathematics, to develop the tools they need for varied educational and career options, and to function effectively as citizens. As our world becomes more dependent upon technology and the application of rapidly changing information, educators will agree that teaching mathematics is increasingly becoming more important. No doubt this remains the ultimate aim of the entire educational endeavor.

Thus it is imperative that schoolchildren receive a high-quality grounding in this subject. This study seeks to find out the difficulties faced in school mathematics education at ground level and certain factors that have an effect on mathematics education.

1.2 HISTORY OF MATHEMATICS

Mathematics is one of the corner stones of our civilization. The historical development of mathematics forms a fascinating story of man’s efforts to acquire and develop various ideas for understanding the physical environment. (Bhimsamkaram C V, 1979). Man has from the earliest times wanted to explore the world around him, in order to sort, systematize and categorize his observations, experiences and
impressions in attempts to solve the riddles of existence and explain natural relationships. The development of mathematics springs from the human urge to explore, measure and grasp. The knowledge and skills which are necessary tools for these purposes develop through mathematical activities.

Mathematics starts with counting. It is not reasonable, however, to suggest that early counting was really mathematics as we understand today. Only when some record of the counting was kept and, therefore, some representation of numbers occurred did mathematics emerge as a subject. A few symbols cemented by a set of rules were the foundation on which the edifice of classical mathematics was erected. It created an idealization of 3-dimensional space called ‘Euclidean Geometry’ and systems of counting and measuring for the business world.

Mathematics as a distinct learning field grew in various civilizations. It has its roots in ancient Egypt and Babylonia. The Babylonian basis of mathematics was inherited by the Greeks and independent development by the Greeks began from around 450 BC. After this, progress continued in Islamic countries. Mathematics flourished in particular in Iran, Syria and India. Later some of this mathematics was translated into Latin and became the mathematics of the West. The diverse discoveries and applicability of mathematics saw the rapid emergence and progress of mathematics as subject in different parts of the world. Modern mathematics can be said to have been born in the 1800s and is characterized by comprehensive and systematic synthesis of mathematical knowledge. Further changes have transformed mathematics to what it is today. Social and Behavioral sciences were the major stimulants for the development of new mathematics. The period since the end of World War II has been the golden age of mathematics. Owing to heavy applications in business, management, biology, medicine, economics, psychology, government...
affairs etc the term mathematics is nowadays replaced by the more inclusive term mathematical sciences which includes mathematics in its pure and applied form (Collier’s Encyclopedia)

1.3 AN OVERVIEW OF INDIAN MATHEMATICS

It is without doubt that mathematics today owes a huge debt to the outstanding contributions made by Indian mathematicians over many hundreds of years. Mathematical ideas that originated in the Indian subcontinent have had a profound impact on the world. In ancient time, mathematics was mainly used in an auxiliary or applied role. Thus, mathematical methods were used to solve problems in architecture and construction (as in the public works of the Harappan civilization) in astronomy and astrology (as in the words of the Jain mathematicians) and in the construction of Vedic altars (as in the case of the Shulba Sutras of Baudhayana and his successors). By the sixth or fifth century BC, mathematics was being studied for its own sake, as well as for its applications in other fields of knowledge. (Murthy V K ,2007)

Mathematics received prominence as a separate subject only in the 12th century, as referred to in the Leelavati of Bhaskaracharya. The situation with regard to mathematics education remained unchanged after AD 1200 though there had been epoch-making discoveries. In spite of political instability during the period up to the 18th century, the native system of education maintained its traditional structure up to the advent of British (Miyan Md ,1983).After independence in 1947, enrollments in schools increased by 30-40% in accordance with the directive principle of our constitution that education should be free and compulsory for all till the age of fourteen years. At present there are 80 million school children studying mathematics at any given time and there is a great diversity among them. About 40-50% of them
are first generation learners whose parents do not know any formal mathematics.(Kapur J N 1978)

1.4   A BRIEF OVERVIEW OF MATHEMATICS EDUCATION

Keeping in view of the importance of mathematics as a subject, educational issues in mathematics assumed a great significance. A great emphasis was placed on mathematics teaching and learning. Mathematics education is a research discipline within mathematics. A broad view of Mathematics education is a scientific discipline which is a study of how people learn and do mathematics and how this is influenced by teaching, social organizations and environment.

Mathematics education as a field of study began to develop slowly at the end of the 19th century in universities. Expansion of programs in teacher education was started in response to the need for more and better prepared teachers. During the twentieth century mathematics education was established as an independent field of research. This period now saw the creation of a Chair in mathematics education was created at the University of Göttingen, under the administration of Felix Klein as early as 1893 and founding of The International Commission on Mathematical Instruction (ICMI) 1908. With the growth of interest in mathematics education the commission was revitalized in the 1960s. The first International Congress on Mathematical Education (ICME) was held in Lyon in 1969. The second congress was in Exeter in 1972, and after that it has been held every four years. (Wikipedia) This set the pace for rigour in mathematics education to be seen in contemporary mathematics. Gradually it became an active and growing field of research contributing to theoretical as well as to applied aspects. Over the last forty years mathematics education together with science and technology has emerged as lively new research areas. Research in
mathematics education at the primary, middle and secondary levels of schooling has attracted much attention of researchers.

According to Alan H. Schoenfeld (2000) mathematics education has two main purposes, one pure which is to understand the nature of mathematical thinking, teaching, and learning; and the other applied which use such understandings to improve mathematics instruction. In India too a considerable amount of work is being done in this field The citations for the two prestigious ICMI medals in mathematics contain references not only to the research done by the awardees but also to their contribution to the practice of mathematics education in their countries and internationally. (Subramaniam K,2005).

Mathematicians are interested in studying the issues related to teaching and learning of their subject. Concerns about inadequate understanding of mathematics by students in schools, falling enrollment in advanced courses, the role of mathematics as a compulsory subject at school level, areas of gender differences in mathematics were issues which encouraged mathematicians to develop detailed analysis of students’ mathematical thinking and methods to improve it. Studies, surveys and eventually other types of empirical research where a part of their effort.

Mathematics education is highly dependent on Psychology. According to Schubring (1988) there is a connection between students understanding of mathematics and their cognitive development. From the beginning educational psychology was a popular vehicle to use in investigating learning of mathematics considering the important place mathematics holds in the school curriculum.

Mathematics education as a discipline sits between mathematics on the one hand, and a range of other disciplines (such as psychology, human development,
sociology, philosophy, epistemology, pedagogy, curriculum studies, policy studies
and science) from which it draws underpinning research findings and concepts. As
society changes, as technology changes and as the education system changes, the
environment for learning mathematics has also been fundamentally altered, which
affects the directions of research. The object of study in mathematics education
encompasses a wide field which includes teaching and learning of mathematics,
teaching learning situations, societal view of mathematics, relation between attitudes
towards mathematics and achievement in the subject, identifying areas of students’
difficulties among others. With its wide applicability mathematics education research
has made significant progress in recent times and the importance of research in
mathematics education has increased manifold.

In India, Kulkarni (1970) conducted the first major study on achievement
survey in mathematics covering the three levels of education, viz., end of primary
(grade V), end of middle (grade VIII) and end of secondary stage (grade X.) in 15
states. The number of students in the sample varied from more than 28,000 at primary
level to nearly 20,000 at the secondary level. The major findings of the study for the
primary level were: boys achieved higher than girls; the socioeconomic conditions of
the parents of school type (e.g., government or private management) provided better
teaching-learning situations; and no relation was found between school achievement
and teacher qualifications. This study was conducted about 29 years back (in 1966-
67) and since then considerable changes have taken place in the Indian system of
school education. Research in mathematics education really picked up in the decade
1961-70. Since then, there has been a steady growth of about three studies every year.
The major areas under which the studies are classified in the trend report are (i)
teaching and teacher behaviour, (ii) curriculum and textbooks, (iii) factors affecting
achievement, (iv) diagnostic and other tests in mathematics (Miyan Md, 1983). Miyan has found that considerable research has gone into methods and strategies of teaching mathematics. The researchers have evaluated the effect of methods on a variety of variables like personality type, achievement, intelligence, level of thinking, sex and concept attainment.

Mathematics Education is probably the most important area concerned with school education and its development is vital for the development of science and technology. (Kapur J N, 1978). The main object of mathematics education research is to be of help in the improvement of classroom learning and teaching. There are many different aspects whereby improvement can be brought about by studying the characteristics of effective teachers, analyzing the errors committed by students, the attitudes of students, teachers and guardians and the environmental factors. Many different players need to contribute to substantially enhance the general level of the learning of mathematics in our schools: policy makers, curriculum designers, textbook writers, teacher trainers and researchers.

Research in mathematics education enables giving a better quality education to the students. Research in mathematics education is concerned with understanding the processes of learning and teaching in order to improve students’ learning of mathematics. A sophisticated body of theoretical knowledge has grown around the attempts to understand the hurdles that students face in learning mathematics. Conceptualizing inherently complex phenomena like a child learning, or a classroom process is a formidable challenge, which must often be met by drawing on a variety of disciplines. Thus researchers in mathematics education need to not only have knowledge of the subject of mathematics, but also to be prepared to study other disciplines that may have a bearing on their work: psychology, history and philosophy.
of mathematics. The interdisciplinary nature of mathematics education research poses a challenge for institutions that are training young researchers. But fortunately this fact also makes the field exciting for many students and researchers with an appetite for knowledge and discovery.

One of the useful contributions of mathematics education research is the elaboration of systematic errors that a large number of students make. Researchers have not only uncovered and classified a large number of common errors in a host of topics, but have also had moderate success in explaining the origin of these errors.

Some of the fundamental contributions from research in mathematics education are theoretical perspectives for understanding thinking, learning, and teaching; descriptions of aspects of cognition (e.g., thinking mathematically; student understandings and misunderstandings of important concepts), existence proofs, descriptions of (positive and negative) consequences of various forms of instruction. (Artigue M., 1999). Mathematics Education has been designed to help inform stakeholders about the decisions they face, to point to recent research findings and to provide access to the most recent thinking of experts on issues of national concern in mathematics education. Thus research in this field has an eventual practical intent of improving students’ learning.

1.5 NEED AND SIGNIFICANCE OF THE STUDY

The importance of mathematics education as a research discipline within mathematics has been emphasized by mathematicians. Mathematics education examines mathematics and its application from the standpoint of how students learn and how understanding develops. A broad view of mathematics education is a scientific discipline which studies how people learn and do mathematics and how this
is influenced by teaching, social, economic other environmental factors. (Dorfler W, 2003). The culture of mathematics education highly values student performance and meaningful learning by students (Gold G, 2003)

Assessments provide a systematic way to inform students, teachers, parents, and educationists about student performance. Hence the need for examinations. However at the same time the motivation, commitment and the imaginative faculties of the learner in any discipline cannot be evaluated through a one-shot examination at the end of an academic year

In school mathematics, certainly emphasis does need to be attached to factual knowledge, procedural fluency and conceptual understanding. New knowledge is to be constructed from experience and prior knowledge using conceptual elements. Rittle-Johnson and Stiegler (1998) found that conceptual understanding and procedural skills are highly correlated. Not only should students have a fluency in basic computational skills but they must also develop an understanding of mathematical concepts. To achieve proficiency in mathematics a student must build new ideas and skills on earlier ones within lessons, from lesson to lesson, from unit to unit, and from year to year.

A subject’s mathematical background is an important component of problem solving abilities (Schoenfeld, 1985); yet adequate mathematical preparation does not guarantee success. Studies show that undergraduates (Schoenfeld, 1985; 1992), graduate mathematics students (Carlson, 1999), and even some professional mathematicians (DeFranco, 1996) struggle to access the appropriate mathematics needed to solve a particular problem. In their work with mathematicians, Carlson and Bloom (2005) suggest that a well-developed and well-connected conceptual
understanding of mathematics facilitated the mathematicians’ problem solving success.

Based on an understanding of the basic concepts the students construct and develop new ideas and skills, and the processes they learn become richer and more complex. Students are then able to articulate the mathematics needed and verbalize a solution path. In addition, they report a better understanding of how topics fit together and relate as well as greater confidence in problem solving.

However, invariably, emphasis on marks on the report card gains ascendancy at the cost of conceptual understanding as well as construction of knowledge based on experience. Additionally it is observed that among students who scored good marks in mathematics in high school, large proportions of them find difficulties in understanding college mathematics. It is indeed likely that in majority of the cases the students learnt mathematics basically just to pass the examination.

Individuals with greater preexisting knowledge about a topic generally understand and remember more than those with more limited prior knowledge. Understanding of basic concepts will in turn help students in retention of prior knowledge. Research has consistently shown that emphasis on teaching for meaning has positive effects on student learning including better initial learning, greater retention and increased likelihood that the ideas will be successfully used in new situations. (Grows and Cebulla 2000). This is what distinguishes a child who has conceptual understanding of his subject as opposed to mere memorization. Mathematics makes sense to students who have a conceptual understanding of the domain. They know not only how to apply skills but also when to apply them and why they should apply them. They understand the structure and logic of mathematics and use the concepts flexibly, effectively, and appropriately. In seeing the big picture
and in understanding the concepts, they are in a stronger position to apply their knowledge to situations and problems they may not have encountered before and readily recognize when they have made procedural errors (Ong Faye 1999). If concept and understanding is not developed properly then learning becomes unlearning at a later stage. The notion that conceptual understanding in mathematics can be separated from precision and fluency in the execution of basic skills is just plain wrong (Klein David, 2000).

With the advent of technology time consuming computations involving operations can be accomplished quickly and effectively. The perception of mathematics as mechanical computation has become outdated (Kapur J N, 1967). Mathematics is now presented as an interdisciplinary subject. The focus is now on the underlying concepts. Mathematics knowledge becomes meaningful and powerful in application. This is possible only when there is a thorough understanding of basic concepts. Learning becomes meaningful if it is saved from mechanical process and blind cramming. It pays to exercise the thinking and reasoning power of the learner as against memorization (Sidhu K S, 1990).

However concepts of mathematics are seen as difficult to understand and appreciate. For many students school mathematics does not make sense. This can be seen as a central cause for the fear of mathematics in children. Topics which do not make sense cause students to lose interest in the subject and develop what is commonly known as phobia towards the subject. Fear of learning of the subject increases the resistance to the learning process. Students develop the habit of memorizing formulas and facts merely to pass the examinations. The situation needs to be attended to.
High achievement in mathematics based on examination marks may not reflect knowledge of basic concepts. A student who is good in computation, attentive in class, conscientious about completing homework and other assignments, willing to put in effort, has regular study hours can score high marks in examinations. Many tests in schools are heavily devoted to the development of computational skills and provide little opportunity for students to demonstrate the complex types of reasoning skills that are characteristic of truly talented students. Tests are designed for assessing a student’s knowledge of procedure and memory of formulas and facts, and given the criticality of examination performance in school life, concept learning is replaced by procedural memory.

However the high achieving students may fail to answer questions which require understanding and the ability to apply concepts rather than recall facts and apply rules. (Kapur J N, 1967). There is considerable variability in the marks achieved by a student in a scholastic achievement test of topics taught in the current session reinforced by practice, memorization and familiarity with the question types as opposed to a test which requires a student’s perception of his/her understanding of each mathematical concept encountered earlier, recollection of the same and ability to apply it to the problem at hand.

Lampert’s (1985) description of the cultural assumptions about mathematics in schools is as follows: “doing mathematics means following the rules laid down by the teacher; knowing mathematics means remembering and applying the correct rule when the teacher asks a question”. A student should never forget that the actual goal of learning is not the grades, even the highest ones, but to obtain knowledge (Sreekanthi Y, 2004). Getting high marks on a paper should not detract from the whole thinking process involved in solving mathematical problems. Mathematical
Ideas required for understanding a particular topic turn out to be basic for understanding many other topics too. The question here arises as to whether teachers should prepare pupils in rehearsed responses that reflect well on the teachers or do they encourage pupils to use strategies and procedures which guide the choice of which skills to use or what knowledge to draw upon.

The focus should be on the students having a real knowledge of basic concepts which will make them successful in their potential jobs and future studies. It is seen that there are cases where the students who scored good grade in mathematics in high school, large proportions of them find difficulties in understanding college mathematics. The question arises whether, the quality of examination questions in mathematics in the public examinations has fallen or whether the students themselves passed the examination without the sound understanding of the required skill in Mathematics. The latter case prompts the belief that the students learned Mathematics is basically just to pass the examination. It is this phenomenon that is of concern to mathematics educators. (Mohd. Sahar Sauian, 2002).

Another aspect is linking school mathematics to out-of-school mathematical activities. With regard to the relation between school and out-of-school mathematics, most research shows a strong discontinuity between school and out-of-school mathematical practice. According to early work on situated cognition, e.g. Lave (1988), this discontinuity is a consequence of learning in and out of school being two distinct social practices. It is seen that when tasks are given to students in the real world, it is seen that students’ are either not able to perform the same or there is a transformation of the given task into a subtly different task. Educational implications with regard to student engagement with realistic tasks are considered. It is argued that
this transformation is interrelated with students’ understandings of mathematics, of technology and of the real world and students’ emerging goals. (Monaghan J, 2007)

It is hoped that through this study the causes of the gap between mathematics achievement in examinations and knowledge of essential concepts can be identified.

Additionally there is seen a natural aptitude for mathematics in certain students. Ability for mathematics must be distinguished from scholastic achievement and actual learning accomplished. A considerable amount of reasoning abilities is associated with high ability in mathematics. A student with a high ability for mathematics will be having a high degree of numerical skills and logical thinking and visualization. Since ability in a particular direction can indicate the choice of future career for a child, this is also an important aspect of education. It is to be noted that ability must be supplemented by proper training. For this it is necessary that there is a congenial environment for aptitude to develop.

The educational system plays a considerable role in the allocation of personnel to various occupational positions. It sorts people according to differences in valued abilities, channels them into streams of training which develop their capabilities, and encourages them into adult roles that are in keeping with their talents. (Naik S P, 1998). In the course of this study, it is hoped that the students with high mathematics ability can be identified.

Thus it is seen that there are a number of factors which affect conceptual understanding of mathematics, ability for mathematics and achievement in mathematics. Several factors influence student performance in mathematics as well as in other subjects, area in which the school is situated, school management, socio-economic factors, school environment, gender, motivation including teachers’ and
parental attitudes towards mathematics. Relevant literature provides evidence of these factors in different parts of the world including India, however no such relationship has been examined in Bongaigaon district. The research work will investigate these factors. This study will be an additional contribution to the understanding of factors affecting mathematics education.

Also keeping in view the importance placed on conceptual understanding by experts in the field of mathematics, an investigation into the knowledge of essential concepts and ability for mathematics in comparison with scholastic achievement of school students will give an insight into the effectiveness of the teaching–learning process.

The Mathematics Olympiad examination conducted by the Assam Academy of Mathematics requires an in-depth knowledge of concepts. The prize winners of the examination are chosen on the basis of a minimum standard fixed by the board of examiners. The results of the Mathematics Olympiad examination for Junior (classes VII and VIII) and Category I (Classes IX and X) in the past four years revealed the following statistics.

![Figure 1.1 Results of mathematics Olympiad in Bongaigaon district](http://www.foxitsoftware.com)
The trend in performance (Fig 1.1) indicate that there is an increase in the number of prizewinners in Mathematics Olympiad in 2002 both in overall and in Bongaigaon. There is however drastic decline in performance in 2003 in case of both categories. What is worrisome is that in 2004, while there is increase in overall prizewinners, performance of Bongaigaon is abysmally low. This decline in student performance from Bongaigaon district reveals a need for a study in Bongaigaon district which investigates mathematics achievement in examinations in relation to knowledge of essential concepts.

1.6 PROBLEM

The study seeks to find out if there is any relationship between school environment, parental socio-economic status, gender and students’ and teachers’ attitude towards mathematics with respect to mathematical achievement in examinations, knowledge of basic concepts and mathematics ability of school students in Bongaigaon district.

- The attributes for school environment have been taken as physical facilities, teaching aids, books, reference books, teacher-student ratio

- The attributes for parental socio-economic status are parental economic status, parental education and parental occupation.

- The attributes for students’ attitude towards mathematics consists of a set of 14 statements to which students respond using a five point Likert scale.

- The attributes for teachers’ attitude towards mathematics consists of a set of 16 statements to which teachers’ respond using a five point Likert scale.
1.7 OBJECTIVES:

- To make a comparative study of the students’ mathematics achievement in examinations, knowledge of basic concepts from syllabus and aptitude for mathematics.

- To ascertain whether there is a relation among mathematics achievement in examinations, knowledge of basic concepts from syllabus and ability for mathematics of the students.

- To ascertain whether school environment, socio-economic conditions and students’ and teachers’ attitude towards mathematics affect mathematics achievement in examinations, knowledge of basic concepts from syllabus and ability for mathematics.

- To compare the above results with respect to government and private schools.

- To compare the above results with respect to rural and urban areas.

- To compare the above results with respect to boys and girls.

1.8 FIELD AREA AND DEMOGRAPHIC PROFILE

The area undertaken for this study is the undivided Bongaigaon district (at present Bongaigaon and Chirang). Bongaigaon district occupies an area of 2510 sq. km. This district of the North Eastern Himalayan sub-region of the country is located at a longitude of 89 degrees east to 90 degrees 96 minutes east and latitude range of 26 degrees 28 minutes north to 26 degrees 54 minutes north. There are seven rural blocks and three urban blocks of Bongaigaon district. About 90% of the population of the district lives in rural areas. The rest 10% covers the urban areas comprising Abhayapuri Town, Bijni Town and Bongaigaon Urban Area. The northern part is
predominantly inhabited by Bodos, the central part by Assamese Koch-Rajbongshis, Assamese Caste Hindus and Scheduled Caste and the Southern part by Immigrant and Indigenous Muslims.

1.9 METHODOLOGY:

The field area has been divided into Government Schools and Private Schools. In order to cover the different strata of population a stratified random sampling of schools have been taken. Further the field area has been divided into rural and urban areas. The data consisted of information on school, students and teachers which were included in the survey area. The sampling frame was based on the list of provincialized government schools and private schools and collected from the office of the Inspector of Schools, Bongaigaon. The sampling was done at two stages. At the first stage the schools were selected by using Fisher Yates table. One third of the total number of provincialized government schools and private secondary schools (30 out of 92 schools) were included in the sample. The proportional method of allocation of sample size to each stratum was taken, whereby the sampling fraction was the same in all strata.

The allocation was done as

\[ \frac{N_1}{75} = \frac{N_2}{17} = \frac{30}{92} \]

where \( N_1 = \) Government schools, \( N_2 = \) Private Schools

Thus, \( N_1 = (30 \times 75)/92 = 24 \) \( N_2 = (17 \times 75)/92 = 6 \)

Thus the number of government schools taken was 24 and the number of private schools taken was 6. There were 17 schools from urban areas and 13 schools from rural areas.
At the second stage the student sample was taken. For the purposes of this study Classes VII and IX were chosen. A simple random sampling of ten students each from Classes VII and IX have been taken from each school by the lottery method. The total number of samples in Class VII was 290 and Class IX was 290. The gender division among the students was - boys 155, girls 135 in class VII and boys 163, girls 127 in class IX.

Questionnaires cum personal information sheets for students, teachers and schools were prepared by the investigator for the purpose of data collection. Furthermore two tests of basic concepts from syllabus and mathematics ability were conducted among the students.

1.10 DATA

The data consisted of information on school, students and teachers which were included in the survey area. For data on individuals the investigator approached the head of all schools personally for necessary permission and with the cooperation of the concerned principals, mathematics teachers and the students, the required data was collected. Records were also collected from the following sources:

- Primary data collected from schools under investigation
- Secondary Education Board (SEBA), Guwahati
- Office of the SSA, Bongaigaon district,
- Office of Deputy Commissioner, Bongaigaon
- Office of the Inspector of Schools, Bongaigaon district
- Libraries
1.11 TOOLS

The following tools were used

**Questionnaire cum personal information sheets:** Three types of questionnaires were constructed by the investigator and administered to the teachers, students and school administrative staff.

The first section of the questionnaire sought personal and information relating to facilities available, and was in the form of a checklist. They contained indicators of a wide range of environmental and social characteristics. The second part assessed a broad range of students’ and teachers’ attitudes concerning mathematics, measured with 5 point Likert-type response scales ranging from strongly agree (1) to strongly disagree (5). The reliability co-efficient for the attitude scales were also calculated for different groups which were examined.

Review of relevant literature and advice from experts in mathematics education were taken during the construction of the questionnaire. Before preparing the questionnaire a number of books and journals were consulted in order to decide the type of questions to be included which would be relevant to the study.

They include Mathematics Interest Inventory—L N Dubey, Educational Psychological and Guidance College / Jabalpur and Michigan Study of Adolescent and Adult life Transitions for researchers. The questionnaire was reviewed by experts in mathematics education. The questionnaire was constructed in order to suit the local conditions. The prepared questionnaire was such that it would provide an insight into (a) School Environment (b) Socio-economic factors (c) Teachers’ attitudes towards mathematics (d) Students’ Attitude towards mathematics. There were items eliciting information about students’ and parents’ perceptions concerning mathematics,
anxiety related to mathematics, their interest in it as a subject, its usefulness in real life and in their individual careers, their understanding of class room lectures, their teacher’s gender bias if any with regard to mathematics learning and interest in mathematics etc. The teachers completed questionnaires that assessed their general beliefs about students, aptitude for mathematics, school environment and their classroom practices.

**Interview:** The researcher met with the school authorities, teachers and students to gain further insights into their views regarding mathematics education and the problems faced by them.

**Tests for mathematics concept:** These were teacher-prepared tests. These tests were developed from contents within school syllabus common to both SEBA and CBSE schools. All items in this test were selected on basis of the contents included in the standard mathematics textbooks used by the schools which were surveyed.

Before the final test was administered, a pilot test to test its feasibility was conducted on 100 students selected randomly by lottery method of two schools, one from an urban area and the other from a rural area. Each correct answer was awarded 1 mark while a wrong answer was awarded 0. After the test papers were collected it was divided into two groups on the basis of marks, a high group and a low group with 50% representation in each group. The number of individual correct answers for each group was calculated and also the high-low difference. The maximum acceptable high–low difference was kept at 10%. After evaluation of each question those which fell in the acceptable range of high-low difference was accepted for the final test.

**Tests of mathematics ability:** These were teacher prepared tests designed to emphasize mathematics ability over achievement. This test was designed to place less
emphasis on computational skills and more emphasis on students' visual/spatial skills, pattern recognition, and logical reasoning skills. Instead of questions of the textbook type the question paper had problems and puzzles which would test the understanding of the students in the areas of reasoning, visualization etc. Before the final test was administered, a pilot test to test its feasibility was conducted on 100 students selected randomly by lottery method of two schools, one from an urban area and the other from a rural area. Each correct answer was awarded 1 mark while a wrong answer was awarded 0. After the test papers were collected it was divided into two groups on the basis of marks, a high group and a low group with 50% representation in each group. The number of individual correct answers for each group was calculated and also the high group - low group difference. The maximum acceptable high - low difference was kept at 10%. After evaluation of each question those which fell in the acceptable range of high-low difference was accepted for the final test.

**Test of achievement:** The criteria for measuring the mathematics achievement in examination was taken as the mathematics marks which a student received at the end of the academic year. This mark was expressed as a percentage with weight age given to unit tests, half yearly examination and annual examination. The marks were collected from the school records of the schools visited.

**1.12 ADMINISTRATION OF THE QUESTIONNAIRES AND TESTS**

The questionnaires were administered to the students in the classroom and they were given 30 minutes to complete it. They were told briefly about the nature of the study and about the task they were supposed to do. It was made clear to them that the exercise was in no way related to the school examination. There was no right or wrong answers. They were required to answer the questions honestly so as to provide an accurate picture of the study. It was explained to them that confidentiality would
be kept. The tests were taken on a date fixed by the school authorities in presence of the investigator.

1.13 CODING AND STATISTICAL TECHNIQUES

The data on each chapter was coded where necessary before it was processed. The data was analyzed with the help of SPSS using the appropriate statistical test in each case. The data obtained were subject to appropriate statistical techniques and interpreted accordingly. A variety of statistical techniques were applied to analyze the data. Means and standard deviations of the different scores obtained by the students were calculated for comparison and to test variability. t-test was used to examine the various null hypotheses formulated on the basis of objectives. Different cross tabulations were constructed to show the joint distribution of two or more variables. Regression Analysis was used to investigate the relationship among the variables. ANOVA (Analysis of Variance) was applied to test the mean of dependent variables across different groups. Post Hoc tests were performed to determine the homogenous groups. Reliability tests were used during construction of scales.