2.1 A Case for Investigation:

Although mathematics has been given more stress in the present curriculum of the secondary education, considering the needs of the individual as well as the society, yet such needs appear to have received scanty attention. The major aims of mathematics education are limited to (1) imparting such limited knowledge as to let pupils appear in external examinations and (2) concentrating on the blind use of rules without understanding the underlying principles. It is not properly correlated with the life situations in which young boys and girls are required to apply mathematics in solving practical problems and in studying other branches of science. The text books for different classes on mathematics do not seem to be properly standardised. Although the text books cover the required syllabi, the contents are found to be related to the same old situations, the methods of teaching being relegated to subject fancies of authors preparing the text. Besides, in the opinion of some qualified mathematics teachers (ref. appendix 2.1) of the secondary schools, the curriculum of mathematics is over crowded and bulky and there is no proper linking of the subject from the lower level to the higher level. In such a state of affair, the achievement of mathematics in various examinations may be held in doubt more particularly when large scale failure in Mathematics occurs as a pernicious disease of the present day society.
Large scale failure in mathematics in the H.S.L.C. Examination (Assam) has already been reported in the previous chapter (page 32) and the table is again reproduced here for purpose of comparison with school examinations as noted below:

Table

The P.C. of pass and failure in the H.S.L.C. Examination in different years

<table>
<thead>
<tr>
<th>Course</th>
<th>Year</th>
<th>p.c. of pass</th>
<th>p.c. of failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Old Course</td>
<td>1971</td>
<td>56.03</td>
<td>43.97</td>
</tr>
<tr>
<td></td>
<td>1972</td>
<td>52.70</td>
<td>47.30</td>
</tr>
<tr>
<td></td>
<td>1973</td>
<td>46.03</td>
<td>53.92</td>
</tr>
<tr>
<td></td>
<td>1974</td>
<td>47.60</td>
<td>52.40</td>
</tr>
<tr>
<td></td>
<td>1975</td>
<td>33.48</td>
<td>66.52</td>
</tr>
<tr>
<td>(B) New Course</td>
<td>1976</td>
<td>41.06</td>
<td>58.94</td>
</tr>
<tr>
<td></td>
<td>1977</td>
<td>29.00</td>
<td>71.00</td>
</tr>
</tbody>
</table>

Class performances in mathematics examinations (annual and biannual) of three secondary schools of Guwahati are given below. The rate of failure is rather high and it gradually increases as we reach the top classes.
### Table

#### % of pass and failure in class Examination in Mathematics

<table>
<thead>
<tr>
<th>Class</th>
<th>Panbazar Girls' H.E. School</th>
<th>Cotton Collegiate H.S. School</th>
<th>Gauhati University Model H.E. School</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Half yearly</td>
<td>Annual</td>
<td>Half yearly</td>
</tr>
<tr>
<td></td>
<td>P%</td>
<td>F%</td>
<td>P%</td>
</tr>
<tr>
<td>V</td>
<td>36</td>
<td>64</td>
<td>56.7</td>
</tr>
<tr>
<td>VI</td>
<td>42.7</td>
<td>57.3</td>
<td>51.6</td>
</tr>
<tr>
<td>VII</td>
<td>50.0</td>
<td>50.0</td>
<td>50.0</td>
</tr>
<tr>
<td>VIII</td>
<td>52.4</td>
<td>47.6</td>
<td>21.0</td>
</tr>
<tr>
<td>IX</td>
<td>72.3</td>
<td>27.7</td>
<td>44.0</td>
</tr>
</tbody>
</table>

P% = Percentage of pass  
F% = Percentage of failure

#### 2.2 Teachers on Mathematics Teaching:

Why do a large number of pupils fail in Mathematics? The reasons are to be explored; yet a large number of factors may be considered as instrumental in making mathematics a hard nut for a large number of pupils. (1) Defective teaching (2) defective examination (3) injudicious double promotion (4) over crowded classes (5) wrong placement of pupils in different classes (6) negligence of school and home work (7) lack of interest and motivation for challenging work (8) poor health of pupils (9) lack of guidance including diagnostic and remedial teaching may be mentioned as potential factors.
All these factors together make mathematics the most dreaded subject in the secondary stage. How far these factors act as potent deterrents in the normal or expected achievement of pupils may be noted in some discussions held among mathematics teachers of seven secondary schools situated in and around the city of Gauhati. These discussions were aimed at the exploration of causes and effects of the teaching learning situation prevailing under the new syllabus of mathematics in different classes of the secondary schools. About 50 teachers participated in those discussions (q.v. Appendix 2.1) which were held schoolwise among mathematics teachers.

The findings are: (1) Arithmetical work at the primary stage is not sufficient to cope with the course of mathematics in class V. The understanding and skill of pupils developed at the primary stage are poor. There appears to be a gap of knowledge between the pre-class V and post class V stages. (2) The classroom teaching of mathematics is done by chalk and talk method in the higher classes. The teaching of the subject is not approached methodically in a large number of situations, due to a shortage of trained teachers in mathematics. No provision has been made for continuous testing of teaching and learning objectives except in the biannual and annual examinations. Instruction in the school is not individualised and there is no room for diagnostic and remedial teaching. (3) The exercises given in the text books are not properly graded and hence pupils find difficulty in working them out. These create some unnecessary problems for teachers to engage themselves in more 'chalk and talk'. (4) The home assignments are almost nil and whenever given, the same are not usually corrected for want of time.
The following are some typical reactions of teachers of mathematics regarding the entire situation involved in teaching learning of secondary school mathematics.

CASE 1 : B.D.*

(1) The mathematical knowledge of the pupils attained at the primary stage is not sufficient to cope with the present course of mathematics in class V.

(2) Appropriate methods of teaching mathematics in the class room are not utilised.

(3) There is no provision of class tests/topic tests for testing continuously the progress of work in different classes.

CASE 2 : M.K.*

(1) Pupils of secondary schools acquire less understanding of fundamental concepts of mathematics.

(2) Pupils are found to devote less time for study.

(3) A gap is found to exist between the learning of primary school arithmetic and the secondary school mathematics.

CASE 3 : P.G.*

(1) Requirements under the new syllabus are often found to be very heavy for a teacher to cope with. The designing of tests to cover a wide range of objectives like acquisition of knowledge, understanding of concepts and insightful learning, development of
skill on the part of pupils, make the teacher's task very difficult, particularly from the point of view of time available for such work.

(2) There is no adequate linking of the syllabi of different classes.

(3) The shortage of qualified teachers affect the teaching of mathematics.

(4) Pupils have no clear understanding of symbolic operations. Common errors are often found in their work relating to fundamentals rules.

(5) One of the main causes of backwardness in mathematics is the failure to cope with numerical operations both conceptual and mechanical. Girls have been found to be rather weaker in such operations. The teacher suggests the drastic method for the restoration of confidence among girl-pupils.

CASE 4 : D.S*

The teacher is of the opinion that (1) rote learning is more prevalent than schematic learning at the secondary stage. The reason for this, he believes, is that 60 p.c. of pupils in each class do not have fundamental ideas of arithmetical operations. Pupils suffer for exclusive dependance upon memorisation without understanding of fundamental concepts.

(2) Pupils find the mathematical language difficult.

(3) He insists on more knowledge of the subject and the acquisition of skill in applying such knowledge. Studies and acti-
vities should be well correlated so that student can gain confidence by developing an insight of the subject.

(4) Common errors in arithmetical calculation, use of the decimal point, finding out of square root of numbers are frequently found in school and home works.

CASE 5 : R.P.*

The teacher is found to be critical about the syllabus of mathematics for class VII. According to him, the syllabus of class VII is wide. The period fixed for the course is not sufficient to teach the whole course systematically. He insists on the use of teaching aids as frequently as possible in class room situations.

2.3 Students on Mathematics Learning:

Some pupils of secondary schools were casually asked about the present situation of learning mathematics, mainly arithmetic and algebra. They were of the opinion that (1) they could not properly understand the contents of different topics of arithmetic and algebra. They tried to commit to memory all those topics and they found it difficult to express at the time of examination. (2) They felt that class teachings proceeded along with the progress of the good pupils in the class and the mediocre-pupils had to suffer. (3) They were of the opinion that the topics on arithmetic, which were included in the old syllabus, were not properly treated in the new syllabus. They expressed the necessity of learning those topics
of arithmetics (profit and loss, unitary method, time and work, discount etc), because these helped in their day to day life situations. They said that all pupils after passing H.S.L.C. Examination might not go for higher studies of mathematics. Therefore, whatever knowledge or skill they could acquire from the secondary mathematics might be utilised in actual life situation. So the divorce of arithmetic from the syllabus in the higher stage of the secondary education was not justified. (4) They felt that the learning of algebra was difficult without proper understanding of arithmetic.

Some of their reactions are given below.

CASE 1 : B.S.*

The pupil says that he can not remember the topics taught in the class and has no interest in them. He feels that the teachers explain the topics from the point of view of 'how' rather than 'why' and therefore, the rhyme and reason of a topic is not understood. Teaching is not done with the help of factual materials.

CASE 2 : P.B.*

The pupil is of the opinion that he is unable to understand the topics discussed in the class. He is unable to apply his mind in solving problems. His difficulty is not understood and nothing is done to remove his difficulty. Asked about his school work and home work, he is of the opinion that as he is unable to do sums on arithmetic and algebra, he can not submit his home works.
Whenever the teacher insists on it, he somehow manages to work few sums from his friend's khata and submits the same to his teacher.

CASE 3: B.K.+

Asked about the text book of mathematics that he has read, he says that he finds the book 'Uju Ganit Part II for Class VI, difficult to understand. Sums on different examples are not properly graded and the language of the sums is difficult to understand. Pupils are not interested to do sums and so teachers have to work out sums for them. The various terms of algebraic number system are found difficult to understand. He tries to memorise, but fails to keep in mind.

2.4 Administrators, Educationists and Guardians on the subject:

The inspector of schools of Kamrup district circle, when asked about his impression on the present day learning of mathematics states that

(1) there has been shortage of qualified teachers of mathematics,

* Vide appendix 2.1, the list of teachers participated in the interview.

+ Vide appendix 2.1, the list of pupils participated in the interview.
(2) the teaching of mathematics is not done whole heartedly and it leads to more distaste towards the subject.

(3) the existing mathematics teachers do not seem to understand the spirit of the revised syllabus along with the examination reform-project. This leads to the large-scale failure in the H.S.L.C. Examination in mathematics,

(4) the knowledge and understanding of the subject by the H.S.L.C. Examination passed candidates fail to match our ideals and expectations. He remarks that a H.S.L.C. passed student often has confused whether $\frac{1}{2}$ is greater than $\frac{1}{3}$.

(5) bad teaching of arithmetic at the primary stage may be one of the defects of the learning of mathematics at the secondary stage.

The Head of the Department of Mathematics, Gauhati University thinks that pupils, in general, find mathematics in the secondary stage, difficult. Most pupils offer mathematics at the collegiate level as an optional subject and in the degree course, the number of students with mathematics as an elective is very small. This is one of the reasons of the shortage of qualified teachers of mathematics. As regards the new syllabus, he thinks that the syllabus, if introduced, will go a long way in modernising mathematics. It may be possible to improve it further on the basis of experience.

A college teacher of mathematics remarks that pupils who offer mathematics as elective in the pre-University Course, are
found weak in secondary mathematics. He cites several examples of which may represent the nature of mathematics acquired by pupils at the secondary stage.

Examples:

(1) \( x^3 = 1 \) is the imaginary cube root of unity.

(2) \( 2 \sin^2 \theta = 1 \)

\[ \Rightarrow 2 \sin \theta = 1 \]

\[ \sin \theta = \frac{1}{2} \]

\[ \Rightarrow \sin \theta = \frac{\pi}{2} \]

(3) \( x^2 + x + 1 = 0 \)

\[ \therefore x = \frac{-x \pm \sqrt{x^2 - 4}}{4} \]

(4) \( \cos^2 \theta = \frac{1}{2} \)

\[ \therefore \cos \theta = \pm \sqrt{2} \]

A guardian of a pupil of a local high school is asked casually his impression about the school mathematics under the new syllabus. He is of the opinion that the new syllabus of mathematics required qualified teachers from class V to class X. Since the traditional approach of teaching is obsolete in the new syllabus, modern methods of teaching are to be used by properly trained teachers.

From the above discussion, it is evident that there is a close relation between the learning of mathematics at the primary
stage and at the secondary stage of the school education. Pupils who cannot grasp the fundamental arithmetical operations, find immense difficulty in understanding the higher courses of arithmetic and algebra. If the reasoning power of mathematics is not properly developed in the mind of pupils, it is difficult for them to understand the geometrical logic. So the learning of mathematics at the lower stage has great bearing at the higher stage.

It is observed that many pupils become disinterested in learning mathematics at the secondary stage due to the defective teaching of mathematics. In the opinion of mathematics teachers, bad method of teaching mathematics cause a lot of harm to pupils. According to them, if pupils are taught mathematics with much unwanted elaboration, it may affect their learning. It is, therefore, to be studied how far the defective learning affect the achievement of pupils in mathematics at the secondary stage.

2.5 A Pilot study:

In order to examine the deficiencies of the learning of four fundamental operations of arithmetic at the higher stage, an attempt has been made to apply the Schonell's Diagnostic Tests in Arithmetic* among the pupils of higher classes of a secondary school, the school being selected as an average school located at the sub-urban area of the city of Gauhati.

* Schonell, F.J. : Diagnosis of individual difficulties in arithmetic.
Schonell developed a set of tests in arithmetic in his book - 'Diagnosis of individual difficulties in Arithmetic'. His aim was to detect the defects of pupils in learning arithmetic, when he observed that the repetition of the same topics at the higher classes deteriorated attitudes toward learning of the subject. His diagnostic tests are intended to help class teacher of mathematics regarding the stage at which the teaching of arithmetic is to be started at the next higher class.

A school near the University Campus is selected for administering the test++. The tests are carried out from class VII to class X. Pupils have been instructed to work out sums of each test with fixed time to test their speed and accuracy. Altogether 160 boys and girls have appeared in the test. The details of the test are given in appendix 'A' and the following constitute the major findings.

1. The nature of performance of all classes is found to be almost the same.

2. The trend of mean-scores is found to be increasing from class VII to class X.

3. Almost 90 pc of pupils have made mistakes in sums involving the operation of zero. Pupils have no clear concept about zero.

++ This test was rendered into assamese at the former Extension Service Centre of the Department of Education and B.T. of the Gauhati University and printed forms were made available for experimental work.
(4) Failure to recall mathematical tables, often consumes enough time and sometimes leads to wrong answers. It also creates fear for long sums. It is evident from the tests that almost all pupils did not attempt long sums of multiplication and division.

(5) In other tests the points observed are: (i) pupils often forget to add excess number to be added to next higher place, (ii) sums having three or more digits are often found incorrect, (iii) The way of borrowing numbers is generally found wrong, (iv) pupils are found weak in arithmetical reasoning power as is evident from the performance in mental arithmetic.

(6) Pupils (both brilliant and dull) are found to be equally weak in mental arithmetic, long division.

It is, therefore, concluded that the arithmetical ability of pupils, while taken to be developed systematically from the primary stage to the high school stage, is not quite adequate. It is observed that a gap is created somewhere between the lower stage and the higher stage. The teaching of arithmetic cannot be successfully done unless a good deal of drill is provided to the pupils. Drill enables them to have the repetition of the knowledge which ultimately strengthens their experience. Attempt should be made to correlate the drilling of the exercises with the facts of life. Such a correlation will have lasting effect.
2.6 Selection of the problem:

From the above preliminary investigations including the pilot study, it is clear that the performance of pupils in secondary school mathematics is not at all encouraging. The low achievement in mathematics from the beginning of schooling may be one of the causes of large scale failure in mathematics in H.S.L.C. Examination. The present study is intended to prove into what basically causes low achievement in mathematics in the secondary stage with a view to suggest measures of improvement in areas like syllabus, text books, method of instruction and such behavioural aspects as would naturally culminate in the proper learning of mathematics in schools.

(i) The problem:

The specific objective of the study is to find out and assess the achievement in learning of school mathematics and the possible reasons for the low achievement of the same. The statement of the problem is 'A critical study of the achievement of mathematics by pupils of secondary schools under the existing syllabus with particular reference to the State of Assam'.

(ii) Area of the problem:

The study is mainly intended to assess the achievement of the learning of arithmetic and algebra of school mathematics,
excluding geometry purely from the purview of discussion.

(iii) Related studies:

There are 117 (35%) studies* in India in the area of achievement of mathematics at the M.Ed. Level. Out of these studies, 114 (97.44%) studies construction of achievement tests and 3 studies the interdisciplinary achievement. None of these studies has provided sequential tests, that is to say, no one battery of tests aims at to assess the mathematics education at different levels of school education. In the area of diagnosis, a total number of 56 (16.71%) studies have been conducted at the M.Ed. level. Out of this diagnostic tests have been constructed in 23 studies and errors in mathematics have been studied in 17 studies, while the difficulties in mathematics have been studied in 76 studies.

A nation wide survey of mathematics Achievement in India was conducted in 1970 by the National Council of Educational Research and Training, New Delhi. The survey was done in three levels - primary, middle and high school level. Tests were constructed on the basis of a common syllabus worked out for the purpose. The survey studied the effect of teaching in objective domains, factors relating to geographical areas, Guardians education and income, teacher's variables and school variables.

(iii) Objectives:

The study aims at:

1. making a systematic inquiry into class wise achievement of learning school mathematics by the pupils of secondary schools of Assam with respect to the major goal of mathematics education.

2. making assessment of the adequacy of conceptualisation, understanding of the basic principles of mathematical operations, development of skill in mathematical work including the formation of habits.

3. finding out common errors and mistakes committed by pupils in arithmetical computation.

4. making an attempt to suggest for the improvement of the prescribed mathematics syllabus, text books and methods of teaching on the basis of evidence gathered from the achievement test, diagnostic tests, analysis of exercise books, interview with pupils, teachers and supervisory staff, educationists and guardians.

(iv) Hypothesis:

The following hypotheses have been worked out tentatively for the proposed study.

1. There is a gap somewhere between the primary stage and the secondary stage in learning arithmetic.
(2) The low achievement in arithmetic from the beginning of schooling may result in the low achievement in the high school leaving certificate examination.

(3) The achievement of pupils in knowledge understanding, skill and application of different topics, is affected by the traditional method of teaching.

(4) The proper weightage to different topics of arithmetic and algebra not given in the new syllabus and new text books.

(5) Pupils from urban, rural and backward areas differ in achievement in mathematics.

(6) The achievement of pupils in mathematics is affected by sex-difference.

(7) There is lack of practice of solving mathematical problems in the class room work and also in the home work.

(8) The lack of proper understanding of elementary arithmetic with proper drill leads to commit common errors in arithmetic computation in higher classes.

(9) The lack of pre-training and in-service training of mathematics teachers about the new approach of teaching affect the achievement of pupils in new mathematics.

(10) The socio-economic and education of the parent/guardians affect achievement in mathematics.
(vi) Definition of terms:

1. School Mathematics - The term 'school mathematics' is used for 'General Mathematics' which is a compulsory subject in the secondary course of Assam.

2. Syllabus - The term 'syllabus' means the revised syllabus of school mathematics introduced in 1973 in the secondary schools of Assam.

3. S.E.B.A. - means the Secondary Education Board of Assam.


5. School work and home work - By the term school work means the mathematical sums and problems worked out in the class by pupils themselves and the term 'home work' means the assignment of mathematical works given to pupils to do at home.

(vii) Method:

In order to test the hypotheses, some qualitative and quantitative data are required. For this purpose, some kind of research tools are to be used as data gathering devices. The devices used in this study are (a) tests, (b) interview, (c) analysis of syllabi, text books and exercise books, (d) school records and (e) Board's records.
Detail of the devices:

(1) Tests:

(a) A battery of sequential tests is constructed, one for each class from class V to class X. The reliability and validity of the tests are worked out. The item difficulty value and the discriminating index of each test are also calculated by doing item analysis.

(b) Schonell's Diagnostic tests are used to reveal pupil's strength and weakness in the field of arithmetic. The purpose of this test is to enquire into the nature of difficulties that pupils have to face while learning mathematics.

(2) Interview:

An interview is seemed to be a satisfactory device, because it makes use of the observation of external appearance of gestures, voice and several modes of expression. And as such an interview is arranged with the mathematics teachers in the district of Kamrup. Similarly the interview with students of the secondary schools, administrators, educationists as well as guardians of pupils have been arranged.

(3) Analysis of syllabi, text books and exercise books:

In order to study the content of syllabus, an analysis of the revised syllabus together with the comparison with syllabi of other states has been done. The text books of different classes have been analysed in details. Further, exercise books of pupils
are collected and are analysed in order to study the school and home works.

(4) School records and Secondary Board's records:

The biannual and annual examination records of pupils from different schools are collected with cooperation of the Head Masters of schools. The records of the performance of mathematics in the H.S.L.C. Examination 1977 are collected and are analysed. The analysis is mainly concerned with the evaluation of mean, standard deviation, standard error and drawing of frequency distribution curve.

Summary:

A preliminary investigation is carried out about the prevailing conditions of mathematics education in the secondary schools of Assam. The investigation is intensified through the interview of teachers and students separately and a pilot study of the existing conditions of the school mathematics in the secondary schools in and around the city of Gauhati. The search reveals that the performance of pupils in mathematics is low. The major factors leading to the low achievement as found in the interview and the pilot study are: (1) imparting of limited knowledge, (2) concentrating or the blind use of rules, (3) heavy syllabus, (4) defective text books, (5) lack of natural urge among pupils to learn mathematics, (6) insufficient arithmetical work at
the primary stage, (7) absence of methodical approach of class
room teaching. Thus the present study is intended to probe into
what basically causes to the low achievement in the subject with a
view to suggest measures of improvement in areas like syllabus,
text book, method of instruction etc. A few hypotheses are worked
out and the necessary devices are selected to collect data for
checking such hypotheses.