CHAPTER FIVE
Discussion and Interpretation

5.1 Introduction
This chapter makes an attempt to discuss the findings and results on the basis of collected data and observations using achievement test for the fulfillment of the purpose of the study.

5.2. Construction of a standardized achievement test in mathematics
Construction of a standardized achievement test in mathematics is a very important part in elementary education in the context of RTE, 2009. To satisfy it, a standardized achievement test in mathematics with full marks 50 for the students completing elementary education was constructed with forty items. The test was administered on 400 students (210 boys and 190 girls) of 19 schools from rural areas of South 24 Parganas. The Split Half method was used to assure reliability. The reliability coefficients of the test found was 0.91. For validity, face validity and content validity were determined by inspection of test-items, judgment of subject experts and careful analysis of actual subject-matter studies and instructional objectives against the blueprint of the test. Also the raw scores were interpreted in terms of seven points scale of grading norms of West Bengal Board of Secondary Education (W.B.B.S.E.) for class VIII. The common content was taken from the text books of mathematics for students up to class VIII published by WBBSE, CBSE and ICSE. The content was divided into fourteen components which were already mentioned in the previous chapter.

5.3 Status of the students in the achievement test
The status of the students’ achievement in mathematics was observed in various items, components and different groups of mathematics. In the previous chapter students’ achievement were compared with respect to area, gender and grade, Therefore, in the present chapter discussion was done according to those categories.

5.3.1 Achievements of the total students
The mean value of the achievement test of the whole students under study was found 23.94 out of 50 marks and standard deviation was 9.39. Again for different category of response, it was observed that 48.39 % students gave correct response, 11.60 % students didn’t response, 1 %
students had given partially and rest of the students gave wrong response. It can be said response of boys students were in a little better position than the response of total students. It could be stated that boys students had given, 36.45 % wrong response, 51.48 % correct response .10.70 % of students couldn’t gave any answer. Almost 6% differences was observed in correct response among boys and girls students.

The result is consistent with the study conducted by NCERT through the National Learning Achievement in mathematics. In the year 2014 in the National Achievement Survey (NAS) for class VIII in mathematics conducted by NCERT the average score of 33 states/ UTs was 245 out of 500 with SE of 0.6. Also the mean value of result (out of 100) in mathematics found by them in the year 2012 is given below:

Table 4.34: Students’ achievements through NAS, 2012

<table>
<thead>
<tr>
<th>Round</th>
<th>Grade III</th>
<th>Grade V</th>
<th>Grade VIII</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round I</td>
<td>58.25</td>
<td>47.45</td>
<td>39.17</td>
</tr>
<tr>
<td>Round II</td>
<td>61.88</td>
<td>49.88</td>
<td>42.17</td>
</tr>
</tbody>
</table>

Under RTE, 2009 schools can meet their adequately yearly progress goals only if all subgroups meet national standards (or show adequate growth) in all subjects tested. The mathematics achievement of Indian children is improving, but still has a long way to go. To monitor achievement levels, Baseline Assessment Survey (BAS) was conducted in 1994 (NCERT, 1998), a Mid Term Assessment Survey (MAS) was conducted by the NCERT since 1997. One of the major objectives of MAS was to measure average performance of students’ achievement on the newly developed competency based achievement tests in language and mathematics at the end of Grade I and at the end of Grade III/IV of primary level. From 2005, the study conducted by NCERT was transformed to the National Learning Achievement in mathematics (NLA). On the National learning achievement survey by NCERT the math scores of third graders have steadily improved since 2005, at least 10% better achievement in pass percentage as in 2006–07 over the benchmarking level in 2005–06, and running of learning enhancement programmes especially
for the early primary grades in 19 States. That is, the steady current flows in the achievement of all children in mathematics in India since 2005.

5.3.2 Achievements of the students according to grade
The researcher followed the grading system of evaluation according to West Bengal Board of Secondary Education for class VIII which is mentioned in table 4.26 in the fourth chapter. Very few students had achieved AA and A+ grade, most of the students (total 48%) had gained B+ and B grade and it was noticeable to state that almost 10% students were disqualified in the test. i.e. they couldn’t achieve the minimum percentage of marks to qualify to the next class.

The students had done their best performances in statistical representation among fourteen components. In the component of construction the students also performed well. 83% students gave correct response in that component. In the component of perimeter, area of plane figures, geometrical transformation and similarity 60%-79% students performed correctly. 45%-59% students responded correctly in the other components namely fundamental geometrical concept, variables and algebraic expressions, linear equation, axioms in straight lines, angles, triangles etc. i.e. the basic fundamentals in mathematics.

The researcher had administered the achievement test in the schools of rural area of South 24 Parganas in West Bengal. The total area was divided into two parts, one adjacent to the city tagged as matured delta area and another nonstop created area nearby to the ocean and far from the city, labeled as active delta area. The reason behind the division into two areas are Matured delta area is the extension of city, satellite city attached to the town, hazards of urbanization such as mobile, internet, cinema, drugs. On the other hand, in active delta area rural status present, surrounded by river, forest, ocean, more virtual distance from city, demographic characteristics is totally different. There are many seasonal hazards like flood, cyclone, soil erosion, struggle with forest life. Besides that, occupations of the people of the two areas are totally different. In active delta area all students have to go to the government aided / affiliated school because there exists hardly private school, but in matured delta area students having economically sound background go to private school (CBSE, ICSE, English medium) and so after social screening economically weak, deprived, de motived students bound to go the government aided / affiliated / sponsored schools. Also students in matured delta area are dependent on private tutors who are low educated fellow. Actually the researcher talked with few students of matured delta area who have no home guidance, dependent on tuition, tutors had secondary level schooling who are unable to teach the real method, concept, values etc. But, students of active delta area
are very much dependent on school teachers who are qualified. Students’ achievement in mathematics for those two areas was shown elaborately in the previous chapter. It can be said that there stands very significant difference between the achievements of students of Active Delta Area and students of Matured Delta Area signifying that students of Active Delta Area have very much better achievements than the students of Matured Delta Area in mathematics.

Discussion with students, teachers, parents revealed the hidden causes behind success which focused the criteria: geographical location of their area, struggling in daily life, inconvenience in communication, lesser availability of information technology, agricultural dependence, good relationship between students and teacher, cooperative attitude of parents towards teachers, nature friendly mind-set, strong bonding of peer feelings, more acquaintances with calculation, more practical knowledge in weight, unit, volume, area, parental occupation namely fishermen, farmer etc. The students of active delta area learn informally many mathematical fundamentals like area, perimeter, concept of unit, weight through their daily life activities. While collecting data the investigator informally discuss with some students about their daily life. The researcher talked with Anshu (student completing of class VIII) helps his father in agriculture every day. He is 15 years old. At the time of ploughing he has to measure the area for dividing the whole area into different parts for growing different types of crops. Then he assists in watering the field. After growing is completed, he helps in weighing the crops to store it in jute bag. Then at the time of selling he has to estimate the price and reckoning the approximate result of the total value of the crops. Another student named Halim goes with his farther for fishing in the sea. He helps to keep the direction and speed of the boat. At the age of 14 he get hold of risky practice of crossing the sea. After catching fish he gives a hand to assess and balance in weighing for selling. In this way, like Anshu and Halim many students of that are bountiful to great effort to their families. As a result they become skilled in calculation, computation, weighing, measuring the land, maintaining speed and direction. These activities facilitate to breed their cognitive domain as well as affective and psychomotor domain also. This work value allows them to work on their own and make decision, also to service to others and work with co-workers in a friendly non-competitive environment. Again the researcher observed that they have to come school by walking or cycling. These help them to keep an eye on the distance, time and speed also. In this manner they perceive the functional ideas of mathematical principles and formulae which guide the way to go ahead in mathematics learning and achievement. Skuy et al., (1996) who expressed
the belief that the extent to which students take responsibility for their own learning is a good predictor of academic success. The present study has drawn attention to the reality that academic achievement in mathematics is influenced by the physical and educational environment of the home. That result was carried by the findings of the study in India and outside India in addition in twenty years back and in recent studies also. As for example, it can be said that in India Rajput (1984), Singh (1986), Deshmukh(1988), Prabha Rashmi (1992), Setia (1992), Mustafa (2009), Nuri & Hulya (2010) have focused the positive contribution of the home environment to the Achievement in Mathematics and outside India Pruett (1997), Jacobbi (1997) and Chen (2001) found that the Achievement in Mathematics is significantly influenced by Home physical and educational Environment. In the same way Bhargava (1980) found very significant and relevant with the findings of the present study which cannot be ignored. He found that the students of lower socio-economic comparison with those students who have high socio-economic status because the students of the low socio-economic status get more opportunity of calculation in their day to day life. They have to go to market and they make transactions and hence they become experts in the mathematical calculations and applications. It proves the validity of the reasons behind the achievement of the students with the findings of thirty six years old study. Also the recent findings could be shown here for the relevance of the present study.

In this context recommendation on Proposed New Education Policy 2016 by National Commission for Protection of Child Rights (NCPCR) can be included here: “Children, especially in rural areas, demonstrate great learning skills through their curiosity, exploration, experiments, and innovations with locally available material. However, their activity based learning is severely challenged in the classrooms which centre on textbooks, information and examinations. The worst sufferer in this situation is science, the subject of explorations, discoveries and innovations.”

5.3.3 Achievements of the students gender-wise

In the present study the overall mean achieved by boys students was 25.67 and that of girls students was found 22.03. Also from analysis by t-test (ref. chapter four, table 4.29) it can be said that there stands significant difference between the achievements of boys and girls signifying that boys have better achievements than girls in mathematics.
The gender based results of this study show female as less achievers in mathematics compared to their male counterparts. It was found that in arithmetic 30% correct response, in algebra 40% correct response, in geometry 50% correct response and in mensuration 60% correct response was obtained by all girls’ students.

This result is consistent with findings of many empirical studies showing that boys tend to outperform girls in mathematics achievement (Battista, 1990; Fennema and Carpenter, 1981; Wood, 1976). In the mathematics content domain males tend to do better than females and in mathematics problem domain females tend to do better than male. The NAS (National Achievement Survey), 2012 by NCERT found trends in Class VIII students which focused that nationally, there was no significant difference between boys and girls achievement levels in mathematics, science and social science. This was also true for most states although in Kerala, girls outperformed boys in all three subjects. In contrast, Opdenakker et.al. (2002), reported that proportion of girls was positively related to mathematics achievement. Further, Anderson et. al. (2006) reported that relationship between student gender and mathematics achievement was weak and mixed. The same result was obtained in the present study also. It was directed (From figure 4.18, chapter four ) that in geometry, mensuration and statistical representation groups, girls students secured the position higher in correct response, but as in previous case arithmetic and algebra groups, they had achieved the lower percentage in correct response. Girls had done better than boys in the component of fundamental geometrical concept, axioms on straight lines, angles, triangles etc. In this study also boys had done better performances than girls in most of the components among the specified fourteen components. That little difference was found because of the fact that girls students are neglected in homes as well as in schools for encouraging of doing mathematics. Conversation with girls students had directed to the decision that most of them are engaged in household work to help her mother. They got hardly time to prepare their homework and mathematics being a subject of practice at elementary level, girls students became backward in mathematics.

It was found also that the girls students of active delta area had done better than the boys students of matured delta area. If component wise result is considered then it can be observed that in all components the girls students of active delta area had done very much better than the boys students of matured delta area. In geometry, the girls students of active delta area had given
response 15% to 20 % better than the boys students of matured delta area in the achievement test in mathematics. The result is momentous encouraging and promising for our country. The findings also provide evidence for talent, capability and aptitude obtainable from girls students. Therefore they deserve quality, merit for doing mathematics under suitable and appropriate circumstances. In the country outside India some previous studies also support the present study’s results as Sinnes (2005), agreed that females in principle will produce exactly the same scientific knowledge as males provided that sufficient firmness is undertaken in scientific inquiry. Also, Abiam and Odok (2006) found no significant relationship between gender and achievement in number and numeration, algebraic and statistics. Fifty years ago, in India too Kulkarni, Lal and Naidu in their survey found that girls belonged to Delhi and Mysore get more marks in comparison to boys. Vermeer et al. (2000) as well had further shown that the gender differences in self confidence were more marked for application problems than computation problems, with girls showing significantly lower confidence for application problem. Again in 2000, Boaler showed that the girls’ confidence in mathematics improved greatly in classes which actively involved girls in the learning of mathematics. In the recent (2014) findings by NCERT through NAS for class VIII there is no significant difference in the performance of boys and girls as well as students from rural schools than urban schools in general. However, students of General and OBC category outperformed than that of SC category students. Therefore, the findings of the present study are departing similar indication with the result found fifty years ago in India and outside India as well and same that of the recent works in mathematics.

5.3.4 Gender - wise achievements of the students in intra- area

From analysis by t-test which was focused in detail in fourth chapter it can be said that there stands significant difference between the achievements of boys of active delta area and girls of active delta area, it enlightened that boys of active delta area have better achievements than girls of active delta area in mathematics. Also, it was found that there stands significant difference between the achievements of boys of matured delta area and girls of matured delta area signifying that boys of matured delta area have better achievements than girls of matured delta area in mathematics. As earlier it gives reasons for their prevailing significant difference between the achievements of girls of active delta area and boys of matured delta area implying that girls of active delta area have better achievements than boys of matured delta area in mathematics. It can be said that there stands very significant difference between the
achievements of girls students of active delta area and girls students of matured delta area showing that girls students of active delta area have very much better achievements than the girls students of matured delta area in mathematics. It focused that maximum boys students of active delta area had achieved A grade (60 %-80 %) whereas maximum girls students had achieved B+ grade ( 45 %-59 % ). Outstanding grade (90 %-100 %) was gained by 5 % of the boys students and 3.75 % of the girls students. But it was noticeable to observe that no girls students of that area had obtained grade D (i.e. below 25 %) whereas 1.25 % of boys students had obtained grade D (From figure 4.13, chapter four). It was observed that maximum of the girls students of active delta area had obtained grade B+ whereas maximum of the girls’ students had obtained the grade B. Also it was noticeable that 25.45% of girls students of matured delta area were at disqualified level of grade (Ref. figure 4.14, chapter four).

5.3. 5 Achievements of the students in different groups of mathematics

Among different groups of mathematics the result focused the point that the students were more comfortable with statistics and the back drop lies in the arithmetic and geometry group. (From figure 4.14) it can be said that an outstanding level of performances was observed for all students in statistical representation group, very good level of achievement was found in mensuration group. In algebra and geometry groups almost 50 % students gave correct response. The achievement of correct response in arithmetic group was very low for all students. It may be due to the fact that practical application of daily life experience of statistics in games, sports, weather reporting, comparison of production of food grains etc. where they have keen interest affected the achievement of students in that group. It can be said that in all the groups of mathematics, boys students of active delta area had given more than 60 % correct response.

It can be said that in mensuration group girls were in better position than boys w.r.t. correct response and in statistical representation group they were in same position .In algebra and geometry groups boys were in a little more better position than girls and in arithmetic group the differences of percentage of correct response was higher for boys students (From figure 4.18).

On the basis of the above discussion, it may be concluded that the items based on ‘Data Handling’ were easy as compared to those of ‘Algebra’ and ‘geometry’, whereas items based on Number System’ and ‘Ratio and Proportion’ were found to be the most difficult for the students. That judgment found in the present study was analogous to the findings of NAS in mathematics,
2014(cycle 3) by NCERT. They found that the items based on ‘Data Handling’ were easy as compared to those of ‘Algebra’ and ‘Number System’, whereas items based on ‘Mensuration’ and ‘Ratio and Proportion’ were found to be the most difficult for the students surveyed at Class VIII level.

5.4. Areas of weaknesses in mathematics

From the analysis set in the previous chapter it can be assumed that the students have difficulties with application based problem where thinking power of reasoning, skill of computation with decimal fraction, deep understanding of underlying concept of mathematical procedure are required. The students faced difficulties in the problems of number system and arithmetic.

In the four items mentioned in the previous chapter four the percentage of correct response is lesser than or equal to 25% i.e., the achievement of these item is below marginal level. (Ref. table 4.31) especially exposed those thrust in which vulnerable outcome had open. An identical impact about the weaknesses in those four items for both boys and girls students was seen. In all the four items performances were in a disgraceful stage. It also revealed the fed-up condition of students of Matured Delta Area in those four items. Again among those four items in two items specified earlier, percentages of correct responses were 9.58 and 9.16 exposing an awful status of weaknesses. The other two items showed a little better juncture in correct response even though vicinity in drawbacks remained the same. These drawbacks reminded us findings of Thakore (1980) in his constructed diagnostic tests on fractions and decimal fractions for the students of grade V of Gujarati medium school in greater Bombay. The tests and the remedial material prepared by the investigator. Ten diagnostic tests were prepared. Tests were administered to the students of 11 schools of Bombay. The major findings were that the students of class V did not have clear concept of fractions. They did not understand the place value of respective figures in decimal fractions. They did not understand addition, subtraction, multiplication and division of decimal fractions. After a long period of span the situation didn’t improve at all.

The researcher had identified the weaknesses in four categories which were- Type 1: Lack of Knowledge to identify the problem, Type 2: Lack of Understanding the method, Type 3: Lack of Power to apply and Type 4: Lack of Power of Skill to compute / evaluate the answer to the problem.
For qualitative analysis when the researcher talked to students, teachers and parents some problems related with the achievement test were revealed, that are discussed below:

Type 1: Lack of Knowledge to identify the problem

For those four items (item number 17, 35, 34 and 33 as mentioned in the chapter four), most of the students were totally confused with the problem, did not identify the problem and its method of solution. It was found that many of them were not familiar with the concept of unitary method and percentage. No systematic approach in writing or thinking, abrupt answer was written. Mistake was found done in subtraction of decimal numbers. They were confused with digits, not acquainted with decimal numbers and their operations, was not able to connect the problem with real-life situation. An abrupt attempt leads the student to get the price of 1 kg sugar Rs. 800. Most of the students had lack of ideas of place value in decimal numbers. No link between the two consequent lines of answer, no idea about what should be done in case of lesser quantity of product, if some data is given for higher quantity, also they had difficulties in the use of proper concept of unit. Conceptual error in case of using unit properly has been committed. Those students were not acquainted with the application of process of percentage or unitary method. They had no idea about when to divide or when to multiply in the process of unitary method, no idea of not using equal sign between two unequal numbers, totally lack of basic concept of arithmetic process. Those students were unaware of any properties relating to a triangle, not acquainted with the relation of an external angle with the two interior angles of a triangle. They possessed no sound knowledge in geometrical properties, even angle – sum properly was unknown. Many students gave an absurd answer without doing any rough work. They were not familiar with weighted mean or average method, not aware with mathematical language. Difficulties in conversion of decimal numbers into fraction were untied.

Type 2: Lack of Understanding the method

Again in many cases the student has identified the problem and diagnosed the method, tabulated it in a mathematical language, the student committed an error in formation of table of rule of three or without writing table directly applied the method of percentage with unitary method committed mistake. Totally lack of basic concept of arithmetic process was found. General (conventional) language proficiency influence the ability to comprehend word problems and the speed with which these problems are comprehended and solved {Clarkson (1991)}. The student
was acquainted with the given type of problem but did not understand the right method appropriate to the sum.

Type 3: Lack of Power to apply

The student had identified the problem as well as the method appropriate for it, wrote the correct table of rule of three but the student committed an error in formation of ratio and proportion by given data. That is, due to conceptual misunderstanding of hidden underlying correct concept of directly proportionate quantities or inversely proportionate quantities could not proceed in right way to complete the sum. Transformation of mathematical language into mathematical process was not familiar, behavior problems such as absenteeism are associated with lower achievement and this type of error.

Type 4: Lack of Power of Skill to compute/evaluate the answer to the problem

In this type the students had identified the problem, formed the table and diagnosed the method of solution in a correct way and had applied the process in a correct way, but at the time of evaluating the answer mistake was done i.e. mistake has been done at the time of calculation. That was due to absolute lack of concentration. Also difficulties in handling the operations on fraction and decimal fraction were a major grounds behind making the scheduled answer to the problem.

The student identified and understood both the problem and the consequent method but mistake was found in the last stage due to lack of practice. In these cases, home environment and the number of siblings are associated with achievement in mathematics. The findings through NAS, 2014 for class VIII by NCERT also shore up the same result.

Item 34 (mentioned in chapter four) was a very short type question on decimal numbers and fractions. This was also an application type question for which concentration and quick power of recognition skills are required. Only 20.5% students had given correct answers. Most of the students did not identify the problem and its method of solution. 65% students gave wrong answers by choosing wrong options given in the item in the test without showing any rough work.
5.5 Causes of Weakness/ Underachievement

From the discussion above it can be noticed that in application-based problem the students were facing most difficulties. In general weakness plunged in arithmetic and mensuration section. Also to make qualitative analysis discussion with students, teachers and parents were done. Therefore causes of weaknesses may be due to the reasons that are given below:

- The student’s ‘previous knowledge’ is not clear.
- The students do not have appropriate acquaintance with the method of the problem.
- The students do not have adequate comprehension to identify mathematical logic behind the method.
- The students may be short of sufficient realization for conversion verbal statement to mathematical statement.
- The students may be deficient in an adequate amount of practices to crack accurate answer.
- The students do not have ample proficiency recognize geometrical figure and associated properties.
- Mathematical anxiety influenced the achievement in mathematics. These thought includes belief system, feelings of inadequacy and fear of failure, poor test preparation and ineffective study methods. The same result was found by Ho et al., (2000) and Perry,( 2004).
- Socioeconomic background of the students: including insufficient exposure to everyday applications of mathematical concepts covered in class and parental attitude towards mathematics. The combined scores of the areas, social, family, education, profession, caste were treated as social status. Total assets and monthly income was treated as an economic status. It was found that a significant relationship existed between economic factors and attitude towards mathematics in respect of rural boys and girls. These findings is supported by the study by Akre and Bais (2008). Also the NAS, 2012 by NCERT suggested that coming from a larger family is associated with lower than average performance. Students with only one sibling outperform by a small, but statistically significant amount, those who have two or more brothers and sisters. Similarly the results suggest that the higher the parents education the more likely a student is to do well. Similarly if the language spoken at
home is the same as the language of instruction or whether the school is in an urban or rural environment can be associated with the achievement.

- Educators' own view: The educator’s own attitude towards mathematics and poor institution by the educator. The teacher has a key role in mediating learning and the study looked at various factors around the teacher and their teaching practices. Students who had their homework checked by their teacher every day tend to do better. What the teacher asks students to do in class also is associated with student achievement levels. Students who reported that they work with other students in small groups in solving mathematical problems tended to perform significantly better in mathematics than those who did not. On the issue of educator attitude, Yushau et al., (2004) in their report on the conceptions, learning and teaching of mathematics, attributed fears and anxiety of mathematics to the instructional approach of the teaching of mathematics.

- Attitude towards mathematics are often expressed in terms of liking or disliking certain aspects or types of mathematics (for example algebra). Stanic et al., 1995 and Maree (1999) found attitude towards mathematics and mathematics confidence to be related to achievement at school level.

- Motivation: A relation between achievement motivation and academic achievement exists. It can be that higher the achievement motivation higher is the academic achievement. Over achievers have more achievement motivation than under achievers. Singh and Kaur (2003) indicated that children coming from high educated groups have high academic achievement motivation. Thus family situation is a significant factor in the development of high achievement motivation.

- School leadership and governance: The NAS, 2012 by NCERT suggested that School leadership and governance seems to have a key role in achievement. Students at schools where the head teachers also teach classes tend to do better. Students at schools which have been inspected tend to do better. Students at schools who reported behavior problems, such as late arrivals, absenteeism, skipping classes or violations of school rules, tend to do worse. Having VEC/AEC/SMC committees is associated with better performance.
• The pupils’ perspective: The pupils perspective is very important and anything that affects a students’ ability or desire to attend school regularly and pay more attention in various curricular activities could be associated with achievement. To help encourage students to attend and stay in school more regularly, schools are offering various incentives. Incentive schemes such as offering a midday meal, free uniforms and scholarships appear to be associated with higher achievement. Of these incentives, scholarships seemed to have the highest impact.

Therefore, from the above discussion it can be assembled the fundamental understanding of these issues around the following four problems which all the educators including the researcher believe to be the core areas of concern (source NCERT):

1. A sense of fear and failure regarding mathematics among a majority of children,

2. A curriculum that disappoints both a talented minority as well as the non-participating majority at the same time,

3. Crude methods of assessment that encourage perception of mathematics as mechanical computation, and

4. Lack of teacher preparation and support in the teaching of mathematics. Previous learning experience: Previous poor performances in mathematics result in anxiety (Ho et al., 2000).

Also in the classroom there are four main issues in the teaching and learning of mathematics:

1. **Teaching methods**

The relationship between teachers’ instructional strategies and students’ achievements are found that appropriate teacher instructional strategies resulted in higher mean achievement measured by grades of students. It was observed that students of teachers who were well organized, achievement oriented and enthusiastic tended to have more positive attitude towards mathematics. In many investigations which studied the mathematical attitude of students and mathematics achievement described that the attitude of students can be influenced by the attitude of the teacher and his method of teaching. Studies carried out have shown that the teachers’ method of mathematics teaching and his personality greatly accounted for the students’ positive attitude towards mathematics and that, without interest and personal effort in learning mathematics by the students, they can hardly perform well in the subject. Students learn best
when the teacher uses a wide range of teaching methods. (Fennema and J. Sherman [1995], W. J. McKeachie and Y. Lin [1991], Yara (2009)). Bono (1991) in his study showed that girls would enjoy math, increase their time on math tasks, and have positive emotional reactions to math if math were taught in a cooperative setting.

2. Resources and teaching aids

Students learn best by doing things: constructing, touching, moving, and investigating. There are many ways of using cheap and available resources in the classroom so that students can learn by doing.

3. Language of the learner

- Language is as important as mathematics in the mathematics classroom. In addition, learning in a second language causes special difficulties. The most influence (Mestre, 1988) refers to proficiency with the symbolic language of mathematics (such as > or <).

- The another way in which language proficiency influence problem solving ability (Mestre, 1998; Sibaya et al., 1996) relates to the extent to which a student can translate a problem stated in general Bengali into a mathematical expressions or expression (which was found for the item number 35).

4. The culture of the learner

Students do all sorts of mathematics at home and in their communities. This is often very different from the mathematics they do in school. Examples should be taken from all over the surroundings of the world of students. Helping students to make that link will improve their mathematics.

5.6 Probable Remedial Measures

The researcher had observed that in numbers and operations on numbers weaknesses found irrespective of gender and area. From that point of view, some points bestowed vibration in the researcher’s mind which are discussed below.

Numeracy Experiences in the Middle Grades and High Schools and Mathematics Achievement
This is an age of data information — presented to us in the form of graphs, charts and statistics. Numbers and quantities control our decisions about almost everything — education, health, government, etc. Employers are dismayed by prospective job candidates’ lack of quantitative skills while postsecondary institutions are forced to offer a variety of remedial mathematics courses. These conditions translate directly into providing more students with “numeracy-rich” learning experiences in the middle grades and in high school. Numeracy not only includes knowledge of fundamental skills in mathematics, but also knowing when and how to use technology, making appropriate predictions from displays of data, and explaining reasoning.

With this in mind, the numeracy indicators for this study are intended to combine key elements of mathematics course content with assignments that extend quantitative thinking beyond the mathematics classroom and have students explain, reason, make predictions and draw conclusions. Students who have somewhat frequent to frequent numeracy experiences score significantly higher in mathematics achievement at both the middle grades and high school levels than students with infrequent numeracy experiences.

**What Can Schools Do to Increase the Frequency of Numeracy Experiences for Their Students?**

**In the middle grades and high school:**

_ Have teachers use a problem-solving approach to teach greater mathematics reasoning and understanding._

_ At the beginning of the lesson, pose a real-world problem that can be solved by applying the concepts and procedures being studied._

_ Allow students to struggle with the problem individually and in groups._

_ Give students time to think about how to solve the problem._

_ Ask several students to present ideas or solutions, and engage the class in discussing and identifying the strengths and weaknesses of each proposed solution._

_ Have students summarize the conclusion and work the problem, focusing on procedures and concepts needed to solve it. Provide additional thought-provoking practice problems for students during the remainder of the class and as part of their homework assignment._
At the conclusion of each chapter or unit, ask students to find a problem in business class, at the work site, in the community or at home that is an application of what they have just learned. Ask them to write up the problem and prepare the solution for presentation to the entire class.

Require students to analyze other students’ work.

Rather than having students just solve problems, also require them to explain how they arrived at their solution.

In the middle grades:

Require mathematics teachers who do not have a major or minor in mathematics to upgrade their content knowledge.

Have mathematics and other teachers — science, social studies, art, physical education and career exploration teachers — meet regularly to plan lessons that use mathematics knowledge and skills to advance students’ knowledge and understanding of their disciplines.

Designate a mathematics coach who can work with teachers in other classes to devise lessons that integrate more mathematics into their classes.

The most important resource undoubtedly is an adequately and appropriately educated teacher.

The main challenge is to find and educate sufficient teachers in the process, as well as the content, of mathematics, its curricular approach and appropriate didactics and teaching approaches. This challenge may seem too demanding for the realities of our countries. The final challenge is to educate stakeholders, beyond members of scientific communities and researchers in mathematics education, to include representatives of business and commercial groups, politicians, parents and local and national authorities. This involvement is essential for the support of teachers and students and for a renewal of the curriculum, both national and international. Six key factors come to the fore. The first is a curriculum based on mathematics process rather than a product, with the focus on deeper learning. The second factor is adequate and appropriate teacher education, as basic education crucially depends on the person who brings about the curriculum, whether present in the classroom or a remote or virtual teacher. Thirdly, to choose strategies that support such a vision of mathematics education. Fourthly, need to add complementary strategies and actions that improve equality of access for groups such as girls,
the poor and minority ethnic groups. Fifthly, need to be aware of the factors that help increase the numbers of students who wish to follow careers in mathematics. The sixth and final factor is the need to involve educators from outside the school system.

Again from the point of view of the rights of the students, the issues of availability, accessibility, acceptability and adaptability are essential. Without these, there can be no quality education. The consequences of a mathematics education in the long-term – to be able to participate in the variety of human activities and meet the challenges to society emphasize the importance of education.

Against all odds and amidst extreme diversity, it was found children who take to mathematics and teachers committed to mathematics education, statistically small, they still make up a large number given the size of the Indian population. While social barriers are a great challenge, the confidence and energy released by overcoming them is very positive. Mathematics, being the discipline of thought without great need for texts, and being the discipline that greatly inspires confidence and self-esteem, becomes then an instrument to break out of adversity for children from these disadvantaged sections, especially girls. Technology industry offers a sense of hope to people, and perhaps due to the popular perceptions of computing, to a surge in interest in mathematics education. Among this is a noticeable increase in the participation, in mathematics learning, of girls and children from underprivileged sections. The educational reform process initiated in the last decade has seen a churning across the country within school mathematics, in terms of attitudes and approaches to it. While it is too early to tell whether these efforts will lead to radical shifts, the trend is positive. Lastly, the use of technology, only recently coming in as a factor, may help India solve some of the systemic problems discussed above.

(Ramanujam, R. Mathematics education in India– An overview)

The above proposals should contribute to this challenge through developing new relationships between teachers and students, where knowledge is no longer the source of power for a few, where science is not an absolute but the fruit of the work of men and women across ages and cultures to which all can contribute. Savater (2004) points out that many in education are inclined to see the difficulties. However, he also points out that education presupposes an optimistic view of human potential. If we have faith in the potential of all involved in education, then we can bring about this vision of quality basic mathematics education for all.
The practices identified in this paper reflect a mixture of emerging strategies and practices in long-term use. The researcher briefly summarizes the research supporting each practice; describe how this research might be applied in actual classroom practice, and list the most important studies that support the practice. The strongest possibility of improving student learning emerges where schools implement multiple changes in the teaching and learning activities affecting the daily life of students. For example, if the aim is to improve students’ scientific problem-solving skills, the school might plan to introduce training for teachers in use of the learning cycle approach; use of computer simulations; and systemic approaches to problem solving.

To simultaneously plan for the training and other provisions needed to sustain all three of these changes would be no small undertaking, but would hold great promise for improving the quality of student problem solving. The researcher had suggested the following for remedial measures:

1. **Opportunity to learn**

The extent of the students’ opportunity to learn mathematics content bears directly and decisively on student mathematics achievement. The term ‘opportunity to learn’ (OTL) refers to what is studied or embodied in the tasks that students perform. In mathematics, OTL includes the scope of the mathematics presented, how the mathematics is taught, and the match between students’ entry skills and new material. The strong relationship between OTL and student performance in mathematics has been documented in many research studies. The concept was studied in the First International Mathematics Study (Husén), where teachers were asked to rate the extent of student exposure to particular mathematical concepts and skills. Strong correlations were found between student OTL scores and mean student achievement scores in mathematics, with high OTL scores associated with high achievement. The link between student mathematics achievement and opportunity to learn was also found in subsequent international studies, such as the Second International Mathematics Study (McKnight et al.) and the Third International Mathematics and Science Study (TIMSS) (Schmidt, McKnight & Raizen). As might be expected, there is also a positive relationship between total time allocated to mathematics and general mathematics achievement. Suarez et al., in a review of research on instructional time, found strong support for the link between allocated instructional time and student performance. Internationally, Keeves found a significant relationship across Australian states between achievement in mathematics and total curriculum time spent on mathematics. In spite of these
research findings, many students still spend only minimal amounts of time in the mathematics class. For instance, Grouws and Smith, in an analysis of data from the 1996 National Assessment of Educational Progress (NAEP) mathematics study, found that 20% of eighth-grade students had thirty minutes or less for mathematics instruction each day.

2. **Focus on meaning**

Focusing instruction on the meaningful development of important mathematical ideas increases the level of student learning.

There is a long history of research, going back to the 1940s and the work of William Brownell, on the effects of teaching for meaning and understanding in mathematics. Investigations have consistently shown that an emphasis on teaching for meaning has positive effects on student learning, including better initial learning, greater retention and an increased likelihood that the ideas will be used in new situations. These results have also been found in studies conducted in high-poverty areas.

Teachers will want to consider how various interpretations of this concept can be incorporated into their classroom practice.

- Emphasize the mathematical meanings of ideas, including how the idea, concept or skill is connected in multiple ways to other mathematical ideas in a logically consistent and sensible manner. Thus, for subtraction, emphasize the inverse, or ‘undoing’, relationship between it and addition.

- Create a classroom learning context in which students can construct meaning. Students can learn important mathematics both in contexts that are closely connected to real life situations and in those that are purely mathematical. The abstractness of a learning environment and how students relate to it must be carefully regulated, closely monitored and thoughtfully chosen.

- Make explicit the connections between mathematics and other subjects. For example, instruction could relate data gathering and data-representation skills to public opinion polling in Social studies. Or, it could relate the mathematical concept of direct variation to the concept of force in physics to help establish a real-world referent for the idea.

- Attend to student meanings and student understanding in instruction. Students’ conceptions of the same idea will vary, as will their methods of solving problems and carrying out procedures.
Teachers should build on students’ intuitive notions and methods in designing and implementing instruction.

3. Learning new concepts and skills while solving problems

Students can learn both concepts and skills by solving problems. Research suggests that students who develop conceptual understanding early perform best on procedural knowledge later. Students with good conceptual understanding are able to perform successfully on near-transfer tasks and to develop procedures and skills they have not been taught. Students without conceptual understanding are able to acquire procedural knowledge when the skill is taught, but research suggests that students with low levels of conceptual understanding need more practice in order to acquire procedural knowledge.

Research by Heid suggests that students are able to understand concepts without prior or concurrent skill development. In her research with calculus students, instruction was focused almost entirely on conceptual understanding. Skills were taught briefly at the end of the course. On procedural skills, the students in the conceptual-understanding approach performed as well as those taught with a traditional approach. In the classroom, there is evidence that students can learn new skills and concepts while they are working out solutions to problems. For example, armed with only a knowledge of basic addition, students can extend their learning by developing informal algorithms for addition of larger numbers. Similarly, by solving carefully chosen non-routine problems, students can develop an understanding of many important mathematical ideas, such as prime numbers and perimeter/area relations.

4. Opportunities for both invention and practice

Giving students both an opportunity to discover and invent new knowledge and an opportunity to practise what they have learned improves student achievement.

Research evidence suggests that students need opportunities for both practice and invention. The findings from a number of research studies show that when students discover mathematical ideas and invent mathematical procedures, they have a stronger conceptual understanding of connections between mathematical ideas.

Many successful reform-oriented programmes include time for students to practise what they have learned and discovered. Students need opportunities to practise what they are learning and
to experience performing the kinds of tasks in which they are expected to demonstrate competence. For example, if teachers want students to be proficient in problem solving, students must be given opportunities to practise problem solving. If strong deductive reasoning is a goal, student work must include tasks that require such reasoning. And, of course, if competence in procedures is an objective the curriculum must include attention to such procedures. Clearly, a balance is needed between the time students spend practising routine procedures and the time which they devote to inventing and discovering new ideas. Teachers need not choose between these activities; indeed, they must not make a choice if students are to develop the mathematical power they need. Teachers must strive to ensure that both activities are included in appropriate proportions and in appropriate ways.

To increase opportunities for invention, teachers should frequently use non-routine problems, periodically introduce a lesson involving a new skill by posing it as a problem to be solved, and regularly allow students to build new knowledge based on their intuitive knowledge and informal procedures.

5. Openness to student solution methods and student interaction

Teaching that incorporates students’ intuitive solution methods can increase student learning, especially when combined with opportunities for student interaction and discussion.

Findings from studies clearly demonstrate two important principles that are associated with the development of students’ deep conceptual understanding of mathematics. First, student achievement and understanding are significantly improved when teachers are aware of how students construct knowledge, are familiar with the intuitive solution methods that students use when they solve problems, and utilize this knowledge when planning and conducting instruction in mathematics. These results have been clearly demonstrated in the primary grades and are beginning to be shown at higher-grade levels. Second, structuring instruction around carefully chosen problems, allowing students to interact when solving these problems, and then providing opportunities for them to share their solution methods result in increased achievement on problem-solving measures. Importantly, these gains come without a loss of achievement in the skills and concepts measured on standardized achievement tests.

Research has also demonstrated that when students have opportunities to develop their own solution methods, they are better able to apply mathematical knowledge in new problem
situations. Research results suggest that teachers should concentrate on providing opportunities for students to interact in problem-rich situations. Besides providing appropriate problem-rich situations, teachers must encourage students to find their own solution methods and give them opportunities to share and compare their solution methods and answers. One way to organize such instruction is to have students work in small groups initially and then share ideas and solutions in a whole-class discussion.

One useful teaching technique is for teachers to assign an interesting problem for students to solve and then move about the room as they work, keeping track of which students are using which strategies (taking notes if necessary). In a whole class setting, the teacher can then call on students to discuss their solution methods in a pre-determined and carefully considered order, these methods often ranging from the most basic to more formal or sophisticated ones. This teaching structure is used successfully in many Japanese mathematics lessons.

6. Small-group learning

Using small groups of students to work on activities, problems and assignments can increase student mathematics achievement. Considerable research evidence within mathematics education indicates that using small groups of various types for different classroom tasks has positive effects on student learning. Davidson, for example, reviewed almost eighty studies in mathematics that compared student achievement in small-group settings with traditional whole-class instruction. In more than 40% of these studies, students in the classes using small-group approaches significantly outscored control students on measures of student performance. Some of the benefits of small group learning are as follows:

First, giving an explanation of an idea, method or solution to a team mate in a group situation was positively related to achievement. Second, receiving ‘non-responsive’ feedback (no feedback or feedback that is not pertinent to what one has said or done) from team mates was negatively related to achievement. Webb’s review also showed that group work was most effective when students were taught how to work in groups and how to give and receive help. Received help was most effective when it was in the form of elaborated explanations (not just the answer) and then applied by the student either to the current problem or to a new problem. Slavin’s research showed positive effects of small-group work on cross-ethnic relations and student attitudes towards school.
When using small groups for mathematics instruction, teachers should:

- choose tasks that deal with important mathematical concepts and ideas;
- select tasks that are appropriate for group work;
- consider having students initially work individually on a task and then follow this with group work where students share and build on their individual ideas and work;
- give clear instructions to the groups and set clear expectations for each;
- emphasize both group goals and individual accountability;
- choose tasks that students find interesting;
- ensure that there is closure to the group work, where key ideas and methods are brought to the surface either by the teacher or the students, or both.

Finally, as several research studies have shown, teachers should not think of small groups as something that must always be used or never be used. Rather, small-group instruction should be thought of as an instructional practice that is appropriate for certain learning objectives, and as a practice that can work well with other organizational arrangements, including whole-class instruction.

7. Whole-class discussion

While teaching teachers should give stress on whole class discussion, it helps students and teachers in various ways. Some of them are discussed in the following:

- Whole-class discussion following individual and group work improves student achievement. In various research findings it is observed that whole-class discussion can be effective when it is used for sharing and explaining the variety of solutions by which individual students have solved problems. It allows students to see the many ways of examining a situation and the variety of appropriate and acceptable solutions. Wood found that whole-class discussion works best when discussion expectations are clearly understood. Students should be expected to evaluate each other’s ideas and reasoning in ways that are not critical of the sharer. This helps to create an environment in which students feel comfortable sharing ideas and discussing each other’s methods and reasoning. Furthermore, students should be expected to
be active listeners who participate in the discussion and feel a sense of responsibility for each other’s understandings.

- Whole-class discussion can also be an effective diagnostic tool for determining the depth of student understanding and identifying misconceptions. Teachers can identify areas of difficulty for particular students, as well as ascertain areas of student success or progress.
- Whole-class discussion can be an effective and useful instructional practice. Some of the instructional opportunities offered in whole-class discussion do not occur in small group or individual settings. Thus, whole-class discussion has an important place in the classroom together with other instructional practices.

8. Number sense

Teaching mathematics with a focus on number sense encourages students to become problem solvers in a wide variety of situations and to view mathematics as a discipline in which thinking is important.

‘Number sense’ relates to having an intuitive feel for number size and combinations, as well as the ability to work flexibly with numbers in problem situations in order to make sound decisions and reasonable judgements. It involves being able to use flexibly the processes of mentally computing, estimating, sensing number magnitudes, moving between representation systems for numbers, and judging the reasonableness of numerical results.

Markovits and Sowder studied seventh-grade classrooms where special units on number magnitude, mental computation and computational estimation were taught. From individual interviews, they determined that after this special instruction students were more likely to use strategies that reflected sound number sense, and that this was a long-lasting change.

Other important research in this area involves the integration of the development of number sense with the teaching of other mathematical topics, as opposed to teaching separate lessons on aspects of number sense. In a study of second graders, Cobb and his colleagues found that students’ number sense was improved as a result of a problem-centred curriculum that emphasized student interaction and self-generated solution methods. Almost every student developed a variety of strategies to solve a wide range of problems. Students also demonstrated other desirable affective outcomes, such as increased persistence in solving problems.
Attention to number sense when teaching a wide variety of mathematical topics tends to enhance the depth of student ability in this area. Competence in the many aspects of number sense is an important mathematical outcome for students. Over 90% of the computation done outside the classroom is done without pencil and paper, using mental computation, estimation or a calculator. However, in many classrooms, efforts to instil number sense are given insufficient attention.

Although more research is needed, an integrated approach to number sense will be likely to result not only in greater number sense but also in other equally important outcomes.

9. Concrete materials

Long-term use of concrete materials is positively related to increases in student mathematics achievement and improved attitudes towards mathematics.

Many studies show that the use of concrete materials can produce meaningful use of notational systems and increase student concept development. In a comprehensive review of activity based learning in mathematics in kindergarten through grade eight, Suydam and Higgins concluded that using manipulative materials produces greater achievement gains than not using them. In a more recent meta-analysis of sixty studies (kindergarten through post-secondary) that compared the effects of using concrete materials with the effects of more abstract instruction, Sowell concluded that the long-term use of concrete instructional materials by teachers knowledgeable in their use improved student achievement and attitudes.

Although successful teaching requires teachers to carefully choose their procedures on the basis of the context in which they will be used, available research suggests that teachers should use manipulative materials in mathematics instruction more regularly in order to give students hands-on experience that helps them construct useful meanings for the mathematical ideas they are learning. Use of the same material to teach multiple ideas over the course of schooling has the advantage of shortening the amount of time it takes to introduce the material and also helps students to see connections between ideas.

The use of concrete material should not be limited to demonstrations. It is essential that children use materials in meaningful ways rather than in a rigid and prescribed way that focuses on remembering rather than on thinking. Thus, as Thompson said ‘before students can make
productive use of concrete materials, they must first be committed to making sense of their activities and be committed to expressing their sense in meaningful ways. Further, it is important that students come to see the two-way relationship between concrete embodiments of a mathematical concept and the notational system used to represent it.

10. Students’ use of calculators

Using calculators in the learning of mathematics can result in increased achievement and improved student attitudes.

The impact of calculator use on student learning has been a popular research area in mathematics education. The many studies conducted have quite consistently shown that thoughtful use of calculators in mathematics classes improves student mathematics achievement and attitudes towards mathematics. From a meta-analysis of seventy-nine non-graphing calculator studies, Hembree and Dessart concluded that the use of hand-held calculators improved student learning. In particular, they found improvement in students’ understanding of arithmetical concepts and in their problem-solving skills. Their analysis also showed that students using calculators tended to have better attitudes towards mathematics and much better self-concepts in mathematics than their counterparts who did not use calculators. They also found that there was no loss in student ability to perform paper-and-pencil computational skills when calculators were used as part of mathematics instruction.

Research on the use of scientific calculators with graphing capabilities has also shown positive effects on student achievement. Most studies have found positive effects on students’ graphing ability, conceptual understanding of graphs and their ability to relate graphical representations to other representations, such as tables and symbolic representations. Other content areas where improvement has been shown when these calculators have been used in instruction include function concepts and spatial visualization. Other studies have found that students are better problem solvers when using graphing calculators.

In addition, students are more flexible in their thinking with regard to solution strategies, have greater perseverance and focus more on trying to understand the problem conceptually rather than simply focusing on computations.