CHAPTER 1

INTRODUCTION
Chapter I

Introduction

1.1 Importance of school education

Education is considered as an important index to measure societal development. This is the reason that education is taken as priority sector for development by all nations. Every nation develops the system of education to express and promote its unique socio-cultural identity and also to meet the challenges of the times. The role of educational development in mitigating several problems of the human society has been realized at all levels. School education is an important segment of the whole educational structure and it is considered as a powerful instrument to develop students' behaviour and hence the society.

There have been many studies related to education issues. While discussing the education and cast in India, Chauhan (2008) pointed that low school enrolment and completion rates, high dropout and failure rates are reported to be the characteristics amongst the weaker section of the society. Shortcomings related to teaching staff have also been identified as the major problems in effective teaching learning (Desai, 1999). Despite of government's effort to provide uniform level of education for its citizen, non-uniform academic experiences of students belonging to different schools are evident in India. Such differences are not only between urban and rural schools, but also amongst the schools having similar location. The existence of varying academic experiences viz., rich and poor, rural and urban in India are also reported (Banaji S. 2005). The
micro level investigations are also conducted to assist effective teaching learning in India. The importance of curriculum reform through changes in evaluation process in effective teaching-learning process is evidenced by such study (Agrawal, M. 2004).

The importance of quality education in nation building has also been realized by several nations including developed countries. Several developed nations including USA realized that their role as leaders in the world’s economy and their capacity to produce wealth and quality jobs depend directly on the ability of education system to produce students who can compete in mathematics and science dominated industries of the future. Thus, improving mathematics and science education has been the priority of the policymaking agenda (Anon, 2005).

1.2 The importance of mathematics education

Mathematics is a creation of human mind and its development is a result of human needs. The present technological and information-oriented society requires all its citizens to be mathematically competent. The knowledge of mathematics is immensely required in almost all spheres of life. There are hardly any activities dealt by human being where tools of mathematics are not required. Ranging from estimation of grocers bill to planning, estimating and constructing one’s residence building-appropriate utilization of mathematical tools makes the job easier, efficient and perfect. Thus it is appropriately said that mathematics makes a man perfect.
The main goal of mathematics education in schools is the mathematisation of the child’s thinking. Mathematics is a powerful learning tool and it is intertwined with all forms of human behaviour and that there is a mathematical way of being in life. As students identify relationship between mathematical concepts and everyday situations and make connections between mathematics and other subjects, they gain the ability to use mathematics to extend and apply their knowledge in other curriculum areas, such as science, music and language. The applications of mathematics to science are clear and well known but mathematics is important in other areas as well. Techniques of data analysis are encumbered in the social sciences and the humanities, as well as business and finance.

Students’ performance in mathematics subject has been investigated through bilateral surveys in two European countries (Robertson, 2000). Requirements of changes in national policies suiting their respective culture are emphasized in order to minimize the differences in performances amongst the countries. The interactions of a large number of socio-economic as well as academic environmental factors influence the student’s performance in school. Poor school performance not only results in the child having a low self-esteem, but also causes significant stress to the parents (Karande and Kulkarni, 2005). Identification of causes of poor performance and execution of corrective action plan so that the students can perform up to their full potential is required. A psychological aspect of female students with special reference to mathematics subject has been matter of investigation in past reporting that high mathematics anxiety is associated with low mathematics achievement (Yee, 1987). Another
interesting finding of such study was that for the most capable students, test anxiety seems to act as a facilitator in their mathematics performance. The role of teachers has also been pointed out by the study stating that students' scores on the perception of their mathematics teachers have the strongest correlation with their mathematics anxiety scores. Teacher's quality supported by training and experiences has influencing role in effective teaching learning. Teaching experience plays important role in success of education (Tui, 1987).

From the above discussion it is evident that mathematics education has not only the priority area of policy makers, but adequate attention has also been drawn to many researchers. The present investigation is concerning the secondary school level mathematics education prevailing in a region of India. A brief discussion on the prevailing education system is presented as the issue is linked with the system of “school education”.

1.3 School education system in India with special reference to mathematics

Education

India is a developing country with vast chunk of human resources. The Indian Government has realized the importance of educational development and therefore, provides required importance in education. A multi-level structured education system prevails in India. The levels of education prevailing in India are presented in Table 1.1 and major educational governing bodies are presented in Table 1.2. The present investigation is pertaining to secondary school education and schools considered in the present study are under the state government board.
Table-1.1 Levels of education system in India

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Level</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Pre- Primary</td>
<td>It consists of children of 3-5 years of age studying in nursery, lower kindergarten and upper kindergarten.</td>
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<tr>
<td>2</td>
<td>Primary</td>
<td>It includes the age group of children of 6-11 years studying in classes from 1st to 5th</td>
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<tr>
<td>3</td>
<td>Middle</td>
<td>It consists of children studying in classes from 6th to 8th</td>
</tr>
<tr>
<td>4</td>
<td>Secondary</td>
<td>It includes students studying in classes 9th and 10th</td>
</tr>
<tr>
<td>5</td>
<td>Higher Secondary</td>
<td>Includes students studying in 11th and 12th classes</td>
</tr>
<tr>
<td>6</td>
<td>Undergraduate</td>
<td>Here, a student goes through higher education, which is completed in college. The duration of undergraduate course may vary according to the subject pursued by the student.</td>
</tr>
<tr>
<td>7</td>
<td>Postgraduate</td>
<td>After completing graduation a student may opt for post graduation</td>
</tr>
</tbody>
</table>

The Indian Government has initiated several plans such as 'Sarva Siksha Abhiyan (SSA), District Primary Education Program (DPEP), Operation Blackboard, Mid Day Meal etc, mainly to improve the level of primary education and to reduce illiteracy. Government also makes plan and policy to address issues related to upper levels of education including secondary education. The national policy of education (NPE, 1986) and program of action (PA, 1992) state that the curriculum of secondary education should expose the students to differentiated roles of science, the humanities, and social science. The roles of teacher and infrastructure facility for effective education are also realized and mentioned in the policy documents. Studies by Fuller (1987) and Fuller and Clarke (1994) in
low-income countries viewed that by improving school qualities (i.e. infrastructure, class size etc.) and teacher qualities (i.e. teachers’ qualifications, trainings, availability of instructional materials such as textbooks etc.), pupil’s performance can be increased.

**Table-1.2 Education Governing bodies in India**

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Level</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>The Central Board of Secondary Education (CBSE)</td>
<td>This is the official governing body of education system in India. It conducts examination and looks after the functioning of schools accredited to central education system from primary to higher secondary level.</td>
</tr>
<tr>
<td>2</td>
<td>The State Government Boards</td>
<td>Apart from CBSE and CISCE each state in India has its own State Board of education, which looks after the educational issues up to higher secondary level. Some states have separate board for secondary and higher secondary levels.</td>
</tr>
<tr>
<td>3</td>
<td>The Council of Indian School Certificate Examination (CISCE)</td>
<td>It is a board for Anglo Indian Studies in India. It conducts two examinations 'Indian Certificate of Secondary Education' and 'Indian School Certificate'. Indian Certificate of secondary education is a k-10 examination for those Indian students who have just completed class 10th and Indian school certificate is a k-12 public examination conducted for those studying in class 12th.</td>
</tr>
<tr>
<td>4</td>
<td>The National Open School</td>
<td>It is also known as National Institute of Open Schooling. It was established by the Government of India in 1989. It is for those students who cannot attend formal schools.</td>
</tr>
<tr>
<td>5</td>
<td>The International School</td>
<td>It controls the schools, which are accredited to curriculum of international standard.</td>
</tr>
</tbody>
</table>
Indian Education Commission, 1964-66 had recommended that mathematics should be taught on a compulsory basis to all pupils as a part of general education during the first 10 years of schooling. According to the report of 9th Five year plan, on education (1997-2000), science and mathematics will be linked to the immediate environment of the child. Special measures will be taken to promote teaching of mathematics and science at the secondary stage by devising appropriate books (Agarwal, J. C., 2004).

Progress in education scenario is remarkable in India probably due to Government policy and programmes. However, some areas still require attention. The quality of secondary education is such an area, which needs special intervention and attention. There are several subjects taught at school *e.g.* language, literature, social studies, science and mathematics. Subject wise performance variations are generally reported. Amongst the subjects taught in schools, mathematics is considered as one of the toughest subjects with poor performances of students. The lower level of pass percentage has been a matter of serious concern. Thus, science subject in general and mathematics in particular has been a problem area for majority of secondary schools in India. There exist regional variations of education vis-à-vis societal development amongst the states of India. The state of Assam is one of the economically backward regions of India located in north-eastern region. The state requires special attention and investigation.
1.4 The education scenario in Assam

Secondary education in Assam is managed by one regional state government board named SEBA (Secondary Board of Education, Assam) besides central boards. SEBA conducts 10th standard test for the students of schools affiliated to it. The secondary education of Assam can be considered as backbone of Assam education due to the volume of students involved to it and importance of level of learning.

It is often reported that academic climate of Assam has become of matter of great concern. Results of Board of Secondary Education of Assam indicate that a large number of students always fail in HSLC examinations. Again failure in mathematics in HSLC examinations plays a very important role in lowering the pass percentage in HSLCE (Quoted in the thesis by R. Choudhury, 1999; pp.11-14& 28). Critics pointed out several discouraging factors such as (a) high percentage of failure in 10th standard examination, (b) acute unemployment, (c) growing indiscipline, (d) colonial pattern of course curriculum and administration, (e) lack of mutual trust between teacher and students, (f) unplanned growth of educational institutes, (g) inadequate financial resources, (h) lack of proper mechanism for teacher employment, (i) lack of proper monitoring mechanism etc are the representation of educational scenario of Assam (The Assam Tribune, Guwahati, dated 25.12.1993; Quoted in the thesis by N. Das, 1994; pp. 271). The validity of such views cannot be totally disagreed from the prevailing scenario. The state has witnessed several socio-political turmoil in recent past centering on
the younger population. An investigation-based solution is imperative to address the problems related to the educational scenario of Assam.

Provision for appropriate employment, through improvement in education system, could distract the younger generation from on-going disturbing activities. The entire north-eastern region has agricultural dominancy with lower economical and industrial activities. The oil and tea are two major industries absorbing manpower based on certain level of academic skill. Similarly, appointments in other local and national sectors also demand competitive academic skill. It is true that secondary school curriculum is prepared to impart necessary academic training for higher education as well as for development of such academic skill. The course curriculum is only one factor responsible for imparting quality education. There are other academic environment factors governing the success of secondary education to achieve its goal. If socio-political disturbances involving youth of this region are considered as a yardstick of educational performance, then analysis of the existing education system prevailing in this region is imperative.

It is being often told that there exists phobia towards mathematics learning amongst the student communities of secondary schools. Mathematical skill is essential not only for the higher education aspiring section, but also success in several competitive examinations for jobs depends upon the basic understanding in mathematics. Thus, perfect teaching-learning in secondary schools in all subjects in general and mathematics subject in particular has been a serious issue needing investigation.
1.5 The process of mathematics teaching-learning

Appropriate identification of “what should be taught”, “what should be learned” and “what should be assessed” in a class based on “expected mathematical knowledge, skills and conceptual understandings” is very essential. The expectations identified for each class describe the knowledge and skills that students are expected to develop and to demonstrate in their class work, on tests and in various other activities on which their achievement is assessed. Teacher’s role is defined here. Teachers are responsible for developing a range of instructional strategies based on sound learning theory. They need to address different student needs and bring enthusiasm and a variety of teaching approaches to the classroom. Teachers should make every reasonable attempt to help all students develop their interests and abilities to the fullest extent.

Studies show that students perform better in school if their parents are involved in their education. Cain-Caston, Mariene, (1993) studied “parent and student attitude” towards mathematics and observed that parents’ and students’ attitudes towards mathematics was significantly related. Parents therefore have an important role to play in supporting their child’s learning. By reading the curriculum, parents can see what their children are learning and why they are learning it. This awareness will enable parents to communicate with teachers, to offer useful information, and to ask relevant questions about their child’s progress. Knowledge of the expectations in various subjects will also help them to interpret their child’s report card and work with the teacher to improve the
student's learning. Unfortunately, in majority of the cases, parents' involvement is not encouraging under the existing social scenario.

Students also have responsibilities, which increase as they advance through elementary and secondary school. Attention and a willingness to work hard will enable students to develop their skills, knowledge, creativity and personal qualities.

Appropriate course curriculum, well adopted teaching methods, trained teachers; conscious parents and motivated students are the essential elements to impart much needed mathematical knowledge and hence produce mathematically competent citizen.

1.6 The philosophy of effective learning of mathematics

A quality that helps children to become themselves able for the society is called knowledge and receiving new inputs of knowledge is called learning. If learning in Mathematics directly affects and improves the qualities like thinking, reasoning, sincerity, clarity and firmness and develops the power of concentration, then this learning is called effective learning.

It is usually taken for granted that high achievement in Mathematics is associated with high interest in the subject. Studies in various countries have already shown that there is a positive correlation between interest and achievement in Mathematics. A study by Ulrich Schiefele and Mihaly Csikszentmihalyi (1995) indicated that quality of experience in mathematics is related to interest in mathematics. Reynolds & Walberg (1992) studied about the
relation between pupils' interest and their achievement in mathematics and observed significant relation between interest and achievement. In another study positive relationship between interest and achievement is observed by Lalithama (1975). Choudhury. R (1999) also studied about the relationship between interest in mathematics and achievement in mathematics and concluded that there exist positive relationship between interest and achievement. Interest is the key factor in achieving success in any affairs of life. A child can attain excellence in education if he/she uses every minute of his/her school life to build himself/herself intellectually, physically, morally and spiritually. Subject matter in Mathematics can be learned as a result of a great variety of teaching methods and learning experiences. But achievement of critical thinking is not likely to be attained by simple methods. Higher categories of the cognitive domain require for more sophisticated types of learning experiences than the simple communication of a correct version of an idea or event to the student. Much more motivation is required, much more activity and participation on the part of the learner are necessary, and more opportunities must be available to help the individual gain insight into the processes he uses or misuses. The mental and cognitive ability are related to students' learning ability as well as learning processes in learning mathematics (Kundu and Tulu, 1989). Pal A. (1989) viewed that achievement in mathematics depends upon four variables namely self-concept, anxiety, attitude and academic motivation.
1.7 The role of mathematics teacher

In the classroom, it is possible for teachers to adopt rather different approaches. They may place emphasis on drill and root learning and use a "text book" approach. Teachers may also stress the need for students to understand principles and ideas and to employ "discovery" methods. Since in a class, teachers have to face students of varieties brilliancy, therefore, they have to apply different skills & techniques to make the teaching effective and learning meaningful. In the teaching of different subjects commonly used techniques are- explanation, narration, exposition, illustrations and questioning. Some other techniques are used to fix the material learnt in the mental make up of the child. Such techniques are drill work, review, repetitive practices, recapitulation and revision, homework, assignments etc. Teachers of a particular topic do not stop the task of a teacher. He has to ascertain whether the knowledge given to the students has been fixed in their minds properly or not. If not, teachers may use a most effective device for fixing the knowledge of Mathematics. Oral work is also another such device that provides good mental exercises. It develops alertness and readiness of the mind and helps much in carrying out recapitulation and revision work.

For successful and effective teaching, planning is the most important step for a teacher. The teacher should know very clearly, what to teach and how to teach. He should have a clear concept about the subject matter. A teacher with his utmost care and skillful teaching can able to teach his students in an interesting manner. Observing the knowledge of students upon different topics teachers
should have to identify the difficult areas in the course content and he should be
given special emphasis to overcome these difficulties of the pupil.

In the Journal of Mathematical Behaviour (Format: volume 24, issue 2,
2005, pages 135-169) Susan Magidson of University of California expresses his
views that to meet the common goals of understanding and improving the teaching
and learning of Mathematic three communities viz. teachers, researchers and
instructional designers work together. Teacher’s work to help students in their
learning, researchers observe the way of teaching and learning and designers
develop instructional materials to support teachers and students. Each community
develops its own perspectives, methods and expertise.

Many educators think that technology may become a catalyst for the
reform of school Mathematics (John olive of University of Georgia, Athens).
According to L. Balasubramaniam, president of school learning solutions of NIIT,
schools should give emphasis upon setting up a mathematics laboratory to remove
mathematics fear of pupils and to make the subject matter more interesting so that
students can able to verify facts and learn mathematical concepts (The Assam
Tribune, August 20, 2008). Technologies that provide teachers and students with
tools for doing Mathematics, dynamic environment for exploration,
experimentation, and conjecturing and powerful languages for creating
algorithmic solutions to problems have transformed the teaching and learning of
Mathematics.

Development and renewal of the skill of teaching through regular
training and participation of technical discussion is another important parameter of
effective teaching of quality teacher. Thus, role of teacher, expressed in terms of
many factors could be a matter of investigation while analyzing the education of a specific area.

Teacher and course curriculum are partially responsible for effective teaching. There are other factors such as (i) domestic environment and (ii) classroom environment, which also influence effective teaching learning in general and mathematics teaching-learning, in particular.

1.8 Role of domestic environment in effective teaching and learning

An ideal domestic status could be conceptualized to provide barrier free environment to the learner so as to show his/her full potential. The parents' role is critical in creating such environment. Many factors such as economical status, level of education, awareness etc could be responsible for creating an ideal environment. These are situation specific and complex in nature. Moreover, most of the factors could be identified but require special technique to quantify. Any investigation pertaining to education requires consideration of these factors and special technique to measure them precisely.

1.9 Role of school environment in effective teaching and learning

There has been lot of researches pointing about the strong relationship between the school environment and learners performances. Researcher viewed that children living in noisy environment can exhibit poor academic performance. Teacher is only one component of school environment. Management and physical
facility, intellectual spirit, mutual behaviour of teacher and students etc are many factors comprising school environment. Section of the society providing support for establishment of school is also critical parameter influencing school environment and hence learners performance. The factors must be either measurable or converted into some measurable parameters to investigate their role in effective teaching-learning.

1.10 The role of syllabus and teaching materials in effective teaching-learning

The syllabus and text books have immense influence on the teaching and learning process of any subject. For any kind of educational improvement, suitable curriculum reforms are necessary. Seth Spaulding (1970) has viewed that one of the reasons for current student unrest throughout the world is the fact that curriculum reforms have not been entirely relevant, neither to what the student brings to it, nor to what the student expects from it. This is also true for the subject like mathematics at school level. The syllabus and text books should be adequate with reference to the needs, age level, interest and psychological aspects of learners. It is expected that syllabus should be ideal on this aspects and must be object oriented. Text books should be able to deliver desired results by supporting both teacher and learner. The clarity and comprehensiveness are other two desired parameters of text books.

The secondary board of education (SEBA) has set some objectives of teaching mathematics at class X (Prescribe syllabus for class X). These are (i) to
bring about the development of ability of the students; (ii) to express their thought clearly, accurately and precisely; (ii) to enable the student to systematically organize and interpret the data given; (iii) to help the students to reach correct conclusion common to all by taking recourse to accurate and logical reasoning; (iv) to analyze a problem discovering fundamental relationship; (v) to develop the power of original thinking and investigation; (vi) to exercise intuitive powers and common sense; (vii) to enable the students to accurately generalize special concepts; (viii) to develop the power of appreciation of the contribution of mathematics to physical and natural science, engineering, philosophy etc and the influence that mathematics exercise upon human progress and civilization; (ix) to cultivate proper habit of study and power of concentration; (x) to build self confidence and reserve power which constitute a strong personality. The SEBA documents further stated the mathematics course has the overall objectives of the proper understanding of and acquiring the ability in performing the four fundamental operations; improving speed consistent with accuracy; developing neatness and legibility; enabling students to solve quantitative problems of life which are within their range; recognize geometrical forms and shapes and practical knowledge about them.

Now, it will be imperative to testify the achievements of the set objectives with reference to the target group.
1.11 Appropriate tools for investigation of school level mathematics education in Assam

Lack of interest in the mathematics subject associated with poor performance in mathematics has been a serious concern for the parents and teachers in Assam. This seems to be a characteristic feature of most of the schools in rural areas of Assam. The poor performance at schools, particularly, in the mathematics subject leads to several social problems as discussed above. The mathematics education at schools in Assam needs special investigation. Identification of appropriate cause(s) through a systematic study of the relevant elements viz. course curriculum, teaching, teacher, parents and students will only enable to seek appropriate solutions. Solutions used on such study will help to improve the mathematics education at school. This in turn will help the students to build up their career with full of confidence and will prove to be an academic boost for the society.

One of the critical issues to address the mathematics education in Assam is to select the tools for investigation. The present investigation cannot be considered an issue of purely social in nature but a technical issue having interlinked social and technical elements. Diagnosis of the appropriate causes of the problems with optimum delineation of the relevant elements requires application of tools. Statistical tools are available to investigate the significance of cause-effect relationship. In addition to statistical procedure, Fuzzy logic has also been emerged as an effective tool to investigate such problem.
1.12 Fuzzy concept

The concept of fuzziness arises due to consciousness of uncertainty in the various day-to-day problems that are seen in making decision with reference to an event, in managing a puzzle situation and predicting of imprecise information’s of our real world. Human beings have to face many kinds of problems in their day-to-day life owing to an element of uncertainty either in the parameters, which define the problem or in the situations in which the problem occurs. Although one can apply the probability theory to handle the uncertainty, it can be applied only to situations whose characteristics are based on random processes. Therefore probability theory was not sufficient for dealing with all kinds of uncertainty. Human beings are always trying to get information about their surroundings and to analyze the information so that they become able to face the challenges of the time. When they are able to receive only partial information about their environment then lack of information produces uncertainty. Varieties of uncertainty appear with reference to varieties of problems. Each type of uncertainty has its mathematical representation. The mathematical modeling of fuzzy concepts was originated by American mathematician Lotfi A Zadeh. He introduced a new theory for the first time in 1965 to handle the uncertainty arising due to partial information about the problem, or due to information which is not fully reliable, or due to imprecision and vagueness of the real world. This new theory is named as fuzzy set theory.

In classical set theory, a collection of well-defined distinct objects is defined as a set. But the collections of objects, which are not well defined, were
ignored until the fuzzy concept came into existence. Up till then only two possibilities “belonging to” and “not belonging to” were considered in the relation between an element and a set. But the fuzzy concept gives us a new way to investigate the relation between sets and their elements. According to this concept an element may partially belong to a set and following this view L. A. Zadeh gave birth of the new motion of ‘fuzzy set’ which includes a collection whether it is well defined or not. Fuzzy sets are sets whose elements have degrees of membership. The degree of membership of an element in a fuzzy set expresses the degree of compatibility of the element with the concept represented by the fuzzy set. A function \( f \) is called a membership function if it assigns each element \( x \) of \( X \) with a number \( f(x) \) in the closed interval \([0, 1]\) that characterizes the degree of membership of \( x \) in \( A \). For a non empty set \( X \) and a membership function \( f: X \rightarrow [0,1] \), \( A = \{(x, f(x)) \mid x \in X\} \) is called a fuzzy set on a classical set \( X \), where the membership function \( f(x) \) quantifies the grade of membership of the elements \( x \) to the fundamental set \( X \). An element mapping to the value \( 0 \) (Zero) means that the number is not included in the given set and \( 1 \) (One) describes a fully included member. Values strictly between \( 0 \) and \( 1 \) characterize the fuzzy members.[G. Klir, Ute. St. Clair, Y.Bo (1997)]

Human beings are always trying to get information about their surroundings and to analyze the information so that they become able to face the challenges of the time. When they are able to receive only partial information about their environment then lack of information produces uncertainty. Varieties of uncertainty appear with reference to varieties of problems. Each type of uncertainty has its mathematical representation.
Fuzzy logic is based on the theory of fuzzy sets dealing with reasoning that is approximate rather than precisely deduced from classical predicate logic. While classical logic deals with propositions that are just true or just false, fuzzy logic deals with propositions known as fuzzy propositions, the truth-value of which is a matter of degree. Fuzzy logic extends classical logic by allowing intermediate truth-values between zero (False) and one (True). The degree of truth of each fuzzy proposition is expressed by a number in unit interval (0, 1).

Fuzzy logic is used in two different perceptions. In a wide perception, it utilizes concepts, principles and methods developed within fuzzy set theory for formulating various forms of sound approximate reasoning. Again in a narrow sense, fuzzy logic is a logical system, which is a generalization of the various multivalued logics providing an effective conceptual framework for dealing with the problem arising in an environment of uncertainty and imprecision. Multivalued logics are deduced by allowing one or more additional truth-values between zero (false) and one (true). These values may be regarded as indeterminate. Exactly one indeterminate truth-value exists in case of a three-valued logic. Truth, falsity & indeterminacy of a three-valued logic are usually denoted by 1, 0 and ½ respectively. After accepting the concept of three valued logics, the concept of “many-valued” logics also has developed with their own interpretations and truth conditions. Many-valued logics are usually regarded as n-valued logics, where n is the number of truth-values. If with reference to a proposition P, truth value ‘½’ is assigned between completely true and completely false, then in case of a proposition which is mostly true and only a little false, the truth value of the proposition might be represented by the number ‘¾’. Similarly a
proposition $P$ that is mostly false might have a truth-value of only $\frac{1}{n}$. Thus between two extreme truth values a wide range of some what true and some what false propositions with their respective truth values are obtained. For any given $n$, the truth-values in these generalized logics are usually labeled by rational numbers in the unit interval $[0, 1]$. Steadily dividing this interval into $(n-1)$ sub-intervals,

$$0 = \frac{0}{n-1}, \frac{1}{n-1}, \frac{2}{n-1}, \ldots, \frac{n-2}{n-1}, \frac{n-1}{n-1} = 1$$

of an $n$-valued logic, $T_n$ are obtained. These values are regarded as degrees of truth.

For each $n \geq 2$, the famous polish logician Lukasiewicz had proposed the $n$-valued logic by $L_n$. The truth values of $L_n$ are taken from $T_n$ and its primitives are defined by the following equations:

$$\tilde{a} = 1 - a$$

$$a \wedge b = \min(a, b)$$

$$a \vee b = \max(a, b)$$

$$a \Rightarrow b = \min(1, 1 + b - a)$$

$$a \Leftrightarrow b = 1 - |a - b|$$

$L_2$, $L_3$, $\ldots$, $L_\infty$ is a sequence of logics where $L_2$ is a classical two-valued logic and logic $L_\infty$ is an infinite valued logic whose truth values include all rational numbers in the unit interval $[0, 1]$. When truth-values are not restricted to rational numbers only, but include all real numbers in the interval $[0, 1]$, we obtain an alternative infinite-valued logic. The primitives of truth of this infinite-valued logic are defined by the above-mentioned equations. Thus fuzzy logic in the narrow sense is rooted in the class of all logics with truth-values in $[0, 1]$.

[G. Klir, Y.Bo]
In our present study we have used a fuzzy logic proposition with fuzzy quantifiers to investigate the mutual reflection between mathematical performance and overall performance of 21 randomly selected schools of Nalbari district of Assam with reference to pass percentage in HSLCE. With reference to mathematics performance the considered proposition is:

\[ P_1: \text{There are about } n \text{ number of schools in } I \text{ whose performance in mathematics subject } mv(i) \text{ is high.} \]

Where \( I \) is the set of schools considered in the study; \( v \) is a variable with values in the interval \([0, 100]\) that express degrees of performance in mathematics subject; \( mv(i) \) is the pass percentage in mathematics of \( i^{th} \) school in \( I \); “about \( n \)” represents a fuzzy quantifier and the linguistic term “high performance” represents a fuzzy set on \([0, 1]\).

Again with reference to performance in overall subjects the following proposition is considered:

\[ P_2: \text{There are about } n \text{ number of schools in } I \text{ whose performance in overall subjects } ov(i) \text{ is high.} \]

Where \( I \) is the set of schools considered in the study; \( v \) is a variable with values in the interval \([0,100]\) that express degrees of performance in overall subjects; \( ov(i) \) is the overall pass percentage of \( i^{th} \) school in \( I \); “about \( n \)” represents a fuzzy quantifier and the linguistic term “high performance” represents a fuzzy set on \([0, 1]\).

The general form of propositions \( P_1 \) & \( P_2 \) is as follows:

\[ P: \text{There are } Q \text{ } i^{th} \text{ in } I \text{ such that } V(i) \text{ is } F, \]
Where $V$ is a variable that for each individual $i$ in a given set $I$ assumes a value $V(i)$, $F$ is a fuzzy set defined on the set of values of variable $V$ and $Q$ is a fuzzy number on $R$.

We have also used conditional and unqualified fuzzy logic propositions in our present study to investigate the following

(i) Reflection of mathematics (state level mathematics Olympiad) performance on HSLCE performance.
(ii) Reflection of school characteristic on learner's mathematics performance.
(iii) Reflection of teacher characteristic on learner's mathematics performance.
(iv) Reflection of learner's domestic status on learner's mathematics performance.
(v) Reflection of educational environment on learner's mathematics performance.

The general form of proposition used is as follows

$P$: If $x$ is $A$ then $y$ is $B$

Where, $x$ and $y$ are variables whose values are in sets $X$ and $Y$ (universes of discourse), respectively; $A$ and $B$ are relevant predicates represented by fuzzy sets.

An important concept that plays a central role in most of its applications is a fuzzy if-then rule, or simply a fuzzy rule. The fuzzy rules that describe relationships at a high level (in a linguistic sense) are typically written as antecedent-consequent pairs of IF-THEN statements as our considered
propositions. If the antecedent is true to some degree of membership, then the consequent is also true to that same degree. The general form of used propositions can be interpreted as y is a member of B to the degree that x is a member of A. [G. Klir; Ute. St. Clair, Y. Bo.; G Klir and T. Folger; G. Klir, Y. Bo.]

1.13 Fuzzy logic and its application

Fuzzy logic is an application area of fuzzy set theory and its broad applicability in many areas of human affairs has been rapidly growing since the early 1990s. Application of fuzzy logic is an important and interesting aspect of ongoing research in many areas including science, economics, medicine etc. Fuzzy logic achieved impressive success in any problem area that involves natural language. It provides a convenient way to incorporate the knowledge of human experts into the expert systems using qualitative and natural language. Fuzzy logic applications were recognized in different branches of the field of engineering. The utility of fuzzy logic was first recognized in electrical engineering. Number of successful real world applications in power systems show that fuzzy logic can be successfully applied to deal with imprecision, ambiguity and probabilistic information in input data. The ability of fuzzy logic based systems to deal with incomplete information, imprecision and incorporation of qualitative knowledge have shown great potential for application in electric load forecasting. Fuzzy logic also involves widely in computer engineering. To implement the various operations involved in fuzzy logic and approximate reasoning the necessity of computer hardware has been recognized since the mid-1980s. Fuzzy computer
hardware allows all inference rules of a complex fuzzy inference engine to be processed in parallel and it extends the scope of applicability of fuzzy controllers, and potentially, other expert systems.

Fuzzy logic & the associated technology play significant role in solving various problems like facilitate automatic driving, optimal navigation by voice instructions in natural language, diagnosis and prevention of failures and automatic parking etc. Over the last several years, there has been work on the development of a fuzzy logic power system stabilizer to enhance the damping of generator oscillations as a joint research work between Kumamato University and the Kyushu Electric power co. Varieties of fuzzy logic applications ranging from consumer products such as Cameras, Camcorders, Washing machines and microwave ovens to industrial process control, medical instrumentation, decision support systems and portfolio selection is observed in the last few years.

Fuzzy logic propositions can also be applied to the comprehensive study of secondary level mathematics education. The satisfactory performance of learners in the specific area is the goal of education. While investigating such performance in a multi-group environment, it could be measured in degrees. Such degrees of performances can then be easily handled through Fuzzy logic propositions. Similarly, the performance-attributing factors could also be measured in terms of some relative degrees. The ideal favouring factors are assigned unity value and factors resulting worst performance are assigned zero value. Any factors with intermediate status are assigned proportional intermediate value. Thereby, whole system can be converted into having “cause-effect”
relationship with relative measurable parameters. The reflectivity of the causal parameters on effect can be tested through fuzzy logic application.

1.14 Objectives of the study

From the discussion made in above sections, it is observed that mathematics education at secondary level in Assam needs object oriented investigation. All the probable factors influencing the mathematics education need to be appropriately represented while designing the investigation procedure. Fuzzy logic has the application merit of the present investigation, primarily due to the nature of the problem. Keeping in view of the above the present investigation has been undertaken with following objectives:

1. To investigate the present scenario of mathematics education at school based on examination results, teachers competency and parents awareness through application of fuzzy logic and basic statistics.

2. To study the mathematics course curriculum (including text book) taught at school with reference to (i) comprehensiveness (ii) clarity and (iii) continuity covering five board topics viz, number sense & numeration, measurement, geometry, algebra and data management including perception in percentage, profit, loss, discount, stock.

3. To identify the short comings of secondary school mathematics education and suggest remedial measures.