CONCLUSIONS AND RECOMMENDATIONS
Chapter V

Conclusions and recommendations

5.1 Background of the study

Mathematics has tremendous contribution to the revolutionary changes of modern world. There are many historically renowned examples of positive impacts of mathematical knowledge in human lives and civilization. Practically, there is hardly any sphere of life that can be imagined without application of mathematics. Importance of mathematics has been dramatically increased for today's technologically driven society. It is appropriately said that foundation of mathematics is built during school education. A strong structure is not possible with weak foundation. Similarly, lacunae with teaching-learning of mathematics subject at school would produce deficient human resources. Sound knowledge on mathematics subject at school can assist an individual in many ways. Success of career starts with logical thinking that has well established root with knowledge on school level mathematics.

The importance of mathematics teaching at schools has been realized by the Government of India as reflected by its education policies. From the third plan onwards-high priority has been given to strengthen and modernize the structure of methodology of teaching mathematics in the secondary level schools. The NCERT and UNICEF have joined hands and launched a number of schemes
and programmes to bring about a revolution in the field of mathematics education. However, school level mathematics education in some regions of India including Assam seems to require appropriate investigation for its improvement. There has been general feeling that majority of students at secondary schools have psychological phobia towards mathematics subject. Correctness of such believe need to be investigated. However, “school level mathematics education” is such a complex matter embodied with interlinked elements like (i) teacher, (ii) school, (iii) parents, (iv) syllabus, (v) society and (vi) students that a systematic methodology is essentially required for any meaningful investigation.

There have been many target oriented research works for improvement of education system in many parts of the world. However, no reported study aiming improvement of mathematics education at secondary school of Assam could be consulted before the present investigation.

The present research work has been undertaken some specific objectives viz., investigation of the present scenario of mathematics education at school through some standard procedure and investigation of factors influencing academic performance in mathematics. The development of methodologies to investigate some distinct and essential aspects of school level mathematics education could be considered unique contribution of the present research work. Analysis of prevailing educational scenario of secondary schools of Assam with special reference to mathematics education, based on comprehensive real-time data sets, is considered another major contribution of this research work. Applications of fuzzy logic and statistical procedure to investigate dependability
of some probable hypotheses concerning school level mathematics education are also essential contributions of the present investigation.

**Findings of the present research works are summarized as below:**

### 5.2 Prevailing academic scenarios and mathematics education

#### 5.2.1 Methodology for fuzzy logic application

A methodology has been developed to ascertain reflection of mathematics performance on overall academic performance of the students belonging to different regions using fuzzy logic proposition (conditional and an unqualified fuzzy logic proposition). The districts of Assam are considered as the separate regions for the investigation. Results of two standard examinations, viz., State Level Mathematics Olympiad (SLMO) and High School Leaving Certificate Examinations (HSLCE) of different districts under considerations are used as input data to represent mathematics performance and general academic performance respectively.

#### 5.2.2 Reflection testing

General academic performances of the districts of Assam are fully reflected by performance in mathematics. The validity of this proposition is
further supported by statistical procedure (Pearson’s correlation and Spearman’s rank co-relation co-efficient) with high degree of significance.

5.2.3. Academic scenario

Wide variations of academic environment and performances exist amongst the schools. The variations of general academic performances as well as performances in mathematics subject amongst the schools are reflection of financial and managerial statuses of the schools.

Academic performances as well as mathematics performance of the government and private schools are better than the schools belonging to non-provincialized schools, which are not getting government’s aids.

The performances in mathematics subject and subjects other than mathematics are positively correlated. Similarly, average pass percentage in HSLCE examination is also positively correlated with the learners’ mathematics performance of schools. However, no positive correlation is observed between 'students and teacher ratio' and the mathematics performance of the schools.

5.2.4 Performances in different sub-areas of mathematics

The results of the specially designed test on mathematics i.e. MAT (Mathematical Ability Test), to investigate and analyze sub-area specific performance covering 13 sub-areas revealed the following:
• There are distinct variations of performances in sub areas, which is a
general characteristic of all schools.

• Difficulties of solving problems on algebraic fraction, variation and
trigonometry were prominently reflected with nil scores in these three
areas by some schools. Performances of rural and recognized category
schools are lower than other schools.

• Idea of set, linear simultaneous and quadratic equations and geometry are
another three areas in which maximum numbers of schools have attained
poor scores.

5.2.5 Learners’ consistency in mathematics performance

Consistencies of performance in mathematics subject for three consecutive
academic years (VIII, IX and X) of selected groups of students of all the schools
under study were evaluated through a standard procedure. The specific findings
are noted below:

• Overall, only 28.28% learners are showing consistent improvement in
mathematics performance. On the other hand, performance of 18.03%
learners is deteriorating. Remaining (more than half) population of
learners indicated complete lack of consistency.

Consistency in performances cannot be fully explained by the
managerial conditions of the schools. For example, in spite of better
managerial inputs, only 18.75% learners of an urban located government
school (119 years old) are showing consistent improvement in
mathematics. Similarly, about 90% of the learners of one urban located private school could not show consistent improvement in mathematics. However, more than 70% of learners showed deteriorating performance in mathematics of a non-recognized rural 9 years old school.

5.2.6 Uniformity of performances

A group of learners with higher maximum, higher minimum, higher average and lower standard deviation of the score is desirable. Such a group would mean presence of better performer students with more uniformity of performance. The specific findings of uniformity performances of schools (based on MAT) are given below:

- An urban (21 years old) private school exhibited the highest level of uniformity in performances in mathematics. On the other hand, learners of a recognized rural (19 years old) school exhibited the lowest uniformity.

- In general, academic performances as well as mathematics performances of the government, provincialized and private schools are better than the non-provincialized schools. Most of the provincialized schools show better uniformity than non-provincialized schools.

- Managerial and financial inputs to recognized and non-recognized schools are not as per the government and private schools. This may be the reason of poor performances of these schools.
5.2.7 Quantification of educational environment and investigating its effect on performance in Mathematics

Three characteristic parameters concerning schools, teacher and domestic status were used to define learners' educational environment. These parameters are defined in terms of 15 distinct factors, which could influence the academic performance in mathematics. The qualitative parameters were then converted into measurable scores to establish functional relationship for statistical and fuzzy logic analysis. The major findings are highlighted below:

On schools:

- Wide variation of school characteristic score is observed with the highest, the lowest and average scores 0.813, 0.250 and 0.5, respectively. All the three urban base schools along with two rural schools have attained better than average scores.

- Scores of urban schools are better compared to rural schools. Moreover, recognized and non-recognized categories of schools environment are poor compared to government, private and provincialized schools.

On teachers:

- The highest (0.650) and the lowest (0.20) teacher characteristic scores are obtained by two provincialized rural base schools. Average teacher characteristic score 0.386 is far below from the ideal score which is one.

- Two urban located schools and one provincialized rural school have attained the scores 0.600, 0.550 and 0.500, respectively. Less than 50% of the schools scored less than average TC score.
• Besides private, government and provincialized categories of schools, recognized and non-recognized categories of schools (one each) also scored better than average TC score.

• Considering better financial and managerial inputs of provincialized schools, further improvement of TC scores is required.

On domestic status:

• Learners’ domestic status of an urban located private school is the best (with score as 0.684) followed by another two urban located schools. On the other hand, a non-recognized rural school has the lowest DS score (0.286). Average DS score is 0.444 and all total 9 schools (out of 21) are found to have better than average DS score.

• Out of 8 non-provincialized schools only two schools are found to have better than average DS score.

• It is observed that learners’ domestic status in urban schools and private schools are better than the rural non-provincialized schools.

On Educational Environment:

• There exist variations in educational environment amongst the schools under study. The highest (0.670) and the lowest (0.296) educational environment scores are obtained by an urban located private school and a provincialized rural located school, respectively.

• Average educational environment score is 0.422. All the three urban located schools along with a provincialized rural school have attained more than 0.5 score. All total 9 schools (out of 21) are found to have better than average score.
• Besides government, private and provincialized categories of schools, one recognized category of school also have better than average EE score.

• In general, better educational environment is observed in urban areas compared to rural areas.

• Learners' mathematics performance is significantly influenced by all the three measured characteristics viz, school characteristic, teacher characteristic and domestic status and hence by the overall educational environment.

• A linear regression \( MP = 0.076 + 0.399 \text{SC} + 0.324 \text{DS} \) could be modeled from the observed data indicating the dependency of mathematics performance on school characteristic and domestic status. Teacher characteristic is not seen in the regression equation with positive co-efficient.

5.3 Development of fuzzy logic procedure for investigating effect of educational environment on performance in mathematics

The effect of educational environment and its three parameters on performance in mathematics are investigated by fuzzy logic procedures. Conditional and unqualified fuzzy logic proposition “If school characteristic (SC) is satisfactory” then “mathematics performance (MP) is high” has been considered and observed the following:
• Eight schools (out of 21) comprising provincialized rural schools, recognized rural schools and non-recognized rural school have exhibited full reflection of school characteristics on mathematics performance.

• Nine schools comprising provincialized rural, recognized rural and non-recognized rural school, with truth-value 0.8 and above, exhibited partial but higher degree of reflection of school characteristics on mathematics performance.

• The truth values of remaining 4 schools comprising rural provincialized and urban located provincialized schools are more than 0.6 (but less than 0.8), indicating partial reflection of the school characteristic on mathematics performance of learners.

• Overall, with varied degree of truth, mathematics performances of the schools are reflected by the school characteristics.

The conditional and unqualified fuzzy logic proposition "If teacher characteristic (TC) is satisfactory" then "mathematics performance (MP) is high" resulted the followings:

• Six schools (out of 21) comprising one government, four provincialized and one private school have exhibited full reflection of teacher characteristics on mathematics performance. Out of three urban located schools, two have exhibited full reflection. The degree of truth-values of six schools, comprising four provincialized and two recognized categories are above 0.8 and less than 1, showing partial but higher degree of reflection.
The truth-values of eight schools are more than 0.6 and less than 0.8 indicating partial reflection of the teacher characteristics on mathematics performance of learners. Majorities of these schools are recognized and non-recognized categories.

The unqualified fuzzy logic proposition "If learners' domestic status (DS) is satisfactory then mathematics performance (MP) is high" has yielded following results:

- Five schools comprising two provincialized schools, two non-provincialized schools (one recognized and another non-recognized) and an urban located private school are exhibited full reflection of domestic status on learner’s performance in mathematics.
- The degree of truth-values of nine schools comprising one government, five provincialized schools and two non-provincialized (one recognized and another one non-recognized) and one urban located private school are above 0.8 and less than 1 showing partial but higher degree of reflection.
- The truth-values of six schools belonging to four provincialized and two non-provincialized categories (one recognized & another one non-recognized) are more than 0.6 and less than 0.8 indicating partial reflection of the learners’ domestic status on mathematics performance.

Finally, the effect of educational environment on performance in mathematics is tested by the conditional and unqualified fuzzy logic proposition "If educational environment (EE) is satisfactory" then "mathematics performance (MP) is high". The results are given below:
• Seven schools comprising two provincialized rural, three recognized rural, one non-recognized rural and one urban located private school have exhibited full reflection of educational environment on learners' mathematics performance.

• The degree of truth-values of four schools, comprising one government, two provincialized rural and one recognized rural are above 0.9 and less than 1 showing partial but higher degree of reflection. On the other hand, truth-values of seven schools belonging to four provincialized, two recognized and one non-recognized are above 0.7 and less than 0.9 showing partial but higher degree of reflection.

• Overall, though the propositions have varied degrees of truth, performance in mathematics is adequately reflected by educational environment.

5.4 Syllabus and textbook with reference to learners' performance in mathematics

The adequacy of the syllabus and text books are analyzed based on the educational environment scores of 21 selected schools along with performance in mathematics in thirteen different areas. The salient points are noted below:

• Some provincialized rural located schools attaining satisfactory educational environment scores are found to have zero scores in the areas of algebraic fraction, variation and trigonometry indicating something non-adequacy either in the study content of these areas or in the way of teaching or in both.
• Besides provincialized schools, some rural recognized schools are also found to have zero scores in the areas of algebraic fraction, variation and trigonometry. Of course educational environment scores of some of these schools are not satisfactory.

• Maximum number of schools comprising government and provincialized schools with better financial and managerial inputs and non-provincialized schools with non-satisfactory educational environment scores are found to have below 40% scores in three significant areas viz. idea of set, linear simultaneous and quadratic equations and geometry. Lack of systematic organization of study content or lack of competency in teaching may cause this poor performance.

• From primary to secondary level the study contents are not very systematic with proper link of one topic to another. Emphasis is not given upon the necessity of preliminary concept of theoretical contents. Necessity of practical applications of theoretical knowledge is ignored in the syllabus & textbooks. Historical background and latest development of study contents are also not seen in the prescribed textbooks.

5.5 Conclusions and Suggestions

• The development of school education has been a major concern almost in all nations. This is also an important agenda in states of India. It is expected that proper education would solve many on-going problems having socio-economic roots in regions like Assam (India). Generally
learners' performance is considered as a yardstick of the success of the education. Mathematics is considered one of the important subjects in school education. The present investigation concerning learners' performance in mathematics subject has been carried out to identify the influencing factors.

- Variability in prevailing secondary school education in Assam is prominent with reference to several factors, which has influence on learners' performance. Attempt to make a quantified assessment of these factors and to test their influence on performance in mathematics subject have supported this fact. Academic reform is a continuous process carried out for its improvement. The results of the present investigation could be useful for such reform programmes and therefore, discussed below.

- The state of Assam is rural dominant. Majority of the population lives in rural areas. Therefore, the development of human resources in rural areas cannot be ignored. The results of present investigation revealed unsatisfactory performances of students belonging to majority of rural schools compared to their urban counterpart. Desirable ideal environment for the pupil concerning school, teacher and domestic factors has been conceptualized to investigate the reasons of differentiated performance. Poor performances in mathematics of pupil studying in rural areas are due to exposure to non-ideal academic environment.

- School environments of sixteen rural schools (out of 18 rural schools) are found below average improvement of which need financial and managerial inputs such as infrastructural facility, classroom management, parents'
involvement and academic meeting in school. The lacks of infrastructural facilities such as school building, library, playground, power connection are characteristic features of rural schools.

- Majority of the parents of rural areas remain unaware of academic affairs of their children. There may be several reasons for such behaviour of parents including their poor educational background and lower level of income. Thus, appropriate target oriented actions are required for improvement of school environment vis-à-vis performance in mathematics in rural areas.

- The role of Government accompanied by the appropriate actions of the social elements can only bring changes in school environment in rural areas.

- Major attributes related to mathematics teacher characteristics influencing learners' mathematics performance are educational background, training and workload. There are less variations of this parameter between rural and urban schools. Workload of teachers in rural schools, as assessed by student and mathematics teacher ratio, are found low due to lower student enrolment in majority of non-government rural schools. This might be the reason of comparatively better teacher characteristic in rural school. However, positive influence of this factor on learners' performance might have overpowered by poorer conditions of school domestic affairs. The action should be taken for its improvement.

- Domestic status of learners in rural schools is poor compared to urban schools. As mentioned earlier, parents' academic and economic
backgrounds are the prime reasons of such conditions. Urban parents are in better positions in both fronts. Parents’ financial condition, academic background and their awareness about the learners’ performance are mostly interrelated. Moreover, direct solution cannot be obtained for a given socio-economic condition. However, schools can take effective steps for such category of learners, where weaknesses in domestic fronts are inevitable. Such weak domestic situations are the inherent characteristics of the rural areas. Therefore, appropriate attention for improvement of conditions of teachers and domestic environment of learners are required for majority of the schools.

- Appropriate strategy should be evolved either to improve the learners’ domestic environment in rural areas or to strengthen the schools and teachers of rural schools so as to improve learners’ performance in mathematics.

- Some rural sectors such as rural health and rural communication are getting attention from the Government and results are reflected with proportionate improvement of these sectors in rural India including Assam. However, educational sector in general and rural education in particular are not getting appropriate attention in Assam.

- Government (GO) schools which are fully managed by Government and Provincialized (PZ) schools which are partially managed by Government have bettered the performance compared to Recognized (RG) and Non-recognized (NR) categories of schools. Financial conditions of both RG and NR schools are poor and these schools are located in rural areas. RG
schools are running with permission from the government education department. On the other hand, NR schools have been established and running with hope to get recognition and hence provincialization of the government. However, there is no provision of financial assistance to these categories of schools from Government. Thus, most of the RG and NR schools face financial crisis. There exists management committee run by local people for each of these schools. The managerial inputs provided by such committee are not sufficient which have been reflected by poor scores of educational environment in these schools. Moreover, for the obvious reason mostly the weaker section of the society has the access to these schools as reflected by poor domestic status.

- The performance of private school (PR) is better than the other categories of school. Though PR schools also do not get government assistance, the financial and managerial health of PR school is better. The fixation of higher fee compelled these schools to remain alert for higher performance so as to attract more students. Moreover, only wealthy parents can afford PR schools. PR schools are mostly run by individual or group and ensures better academic environment as reflected in this study.

- Analyzing the performance in mathematics subject of the pupil of some secondary schools in Assam, it is observed that serious and immediate steps must be initiated to address the issues, which has resulted poor performance in majority of the schools. Though the present investigation considers only mathematics subject, similar scenario might also prevail in other subjects. In general, the difference level of performances could be
seen in line with the difference in location (rural vs. urban) and management (government, non-government and private). Poor educational environments and hence poor performance in mathematics have been the characteristics of rural schools and non-private schools, which are not getting government assistance. Appropriate intervention is required to improve the academic performance of majority of secondary schools in Assam.

5.6 Suggestions for further research

Educational research plays a pivotal role in solving various educational problems. The progress of our society depends upon the quality of research undertaken and its (impact) effect is felt in the development of science & technology. The followings are some of the suggestions for further research:

- Research may be done on students' attitude and their performance in mathematics.
- Studies may be done on mathematics phobia of parents' and its effect upon their children.
- Research may be done on pattern and curriculum and its impact upon quality of education.
- Research may be done on how interest in mathematics reflects the achievement in mathematics.
- Study about public awareness of the importance of mathematics education to the country's future.
• Investigation may be done to identify the effective factors around the teaching-learning process.
• Study may be done about the anxiety and performance in mathematics of secondary level students.