CHAPTER 2

REVIEW OF RELATED RESEARCH WORK

2.1 INTRODUCTION

This chapter presents a review of the literature consulted for the study. The number of research studies conducted in mathematics education over the past three decades has increased dramatically (Kilpatrick, 1992). The resulting research base spans a broad range of content, grade levels and research methodologies. The results from these studies, together with relevant findings from research in other domains, such as cognitive psychology, are used to identify the successful teaching strategies and practices.

A good deal of research had gone into methods/strategies of teaching mathematics and teacher behaviour. Other areas of research include effective learning that is, understanding mathematics concept as opposed to rote learning; comparative studies in mathematics education across countries, states and districts; diagnostic and other tests in mathematics; curriculum and textbooks; psychological factors affecting achievement in mathematics which are intelligence, level of thinking, sex, concept attainment in mathematics, motivation and reasoning ability, general mental ability, self-concept, attitude towards mathematics, mathematical creativity and so on. School and socio-economic factors which influence student outcomes on mathematics education have also been investigated in research studies.

A review of literature relevant to this study has been given below. Most research works are seen to investigate a set of interrelated factors concerning
mathematics education. This provides a basis of support for justifying the choice of topic and the significance of the study in the present study. Problems in mathematics education are universal. The review thus covers literature that provides an insight into the research studies done in other parts of the world, in our own country and specifically those researches related to mathematics education in the North-eastern part of India.

The studies have been largely grouped under the headings of Attainment of concepts in mathematics, Socio-economic factors affecting mathematics achievement, School factors affecting mathematics achievement, Attitudes towards mathematics, Gender and mathematics, Mathematics Textbooks and Teaching methods and development of tests in mathematics. The pattern of grouping could not be followed in case of works done in North East India because of lack of adequate studies.

2.2 RELATED RESEARCH WORK IN OTHER COUNTRIES

1. Attainment of concepts in mathematics

Biggs and Moore (1993) claimed that learning depends on the way the learners interact with situations, beliefs, attitudes, and previous experiences. For effective learning, knowledge must be actively constructed by learners as opposed to traditional memorization. Hiebert and Carpenter (1992) describe the construction of larger and more organized networks of knowledge as learning with understanding. Radu M, (2002) in the paper ‘Basic Skills Versus conceptual understanding in Mathematics Education: The case of the fraction division’ supports the view that understanding and procedural skill should be treated as two separate, irreducible, complementary components of learning.
2. **Socio-economic factors affecting mathematics achievement**

Coleman’s (1966) study on Equality of Educational Opportunity, is considered a landmark in mathematics education research where socioeconomic status has been seen as a strong predictor of student achievement. The results of a national survey of mathematics achievement at the end of primary school in Vietnam found that lower achievement levels were persistently aligned with low socio-economic groups. Griffin P (2007). Muhammed Maqsud, Department of Foundations of Education, University of Bophuthatswana and Chaudhury M Khalique, Department of Mathematics, University of Bophuthatswana (1991) in their paper ‘Relationships of some socio-personal factors to mathematics achievement of secondary school and university students in Bophuthatswana’ made exploratory efforts to identify possible non-pedagogical factors responsible for poor matriculation mathematics results in Bophuthatswana. Studies were carried out to examine relationships of socio-personal variables to mathematics achievement. They looked into the impact of socioeconomic background, school alienation, sex, self-concept and attitude toward mathematics on mathematics performances of secondary school pupils. The data of these studies invited the attention of mathematics educators to the importance of attitude toward mathematics, mathematics anxiety and socio-personal variables to mathematics achievement.

3. **School factors affecting mathematics achievement**

Zhang, D. (1992) in Developments in school mathematics education around the world Proceedings of the third UCSMP (University of Chicago School Mathematics Project) International Conference on Mathematics Education, uses a considerable amount of data to describe the current situation and problems emerging in mathematics education in China. Five key problems are identified and discussed in
the paper: severe entrance examinations; mathematics as a rigorous, logical, and deductive system; high intensity school training; traditional didactical principles, such as ‘practice makes perfect’ and, effective teaching of routine mathematical problem solving. Marlaine Lockheed, Barbara Burns(1990) in their paper ‘School effects on achievement in Secondary mathematics in Brazil’ identified the factors of school achievement. Important factors were class size where it was found that achievement was higher in larger classes, the number of hours math was taught, the more the better, the school's organizational complexity, average family social class background, and the number of hours students spent working. Alan Brimer, George F. Madaus, Bernard Chapman, Thomas Kellaghan, Robert Wood (1980) in their paper ‘Sources of Difference in School Achievement’ conducted an investigation into the correlates of achievement differences between the schools in and around London. School effects, family influences, nature of the population were all contributors to achievement levels.

4. **Attitudes towards mathematics**

Marlene Schommer-Aikins, Orpha K. Duell, Rosetta Hutter (2005), Wichita State University, in their paper Epistemological Beliefs, Mathematical Problem-Solving Beliefs, and Academic Performance of middle School Students examined the structure of middle school students' general epistemological beliefs and domain-specific mathematical problem-solving beliefs by asking whether the 2 belief systems are related and whether they predict students' academic performance. Over 1,200 seventh- and eighth-grade students completed an Epistemological Questionnaire, the Indiana Mathematical Belief Scale, and the Fennema-Sherman Usefulness Scale. Based on regression analyses, beliefs in quick/fixed learning (i.e., that learning is fast and instinctual) and studying aimlessly (i.e., studying without strategy) were
significantly related to beliefs about effortful math, useful math, understand math concepts, and math confidence. Furthermore, path analysis suggested that both general and domain-specific epistemological beliefs predicted academic performance as measured by solving mathematic problems and overall grade point average. Bolaji (2005) in a study of the influence of students’ attitude towards mathematics found that the teachers’ method of mathematics teaching and his personality greatly accounted for the students’ positive attitude towards mathematics. Olatoye (2001) found that students attitude towards science have significant direct effect on student achievement in the subject. Perry B et al (2002) studied the association of beliefs towards mathematics and the teaching-learning scenario of the subject. In this paper Beliefs of primary teachers about mathematics and its teaching and learning: views from Singapore, Philippines, Mainland China, Hong Kong, Taiwan and Australia which spanned the mathematics education scenario across different nations, the authors examined 1254 primary school teachers in terms of their beliefs about mathematics and its teaching and learning in terms of their different cultural backgrounds across Singapore, Philippines, Mainland China, Hong Kong, Taiwan and Australia. The authors concluded that teacher beliefs are rooted in, and constrained by the culture of the society in which the teachers live and work. This in turn could explain a part of the cross country disparity in student outcome in mathematics. The data are informative and useful in the analysis of the relationship of teachers’ beliefs with students’ achievement. Cao, Zh. and Bishop, A. (2001) Students’ attributions of success and failure in mathematics: findings in China and Australia. The authors investigate Chinese students’ attributions of success and failure in mathematics in mainland China in order to compare that with students in Australia. The study shows that Chinese students regard environment and effort as important factors to success in
mathematics, while students in Australia consider task and environment as essential factors. Gender differences in mathematics learning are also analysed in the paper. Xin Ma, University of North Brunswick and Nand Kishore (1997), University of North Columbia in their dissertation conducted a meta analysis on correlation of mathematics to student attitude towards the subject. In their paper ‘Assessing the relationship between Attitude towards mathematics and Achievement in mathematics--A Meta Analysis’, they found that there is a strong relationship between Attitude towards mathematics and Achievement in mathematics. They documented the facts that teachers and mathematics educators generally believe that children learn more effectively when they are more interested in what they learn and they will achieve better marks in mathematics if they like mathematics. However there are other factors like gender, grade and ethnicity which have important effects on the above relationship. Patricia T. Eaton, Stranmillis University College, Belfast, Northern Ireland, Sonia Kidd, University of Ulster, Coleraine, Northern Ireland in their paper ‘Self-conceptualised perceptions of attitude and ability among student teachers’ reported the preliminary results of a survey examining students’ attitudes to mathematics at the beginning of their initial teacher training programmes. It compares the attitudes of those students in Northern Ireland taking a postgraduate course with those undertaking an undergraduate degree and particularly focuses on their views of their own competence and confidence in mathematics, and their perceptions of how those views have been informed. It also analyses the emotional response of the students to mathematics. Neale 1969 and Hungerman 1967 are among researches who have found positive attitudes towards mathematics are conducive to success in learning mathematics. Hazma Mukhtar (1952) in a study of 12 and 14 year old boys
demonstrated the relation of motivational and attitudinal factors to the problems of learning mathematics

5. Gender and mathematics

Olof Bjorg Steinthorsdóttir, Bharath Sriraman (2003), ‘Iceland and rural/urban girls- PISA, examined from an emancipatory viewpoint’ studied about the status of research about gender and mathematics. They raised the question whether the gender gap has closed for certain class of society and also the areas where the gap prevailed. Interestingly in Iceland, there were significant gender differences in mathematics achievement in favor of girls. Dividing Iceland into two regions, Reykjavik metropolitan area and rural area, significant gender differences in achievement was only found in rural Iceland. Despite this unusual gender differences in favor of girls found in Iceland, Icelandic girls are not different from other girls in the study when it comes to math anxiety, and mathematical confidence, there the gender differences are in favor of boys. Turner, R. (1994) in his paper ‘Sex differences in mathematical performance among Chinese middle school students’ investigated sex differences of first year secondary school students in mathematical performance in Wuhan, a central city of China. The study focuses on three mathematical areas: logic, space and numeracy. Hanson Katherine (1992) ‘Teaching Mathematics Effectively and Equitably to females’ examined how girls are treated in mathematics education in order to identify ways to increase female interest and achievement in mathematics. Her article explored girls’ learning styles, attitudes, and behaviors in math classes that also shows the importance of analyzing the curriculum and attitudes of teachers when attempting to understand girls' relation to math. Stipek Deborah, Gralinski, Heidi,(1991) "Gender Differences in Children's Achievement-Related Beliefs and Emotional Responses to Success and Failure in
The study indicates that girls have lower expectations for themselves in math than boys, and that girls believe they do not have mathematical ability. When girls do poorly in math, they attribute their poor performance to their inability to do math. This study explores the beliefs of third-graders and junior high school students (male and female). It shows that girls' beliefs begin early in their education and persist into junior high school (and probably beyond). Therefore, starting at the elementary school level, teachers need to encourage girls to have higher expectations for themselves in math, and offer girls alternative, positive explanations of their math performance.

6. Mathematics Textbooks

Jamison D T et al (1981) experimental study of the effect of textbook availability on mathematics achievement in Nicaragua. Comparisons were made among two classes. One in which textbooks were available and another where textbooks are relatively rare. For the second group a radio-based instructional program that used student worksheets but no other textual material was available for teaching purposes. It was found that both the textbook and the radio treatments had significant positive effects on achievement. Availability of textbooks increased student scores. Jukka Törnroos (2005) worked on an item-based analysis of textbook contents. The implication was that even a quite simple analysis of textbooks can produce valuable information when looking for explanations for student achievement in mathematics. American Association for the Advancement of Science (1999) in their project 2061 conducted a rigorous analysis of 12 middle school mathematics textbooks and rated them accordingly. This standard based textbook evaluation was conducted by independent analysis teams who had extensive knowledge of...
mathematics content and of research on teaching and learning. The focus was on how likely the textbooks would help students achieve six key learning goals.

7. **Teaching methods and development of tests in mathematics**

Ketterin Geller (2009) in his paper “Diagnostic Assessments in Mathematics to Support Instructional Decision Making” has worked on current approaches to diagnosis in mathematics and highlighted the strengths and limitations of each approach for making instructional decisions. Cognitive diagnostic assessments is pointed out as an emerging solution for providing detailed and precise information about students’ thinking that is needed to provide appropriate educational opportunities for students. Edwards P (1997) worked on the effects of mathematics diagnostic tests to test student ability. He concluded that careful monitoring of this test-and-support combination has to be done so that its real effectiveness is maximized.

2.3 **RELATED RESEARCH WORK IN OTHER PARTS OF INDIA**

1. **Attainment of concepts in mathematics**:

Lalitha Bai T K (1992) in her PhD thesis ‘A comparative study of the cognitive factor structures of high, average and low achievers in secondary school mathematics’, found that high achievers scored highly on abstract reasoning, numerical spatial faculty apart from numerical ability. Mainka G.K. (1983) in her Ph.D thesis, ‘Acquisition of Concept in Mathematics of Pupils at Primary School Level, and its relation to Some Personal and Environmental Variables of the Pupils’ studied the understanding and the acquisition of mathematical concepts of pupils. She worked towards determining development level of mathematical concepts in each pupil which might facilitate the adaptation of material and instructional procedures.
according to the individual needs and the abilities of the pupils, the development of mathematical concepts according to grades and the sex wise level of acquisition of mathematical concepts at each grade level. The study revealed that scores of pupils in each concept showed consistent rise with increasing education level, revealing the existence of grade wise differences in the acquisition of set, number and space concept at primary school level. The majority of pupils who were promoted to the next grade did not show acquisition of concepts of the lower grade. A pupil did not acquire any concept to its fullest from in one grade but the growth of mathematical concepts took place at all levels with different degrees of individual differences among the acquisition of mathematical concepts at primary school level. With increasing age, a pupil made up in one or other concepts in mathematics, but his success in one concept was limited by the success in other concepts. Concepts in higher mathematical hierarchy could not be developed unless the lower concepts were acquired. Consideration is given to the acquisition of mathematical concepts by J. N. Kapur (1976) in his paper ‘Culture, excitement and relevance of mathematics’. The relevance of modern mathematics to the development of students' abilities has been studied by Bansal (1979) who compared abilities like critical thinking and divergent thinking of students taught modem mathematics and those taught traditional mathematics. Of course he has very objectively exercised control over the two groups in respect of the variables that would affect the criterion variables. The results were in favour of modem mathematics. Clarifying the role and importance of fractions Naik, S. and Subramaniam, K. (2008) worked towards facilitating understanding of fractions by students and learning approaches that lead from initial comprehension of fractions to their use in mathematics curriculum. Sarala S (1990) in her doctoral work entitled “Conceptual errors of secondary school pupils in learning select errors
in modern mathematics” found that numbers of errors were large and were influenced by sex, locality of the school, intelligence, study habits, and socio-economic status.

2. Socio-economic factors affecting mathematics achievement

Prabha R N (1992) in her PhD thesis ‘An investigation into the effectiveness of programmed mathematics in relation to some socio-academic variables’, found that programmed learning is far superior to conventional learning and the following factors---mother’s education, father’s education, profession, income and caste affect the learning of mathematics. A number of researchers have confirmed that intelligence and socioeconomic background are major contributors to mathematics achievement (Singh, 1986; Nilima Kumari, 1984; Rajput, 1984; Gakhar, 1981; Jabbal, 1981; Kabu, 1980; Nalinidevi, 1976). Selta S (1992) studied ‘The Socio-psychological and educational factors of differential learning rate in modern mathematics at senior secondary stage’ obtained the finding that rapid, average and slow learners differ significantly in their intellectual and socio-economic status levels. Additionally socio-economic status levels, intelligence, personality and adjustment cluster together with achievement in mathematics.

3. School factors affecting mathematics achievement

Gadgil (1979) studied the causes of failures at the SSC examination (standard X) and found that school factors like inadequate coverage of the syllabus, inadequate attention to difficult topics and a personal factor, namely, lack of motivation had been responsible for failures. In a study Shukla et al (1994) investigated the relationship of schools factors with language and mathematics achievement of primary school students. They found that facilities for teacher, adequate classroom facilities, teaching experience of headmaster, time devoted to teaching arithmetic, educational facilities
available in the school and functional parent-teacher association had a salutary effect on the student's achievement.

4. **Attitudes towards mathematics**

Saha (2007) conducted a study ‘Gender, Attitude to Mathematics, Cognitive style and Achievement in Mathematics’. It was found that all the three contributes to statistically significant difference in achievement in mathematics. Harihnan D (1992) in his studies on ‘Attitudes of high school students towards homework and achievement in mathematics’ developed measures to measure the attitude of high school students towards homework in mathematics and academic achievement. He concluded that girls, urban and private school students have a more positive attitude towards homework and students with this positive attitude have better academic achievements. Rosaly A (1992) had studied the relationship between attitude of students towards mathematics and mathematics achievement and found that the two were highly correlated and urban boys and girls showed a more positive attitude towards mathematics than rural boys and girls. Reasoning power, space visualizations, attitude towards mathematics were found significantly related to mathematics achievement (Patel, 1984). Singh (1986) found attitudes to be related to mathematics achievement.

5. **Gender and mathematics**

Ravindra G, Basavvya D, Basti B C, (2004) studied in the Indian context the possible areas of gender differences with respect to the following abilities arithmetical ability, abstract thanking, logical thinking, symbolizing concepts, mathematical modeling, application skills and attitudes. Their main findings were that boys were good in abstract thinking and symbolizing concepts whereas girls were good in logical
thinking and mathematical modeling. Both males and females have the same perception of mathematics and the same level of liking for mathematics. Males stated that social factors do not favour girls for going in for higher studies in mathematics leading to scarcity in top level women mathematicians while females stated that the vocational interest of women were different as the cause. A study by Katiyar (1979) reported that boys and girls did not differ in mathematics achievement.


Krishna Kumari et al( 1980) in ‘An Investigation into the Use of Mathematics Textbook (Class II) as a Tool of Teaching’, SCERT, Haryana, conducted a survey to find out how far the teachers were conversant with the content given in the textbook of mathematics (class II) and taught this content to their students. Verification was also sought as to whether the teachers taught mathematics in class II according to the approach given in the textbook. The main findings were: Thirty-six per cent of the teachers did not at all look into the methodology provided in the textbook; rather they continued with the old pattern of teaching methods and did not even study the change in the syllabus. 49% of the teachers made partial use of the methodology suggested in the textbook and 15% of the teachers studied the textbook thoroughly and tried their best to assimilate the new concepts and methods. Gopalakrishna (1977) critically analyzed the syllabus and textbooks in upper primary classes in Kerala. Another study in Kerala by Lalithamma (1981) attempted to develop criteria for writing and evaluating textbooks in mathematics prescribed for secondary schools. Walavalkar (1971) studied, critically, the mathematics textbooks in primary schools of Maharashtra and found that the text material had relevance to daily life and was suited to the capacity of the pupils In a project, SCERT, Andhra Pradesh (1981), evaluated the textbooks prescribed for classes VI and VII and also analysed the views of
parents, teachers and students about these textbooks. By and large, parents, teachers and students found continuity in the development of content in mathematics textbooks. Parents felt unable to help their wards in solving problems included in mathematics textbooks. With a view to having a picture of general mistakes committed by students in answering questions, Sali (1978) analysed answer-books of mathematics and English of the secondary school leaving examination and found that transposition, forming equations, solving equations with coefficients and fractions, etc., were the areas of common mistakes in algebra; the common errors in geometry were writing figures, using theorems on perpendicular bisector of chord, applying Pythagoras theorem and properties of isosceles triangles.

7. **Teaching methods and development of tests in mathematics**

Dandapani C (1992) in his Ph.D thesis ‘Dimensions of effective teaching of mathematics’ has developed a function depending linearly on eleven variables representing problem solving, skill, review, reinforcement, assignment, organization of subject matter, warmth of teacher, planning, preparation, concept teaching and valuation to distinguish between effective and non-effective mathematics teachers. The results showed that effective and non-effective teachers differ in all eleven variables. Donnipad Manjunath (2009) in his paper ‘A Study Of The Use Of Mathematics Laboratory For Teaching Mathematics By Developing A Strategy And Testing Its Effectiveness’ has revealed that the strategy evolved for teaching mathematics in a mathematics laboratory was effective than didactic traditional methods.

Researchers like Das and Barua (1968) and Rastogi (1983)) have constructed diagnostic tests and suggested remedial measures for specific weaknesses in arithmetic. Tests in mathematical creativity have also been developed. Mohammad
Miyan (1982) constructed a test of mathematical creativity for students of class IX which included abilities to analyse, determine patterns, see likenesses and differences and application. Parasnis (1985) standardized a test (in Marathi) for measuring creativity of class X students. According to the author, creativity in mathematics is measurable in terms of five factors, namely, visualization, reorganization, judgement, number fluency, and divergent production.

2.4 RELATED RESEARCH WORK IN NORTH-EAST INDIA

Choudhury R (1999) had worked on the topic ‘Some problems in learning mathematics at secondary stage with relation to high schools in greater Guwahati’. The findings in her thesis pointed out that mathematical literacy is indispensable for a person to be regarded as educated, the factors arithmetic ability, interest in mathematics, IQ and sex of pupils are significantly correlated with achievement in mathematics. Sharma A K (1978) in his PhD thesis ‘A critical study of the achievement in mathematics by pupils of secondary schools with particular reference to the state of Assam’ gave the findings that class–room teaching of mathematics is done by the lecture and blackboard methods extending up to higher classes, number of teachers with specific training in mathematics is significantly low, methodical teaching of mathematics is not prevalent, textbooks which are not graded properly they fail to attract the students thereby being one of the causes of dislike towards mathematics. All these factors are responsible for mathematics achievement of the student. Das R.C. and Barua A.P. (1968) in their work, “Effect of Remedial Teaching in Arithmetic, A Study with Grade IV Pupils, SIE, Assam”, determined the effect of remedial teaching in arithmetic in grade IV. The major educational implication of the study is that remedial teaching, even for a small period compared to the total duration of working days in the year, can effect significant improvement in
achievement in arithmetic. Rastogi S. (1983) in his Ph.D thesis ‘Diagnosis of Weaknesses in Arithmetic as Related to the Basic Arithmetic Skills and Their Remedial Measures’ studied the existence of a probable relationship between achievement in mathematics and command over basic arithmetic skills, between command over basic arithmetic skills and attitude towards mathematics, and a relationship between achievement in mathematics and attitude towards mathematics. The design of the study was essentially experimental in nature. A test of basic skills in arithmetic and an attitude scale to measure attitude towards mathematics were constructed and tested on nine different schools, one from each district of Arunachal Pradesh. The major findings were that one of the important causes of backwardness in mathematics was the poor command over basic arithmetic skills, Attitudes were closely linked with achievement. There were no significant sex differences in either attitude towards mathematics or achievement in mathematics. Mishra D D (1996) in his studies on “Testing the effectiveness of new instructional methods in attaining better achievement in mathematics in the secondary schools of Arunachal Pradesh” presented his findings that step by step sequential approach to mathematics is needed in the classrooms, mathematics teachers of Arunachal Pradesh need to labour hard to teach mathematics and teachers’ training in mathematics is imperative for better learning in mathematics. The acquisition of basic concepts by students is also dependent on the teaching method. Dev (1979) surveyed the schools of Nagaland with a view to finding out teaching methods popular with mathematics teachers. He discovered that teachers were more interested in the lecture method and had a negative attitude towards reflective type questioning. This accounted for the low standard of pupils’ achievement in mathematics.
Thus it is seen that the various factors which are a part of mathematics education have been well documented. These form the basis for the present research in mathematics education. This research proceeds to study some of the factors which affect mathematics education in undivided Bongaigaon district. The investigation hopes to gain a valuable insight into these factors.