Chapter 5

FINDINGS AND CONCLUSION

SUMMARY FINDINGS AND CONCLUSION

In the light of interpretation of data, hypothesis formulated for the present study was tested and the conclusions were drawn with respect to the objectives of the data. It includes purpose of the study, objectives, hypotheses, brief description about the methodology, tenability of the hypotheses, major findings and discussion.

5.1 PURPOSE OF THE STUDY

The teaching and learning of mathematics have always been a matter of central concern in educational research. Since mathematics is a fundamental subject in school curricula, the desire to improve the effectiveness of teaching has stimulated a broad range of studies designed to understand the nature and development of mathematical abilities and the teaching strategies. Ability grouping increases student achievement by reducing the disparity in student ability levels. Ability grouping allows the teacher to increase the pace and raise the level of instruction for high ability students, and to provide more individual attention, repetition, and review for low ability students. The purpose of this research was to study the effectiveness of differentiated instruction based on ability grouping on the academic achievement in mathematics.

5.2. DIFFERENTIATED INSTRUCTION

Differentiating instruction means creating multiple paths so that students of different abilities, interest or learning need experience equally appropriate ways to absorb, use, develop and present concepts as a part of the daily learning process. It allows students to take greater responsibility and ownership of their own

learning. *Brain Research* identified the assumptions underlying the differentiated instruction are:

- No two children are alike.
- No two children learn in the identical way.
- An enriched environment for one student is not necessarily enriched for another.
- In the classroom one should teach children to think for themselves.

In Principles and Standards for School Mathematics, published by the National Council of Teachers of Mathematics of United States of America (NCTM, 2000) the writers asserted that, "All students, regardless of their personal characteristics, backgrounds, or physical challenges, must have opportunities to study and support to learn mathematics. Equity does not mean that every student should receive identical instruction; instead, it demands that reasonable and appropriate accommodations be made as needed to promote access and attainment for all students." This statement suggests that effective instruction utilizes a continuum of methods to serve diverse student populations (Singelton, Tucker, & Weaver, 2002). Teachers can no longer rely on the notion that one size fits all and must instead create opportunities for students to learn in every situation. One of the biggest misconceptions about teaching and learning mathematics is the belief that there is only one method for determining solutions (Kelly, 2005). Those embracing this sentiment have left students with disabilities in a challenging position. Borg and Stranahan (2002) were on the stand that students will do better in a class when their learning styles are similar to the instructor's teaching style. So grouping children by ability is an inescapable practice.

5.3 HIGH ABILITY STUDENTS

A high ability student in mathematics is one who performs at or shows the potential for performing at an outstanding level of accomplishment in at least one domain when compared with other students of the same age, experience, or environment; and is characterized by exceptional gifts, talents, motivation, or interests. High ability students differ from their classmates in pace at which they learn, depth of their understanding and interest that they hold, which are especially important in mathematics.

Since high ability students possess above characteristics they get bored with routine tasks but they resist changing away from interesting topics or activities. They are impatient with failure. According to Wine Brenner (1992), when teachers assume that the curriculum guides they have been given must be applied to all students, it creates a situation that most gifted students have a hard time dealing with. Many of these students will go through the motions, do the work and get an easy top grade. Other gifted students who are less motivated will turn in work that is sloppy and careless; because they feel, they are wasting time. Still other gifted students will simply give up, reject anymore repetition and refuse to do something they know is not necessary. Also High level ability students generally complete their work earlier than average and lower students. Instead of them being given challenging or enrichment material, often times they are just given more of the same work to do. Sometimes gifted students are put into a group of themselves and left to figure out the work on their own. During this time teacher focuses more on the needs of the average and low ability students. When the teacher does not know what to do with gifted students, those gifted children become frustrated. All these point out that, to teach according to their learning style, high ability

students could be placed in a separate class and explore them to various experiences through which they construct knowledge.

Constructivism is a psychological theory of knowledge, which argues that humans generate knowledge and meaning from their experiences. Constructivist teaching approach is based on the constructivist learning theory. This theoretical framework relies on the earlier framework of cognitivism, which holds that learning should build upon knowledge that a student already knows; this prior knowledge is called a schema (Piaget, 1967). Constructivists suggest learning is more effective when a student is actively engaged in the construction of knowledge rather than passively receiving it. Constructivism is child-centered; it proposes that learning environments should support multiple perspectives or interpretations of reality, knowledge construction, context-rich, experience-based activities. Constructivism focuses on knowledge construction, not knowledge reproduction. It is a belief that one constructs knowledge from one's experiences, mental structures, and beliefs that are used to interpret objects and events. The mind is instrumental and essential in interpreting events, objects, and perspectives on the base that is personal and individualistic. Our view of the external world differs from others because of our unique set of experiences. Learning is an internal process and influenced by the learner's personality, prior knowledge and learning goals. Constructivism describes a learner-centered environment where knowledge and the making of knowledge is interactive, inductive, and collaborative, where multiple perspectives are represented, and where questions are valued.

5.4 AVERAGE ABILITY STUDENTS

Average ability students, on most accounts, have been neglected by the researchers. There are very few studies which are related to average ability students. Research suggests that in mixed

ability classrooms, students of average ability are capable of learning more and faster. But some other suggests that average ability students achieve at the same rate whether or not they are involved in ability grouping. Most of the educationists think in this way too. But Gentry & Owen (1999) found that average ability students have better achievement when they are grouped for a subject or two. Also there is a significant difference between high, average and low ability students in cognitive and non cognitive factors (Ayishabi, 1988; Joseph, 2006). Summarize that, average ability students also need to be taught by differentiated instruction.

Average ability students prefer visual learning style (John, Lauren and Michel, 1998). Average ability Students are expected to master all of the objectives. They can learn from modeling and can do independent work. Average ability students need review and practice. Integrated technology approach enhances the learning of average ability students. In its most recent document, the National Council of Teachers of Mathematics of United States of America (NCTM, 2000) stated, "Technology is essential in teaching and learning mathematics; it influences what is taught and enhances students' learning"

5.5 LOW ABILITY STUDENTS

Low ability students when compared with normal students have been found inferior in intelligence and physical development. They have lesser capacity of abstract thinking and to correlate various experiences. In the class room low ability students get frustrated when teachers direct the instruction to average ability students. Students develop math's anxiety which interferes with their ability to handle academic situations and everyday life that involve the manipulation of numbers. Tension and anxiety prevent low ability students from performing well in math which leads them to failure in mathematics Willaim (1988). Often times, lower level

students have not had enough time to understand concepts and skills before the teacher moves to next lesson. The assignment given to them is too difficult and falls too far ahead of their grade level. They lack motivation to learn, either because their background has been too deprived, their home-induced emotional problems are too severe or their learning attempts have received no suitable encouragement or inconsistent reinforcement by the teacher. They become failure oriented because of repeated defeats and thus no longer believe them capable of learning. Low ability students express frustration because they needed more time to understand what was being taught. We should remember that some people will never be able to run a mile in four minute or to play Beethoven Moonlight Sonata (Hoffman & Worthy, 1996). In fact, some research suggests that low ability students have increased achievement when high ability students are removed from the regular classroom (Gentry & Owen, 1999). Condense is that, grouping together and taught accordingly may be the one of the possibilities for low ability students for their betterment.

Scaffold instruction is "the systematic sequencing of prompted content, materials, tasks, and teacher and peer support to optimize learning" (Chard, Dickson, & Simmons, 1993). Using scaffold instruction optimizes student learning by providing a supportive environment while facilitating student independence. Scaffolding is a process in which students are given support until they can apply new skills and strategies independently (Meister & Rosenshine, 1992).

Scaffolding allows the teacher to help students transition from assisted tasks to independent performances (Askew & Bliss, 1996; Bodrova & Leong, 1998; Palincsar, 1998). It is a step-by-step process that provides the learner with sufficient guidance until the process is learned, and then gradually removes the supports in

order to transfer the responsibility for completing the task to the student. The role of the scaffolding, however, is to eliminate the problems that could block students from getting it. The teacher must provide students with the optimal amount of support necessary to complete the task, and then progressively decrease the level of assistance until the student becomes capable of completing the activity independently (Elicker, 1995; Bodrova & Leong, 1998).

5.6 REVIEW OF RELATED LITERATURE

From the review of related literature, it can be seen that so many novel experiments were conducted in mathematics achievement (Jennifer & Kelly, 2009; Jenna, Sarah & Stephanie, 2009; Michael, 2008; Dennis & Eugene, 2007; Kimberly, 2004; Marian, 2003; Elizabeth, et. al., 2002; Sumangala, 1995; Rangappa, 1992; Bhaskaran, 1991; Ngailinkin, 1991). Recent studies were conducted on ability grouping in the international level (Bracha & Shlomit, 2008; Jamie, et.al., 2008; Judith & Susan, 2008; Yvette, 2007; Maureen, 2007). In the national level Kamalamani (2001) and Kantroo (1997) were conducted studies on non cognitive variables of ability grouping Ability grouping has a significant role in the achievement of mathematics. But most of the studies were conducted on ability grouping in descriptive method. Very few studies were conducted on ability grouping in India especially in Kerala. There were many limitations also found in ability grouping (Slavin, 1990). But these limitations were because of the same teaching approach for differently grouped classes (Kulik & Kulik, 1992). High ability students, average ability students and low ability students possess different characteristics. That is why, different instructional strategies were necessary in teaching of mathematics (Judith and Susan, 2008; Changhui, 2007; Saju, 2005). Hence researcher formed the research question as 'how will

differentiated instruction based on ability grouping affect the academic achievement in mathematics'.

5.7 RATIONALE FOR THE STUDY

The teaching and learning of mathematics have always been a matter of central concern in educational research. Since mathematics is a fundamental subject in school curricula, the desire to improve the effectiveness of teaching has stimulated a broad range of studies designed to understand the nature and development of mathematical abilities and the teaching strategies.

The subject mathematics is of great value: aesthetic, utilitarian and social. Mathematics sets the path to self-actualization. But mathematics is not a subject of choice for many students. Majority of students are afraid of mathematics and develop a phobia towards mathematics. Results of X standard students belong to Kerala Board of Public Instruction of few years show the true story. Failure in mathematics is very high in every year. For the last few years the percentage of failure in mathematics varied from 75% to 90% (Directorate of Public Instruction, Government of Kerala). Also in secondary level, the students understanding about the basic concepts of mathematics doesn't meet the expected level (Sasidharan, 1992; Pushpanadham, 1996 & Rachana, 2009). So the research in mathematics education is a major concern.

Ability grouping increases student achievement by reducing the disparity in student ability levels. Ability grouping allows the teacher to increase the pace and raise the level of instruction for high ability students, and to provide more individual attention, repetition, and review for low ability students. While most of the people assume that students will learn better if they are grouped together with those who have similar capabilities, research has shown that putting children into separate classes to accommodate

their differences from early school years is neither necessary nor very effective. But Bracha and Shlomit (2008) and Yvette (2007) proved that it plays a major role in secondary level for enhancing the achievement and motivation. On contrary Slavin (1990), while examining the effects of ability grouping on achievement of secondary students (middle, junior high, and high school), reported that in comparisons of ability grouping and heterogeneous grouping over periods of from one semester to five years, overall achievement effects were found to be essentially zero at all grade levels. But because of the different characteristics of high, average and low ability students, different instructional strategies are necessary in teaching of mathematics (Saju, 2005). Ability grouping is practicing in different countries with different forms. In Britain, the trend has been towards the increased setting (Boaler, Dylan & Brown, 2000). In U. S. A., grouping by subject has become more typical than streaming (Loveless, 1998). In France, ability grouping is not permitted (Greenway, 1999), while the British Government has endorsed and promoted ability grouping for the past decade (Andrews, 2001). Now in Kerala, inclusive education is practicing.

Students develop attitude towards mathematics through the instructional method that adopted by the teacher in the classroom. Kulik, J. and Kulik, C. (1982) and Kulik, C. (1985) reviewed the research regarding effects of grouping on attitude and self-esteem. They found that ability grouping in a subject resulted in a better attitude toward that subject but did not change attitudes about school. So the attitude towards mathematics is also a concern. Recent policy of NCERT, National Curriculum Framework for School Education (NCF, 2005), also categorically emphasize the importance of differentiated instruction. Researcher has not come across any study on differentiated instruction and its impact on

academic achievement and attitude towards mathematics. So the researcher conducted a study with the following research questions.

5.8 RESEARCH QUESTIONS

The research questions were:

- How will differentiated instruction based on ability grouping affect the academic achievement in mathematics?
- To what extent differentiated instruction can develop attitude towards mathematics among students?
- Whether the differentiated instruction in mathematics enhances students learning?

5.9 STATEMENT OF THE PROBLEM

The problem entitled as "effectiveness of differentiated instruction based on ability grouping on the academic achievement in mathematics among the IX standard students in Kerala".

5.10 OBJECTIVES OF THE STUDY

The objectives of the study were:

- To develop differentiated instructional designs based on ability grouping for teaching mathematics in Kerala at standard IX.
- To implement the differentiated instructional designs in individual ability groups of IX standard students in mathematics.
- To study the effectiveness of differentiated instruction based on ability grouping with respect to the academic achievement in mathematics among IX standard students in Kerala.

- To study the effectiveness of differentiated instruction based on ability grouping with respect to the attitude of students towards mathematics.

5.11 OPERATIONAL DEFINITION OF THE TERMS USED

5.11.1. ABILITY GROUPING

Ability grouping refers to the grouping of students based on their achievement scores in mathematics in the previous year's final examination and the scores obtained from the ability test in mathematics conducted by the researcher. The ability test includes Kerala University Test of Spatial Ability (1982), which was developed and standardized by N. P. Pillai, A. S. Nair and M. P. Ouseph, Kerala Test of Perceptual Speed (1985), which was developed and standardized by A. Sukumaran Nair and N. Krishnakurup and Kerala University test of Numerical Ability (1982), which was developed and standardized by N. P. Pillai, A. S. Nair and A. Indira Bai.

5.11.2. DIFFERENTIATED INSTRUCTION

Differentiated instruction refers to the instructional designs that were developed by the researcher for the students of different ability groups.

5.11.3. ACADEMIC ACHIEVEMENT

Academic achievement refers to the score obtained in an achievement test in mathematics which was constructed and standardized by the researcher.

5.12 DELIMITATION OF THE STUDY

The study is delimited to the IX standard students of Kerala Board of Public Instruction.

5.13 HYPOTHESES OF THE STUDY

The hypotheses in this study were:

- There is no significant difference in the academic achievement in mathematics among the IX standard students in ability groups when taught by differentiated instruction and the students in mixed ability group when taught by traditional method of instruction.
- There is no significant difference in the academic achievement in mathematics among the IX standard students in high ability group when taught by differentiated instruction and the high ability students in mixed ability group when taught by traditional method of instruction.
- There is no significant difference in the academic achievement in mathematics among the IX standard students in average ability group when taught by differentiated instruction and the average ability students in mixed ability group when taught by traditional method of instruction.
- There is no significant difference in the academic achievement in mathematics among the students of standard IX in low ability group when taught by differentiated instruction and the low ability students in mixed ability group when taught by traditional method of instruction.
- There is no significant effect of differentiated instruction on the attitude towards mathematics among the IX standard students of high ability group.

- There is no significant effect of differentiated instruction on the attitude towards mathematics among the IX standard students of average ability group.

- There is no significant effect of differentiated instruction on the attitude towards mathematics among the IX standard students of low ability group.

- There is no significant effect of differentiated instruction on attitude towards mathematics among the IX standard students in ability groups and the students in mixed ability group when taught by traditional method of instruction.

- There is no significant effect of differentiated instruction on attitude towards mathematics among the IX standard students in high ability group and the high ability students in mixed ability group when taught by traditional method of instruction.

- There is no significant effect of differentiated instruction on attitude towards mathematics among the IX standard students in average ability group and the average ability students in mixed ability group when taught by traditional method of instruction.

- There is no significant effect of differentiated instruction on attitude towards mathematics among the IX standard students in low ability group and the low ability students in mixed ability group when taught by traditional method of instruction.

5.14 METHODOLOGY

5.14.1. METHOD SELECTED FOR THE STUDY

Since the aim of the study is to find out the effectiveness of differentiated instruction based on ability grouping on the academic achievement in mathematics instruction among the secondary schools in Kerala, the experimental method was adopted for the study.

5.14.2. RESEARCH DESIGN

The research design selected for the present study is pretest-posttest control group design. The researcher selected this design because the combination of random assignment and the presence of a pretest and a control group serve to control for all sources of internal validity.

5.14.3. VARIABLES IN THE STUDY

In this study independent variable is the differentiated instruction based on ability grouping in mathematics and dependent variables are the achievement in mathematics and attitude towards mathematics.

5.14.4. POPULATION

Population of the study consists of IX standard students from 2,608 secondary schools (Directorate of Public Instruction, Government of Kerala), following the Kerala State syllabus for the academic year 2009-2010, in Kerala.

5.14.5. SAMPLE

Purposive sampling technique was used to identify the secondary schools situated in three different districts of Kerala for making participant observation for understanding the teaching-

learning process of mathematics in heterogeneous groups in regular classrooms considering the following criteria;

- The school has at least three sections of standard IX because to ensure sufficient samples for homogeneous grouping.
- The school consistently gets average results in mathematics in previous Board Examinations to ensure heterogeneity.

Thus nine schools were identified and the researcher observed 54 mathematics classes of standard VIII, IX and X to study the different learning styles of the students in mathematics and the problems occurring in a mathematics classroom. From these schools researcher randomly selected a school for experimentation.

5.14.6. RESEARCH TOOLS AND TECHNIQUES

Following were the tools used for the data collection:

5.14.6.1 Ability Test

To know the mathematical ability of students Kerala University Test of Spatial Ability (1982), Kerala Test of Perceptual Speed (1976) and Kerala University Test of Numerical Ability (1982) were used along with previous year's final year examination score. The Kerala University Test of Spatial Ability was developed and standardized by N. P. Pillai, A. S. Nair and M. P. Ouseph, Kerala Test of Perceptual Speed was developed and standardized by A. Sukumaran Nair and N. Krishnakurup and Kerala University Test of Numerical Ability was developed and standardized by N. P. Pillai, A. S. Nair and A. Indira Bai. Based on the sum of these scores obtained by administering these tests, students were divided in to three groups - high ability students, average ability students and low ability students.

5.14.6.2 Attitude Scale in Mathematics

To check the attitude of IX standard students towards mathematics, modified Fennema - Sherman Mathematics Attitude Scales (1983) was used by the researcher. The researcher conducted this test before and after the experimentation and tested for significant difference to know the attitude towards mathematics in ability groups as well as in mixed ability group.

5.14.6.3 Designs for Differentiated Instruction

The researcher developed instructional designs for differentiated instruction based on mathematical ability of students and validated the same with the help of subject experts. The standard IX mathematics text book prescribed by Education Department, Government of Kerala, was taken as a frame of reference.

5.14.6.4 Achievement Test in Mathematics

An achievement test in mathematics of Standard IX was constructed and standardized by the researcher. While developing the test, researcher given utmost importance to test the associated abilities in mathematics in both procedural and conceptual knowledge with respect to each topic. The researcher constructed a draft test of 60 items first and administered to a sample of 500 in number. Item analysis was done by taking the scores of upper 27% and lower 27%. With the help of difficulty index and discriminating power, 40 items were selected for achievement test. Then validity and reliability were established by suitable methods.

5.14.7 PROCEDURE ADOPTED FOR DATA COLLECTION

The researcher conducted ability test for standard VIII students in the academic year 2008-2009. Also collected their' final marks for the academic year 2008-2009. Based on these two scores

the students were categorized in to three groups as high ability students, average ability students and low ability students for the academic year 2009-2010. Researcher randomly assigned same number of students to experimental group (ability group) and control group (mixed ability group). The experimental group consists of three: high ability group, average ability group and low ability group, in which all the three groups were separately taught by differentiated instruction. The control group consists of a mix of three: high ability students, average ability students and low ability students, in which all the students were taught by traditional method of instruction.

The researcher obtained the pre-test scores by administering the achievement test and attitude test before the experimentation. Then the experimental group was taught by differentiated instruction and the control group was taught by traditional method of instruction. Researcher obtained the post-test scores by administering the achievement test and attitude test after experimentation. By comparing these scores the analysis was done.

5.15 TENABILITY OF HYPOTHESES

The first hypothesis states that "there is no significant difference in the academic achievement in mathematics among the IX standard students in ability groups when taught by differentiated instruction and the students in mixed ability group when taught by traditional method of instruction".

The findings of the study rejected the hypothesis. The result of the study indicates that there is a significant difference in the academic achievement in mathematics among the students of standard IX in ability groups when taught by differentiated instruction and the students in mixed ability group when taught by traditional method of instruction.

The second hypothesis states that "there is no significant difference in the academic achievement in mathematics among the IX standard students in high ability group when taught by differentiated instruction and the high ability students in mixed ability group when taught by traditional method of instruction".

The findings of the study rejected the hypothesis. The result of the study indicates that there is a significant difference in the academic achievement in mathematics among the IX standard students in high ability group when taught by differentiated instruction and the high ability students in mixed ability group when taught by traditional method of instruction.

The third hypothesis states that "there is no significant difference in the academic achievement in mathematics among the IX standard students in average ability group when taught by differentiated instruction and the average ability students in mixed ability group when taught by traditional method of instruction".

The findings of the study rejected the hypothesis. The result of the study indicates that there is a significant difference in the academic achievement in mathematics among the IX standard students in average ability group when taught by differentiated instruction and the average ability students in mixed ability group when taught by traditional method of instruction.

The fourth hypothesis states that "there is no significant difference in the academic achievement in mathematics among the IX standard students in low ability group when taught by differentiated instruction and the low ability students in mixed ability group when taught by traditional method of instruction".

The findings of the study rejected the hypothesis. The result of the study indicates that there is a significant difference in the academic achievement in mathematics among the IX standard

students in low ability group when taught by differentiated instruction and the low ability students in mixed ability group when taught by traditional method of instruction.

The fifth hypothesis states that "there is no significant effect of differentiated instruction on the attitude towards mathematics among the IX standard students of high ability group".

The findings of the study rejected the hypothesis. The result of the study indicates that differentiated instruction has a significant effect on the attitude towards mathematics among the IX standard students of high ability group.

The sixth hypothesis states that "there is no significant effect of differentiated instruction on the attitude towards mathematics among the IX standard students of average ability group".

The findings of the study rejected the hypothesis. The result of the study indicates that differentiated instruction has a significant effect on the attitude towards mathematics among the IX standard students of average ability group.

The seventh hypothesis states that "there is no significant effect of differentiated instruction on the attitude towards mathematics among the IX standard students of low ability group".

The findings of the study rejected the hypothesis. The result of the study indicates that differentiated instruction has a significant effect on the attitude towards mathematics among the IX standard students of low ability group.

The eighth hypothesis states that "there is no significant effect of differentiated instruction on attitude towards mathematics among the IX standard students in ability groups and the students in mixed ability group when taught by traditional method of instruction".

The findings of the study rejected the hypothesis. The result of the study indicate that there is a significant effect of differentiated instruction on the attitude towards mathematics among the IX standard students in ability groups and the students in mixed ability group when taught by traditional method of instruction.

The ninth hypothesis states that "there is no significant effect of differentiated instruction on attitude towards mathematics among the IX standard students in high ability group and the high ability students in mixed ability group when taught by traditional method of instruction".

The findings of the study rejected the hypothesis. The result of the study indicate that there is a significant effect of differentiated instruction on the attitude towards mathematics among the IX standard students in high ability group and the high ability students in mixed ability group when taught by traditional method of instruction.

The tenth hypothesis states that "there is no significant effect of differentiated instruction on attitude towards mathematics among the IX standard students in average ability group and the average ability students in mixed ability group when taught by traditional method of instruction".

The findings of the study rejected the hypothesis. The result of the study indicate that there is a significant effect of differentiated instruction on the attitude towards mathematics among the IX standard students in average ability group and the average ability students in mixed ability group when taught by traditional method of instruction.

The eleventh hypothesis states that "there is no significant effect of differentiated instruction on attitude towards mathematics among the IX standard students in low ability group and the low ability students in mixed ability group when taught by traditional method of instruction".

The findings of the study rejected the hypothesis. The result of the study indicate that there is a significant effect of differentiated instruction on the attitude towards mathematics among the IX standard students in low ability group and the low ability students in mixed ability group when taught by traditional method of instruction.

5.16 MAJOR FINDINGS

The following are the major findings:

1. The mathematics achievement score of the students in ability groups taught through differentiated instruction was significantly higher in comparison to mathematics achievement score of the students in mixed ability group taught through traditional method of instruction.

This finding is based on the following:

The F value from the analysis of covariance of the mathematics achievement score of the students in ability groups taught by differentiated instruction and the students in mixed ability group taught by traditional method of instruction is significant at 0.05 level. ($F_{yx} = 5.15$; $p < 0.05$).

The adjusted mean scores of the students in ability groups taught by differentiated instruction and the students in mixed ability group taught by traditional method of instruction are 28.05 and 25.76. The t value of adjusted means of the students in ability groups taught by differentiated instruction and the students in mixed ability group taught by traditional method of instruction is significant at 0.05 level ($t = 2.27$; $p < 0.05$). Thus differentiated

instruction is helped the students in ability groups for enhancing the mathematics achievement over traditional method of instruction.

2. The mathematics achievement score of the students in high ability group taught through differentiated instruction was significantly higher in comparison to mathematics achievement score of the high ability students in mixed ability group taught through traditional method of instruction.

This finding is based on the following:

The F value from the analysis of covariance of the mathematics achievement score of the students having high ability in ability groups taught by differentiated instruction and the students having high ability in mixed ability group taught by traditional method of instruction is significant at 0.01 level. ($F_{yx} = 7.55$; $p < 0.01$).

The adjusted mean scores of the students having high ability in ability groups taught by differentiated instruction and the students having high ability in mixed ability group taught by traditional method of instruction are 35.63 and 34.20. The t value of adjusted means of the students having high ability in ability groups taught by differentiated instruction and the students having high ability in mixed ability group taught by traditional method of instruction is significant at 0.01 level. ($t = 2.75$; $p<0.01$). Thus differentiated instruction is helped the high ability students for enhancing the mathematics achievement over traditional method of instruction.

3. The mathematics achievement score of the students in average ability group taught through differentiated instruction was significantly higher in comparison to mathematics

achievement score of the average ability students in mixed ability group taught through traditional method of instruction.

This finding is based on the following:

The F value from the analysis of covariance of the mathematics achievement score of the students having average ability in ability groups taught by differentiated instruction and the students having average ability in mixed ability group taught by traditional method of instruction is significant at 0.05 level ($F_{yx} = 6.83$; $p < 0.05$).

The adjusted mean scores of the students having average ability in ability groups taught by differentiated instruction and the students having average ability in mixed ability group taught by traditional method of instruction are 28.14 and 26.28. The t value of adjusted means of the students having average ability in ability groups taught by differentiated instruction and the students having average ability in mixed ability group taught by traditional method of instruction is significant at 0.05 level.($t = 2.62$; $p<0.05$). Thus differentiated instruction is helped the average ability students for enhancing the mathematics achievement over traditional method of instruction.

4. The mathematics achievement score of the students in low ability group taught through differentiated instruction was significantly higher in comparison to mathematics achievement score of the students having low ability in mixed ability group taught through traditional method of instruction.

This finding is based on the following:

The F value from the analysis of covariance of the mathematics achievement score of the students having low ability in ability groups taught by differentiated instruction and the students having low ability in mixed ability group taught by

traditional method of instruction is significant at 0.01 level (F_{yx} = 10.08; p < 0.01).

The adjusted mean scores of the students having low ability in ability groups taught by differentiated instruction and the students having low ability in mixed ability group taught by traditional method of instruction are 19.63 and 17.33. The t value of adjusted means of the students having low ability in ability groups taught by differentiated instruction and the students having low ability in mixed ability group taught by traditional method of instruction is significant at 0.01 level. (t = 3.18; p < 0.01). Thus differentiated instruction is helped the low ability students for enhancing the mathematics achievement over traditional method of instruction.

5. Differentiated instruction has a significant effect on attitude towards mathematics among students in high ability group.

This finding is based on the following:

The mean attitude scores of the students in high ability group taught by differentiated instruction and the students in high ability group before the instruction are 270.93 and 264.09. The t value of mean attitude scores of the students in high ability group taught by differentiated instruction and the students in high ability group before the instruction is significant at 0.05 level. (t = 2.36; p < 0.05). Thus differentiated instruction helped the high ability students for a significant effect on attitude towards mathematics.

6. Differentiated instruction has a significant effect on attitude towards mathematics among students in average ability group.

This finding is based on the following:

The mean attitude scores of the students in average ability group taught by differentiated instruction and the students in average ability group before the instruction are 242.14 and 216.17. The t value of mean attitude scores of the students in average ability group taught by differentiated instruction and the students in average ability group before the instruction is significant at 0.01 level. ($t = 7.7$; $p < 0.01$). Thus differentiated instruction helped the average ability students for a significant effect on attitude towards mathematics.

7. Differentiated instruction has a significant effect on attitude towards mathematics among students in low ability group.

This finding is based on the following:

The mean attitude scores of the students in low ability group taught by differentiated instruction and the students in low ability group before the instruction are 242.14 and 216.17. The t value of mean attitude scores of the students in low ability group taught by differentiated instruction and the students in low ability group before the instruction is significant at 0.01 level. ($t = 7.7$; $p < 0.01$). Thus differentiated instruction helped the low ability students for a significant effect on attitude towards mathematics.

8. Differentiated instruction has a significant effect on attitude towards mathematics among the students in ability groups when compared with the students in mixed ability group.

This finding is based on the following:

The F value from the analysis of covariance of the attitude towards mathematics of the students in ability groups taught by differentiated instruction and the students in mixed ability group

taught by traditional method of instruction is significant at 0.01 level. (F_{yx} = 163.37; p < 0.01).

The adjusted mean attitude scores of the students in ability groups taught by differentiated instruction and the students in mixed ability group taught by traditional method of instruction are 243.25 and 217.23. The t value of adjusted mean attitude scores of the students in ability groups taught by differentiated instruction and the students in mixed ability group taught by traditional method of instruction is significant at 0.01 level (t = 12.79; p<0.01). Thus differentiated instruction helped the students in ability groups for a significant effect on attitude towards mathematics than the students in mixed ability classroom.

9. Differentiated instruction has a significant effect on attitude towards mathematics among the students in high ability group when compared with the high ability students in mixed ability group.

This finding is based on the following:

The F value from the analysis of covariance of the attitude towards mathematics of the students having high ability in ability groups taught by differentiated instruction and the students having high ability in mixed ability group taught by traditional method of instruction is significant at 0.01 level. (F_{yx} = 13.24; p < 0.01).

The adjusted mean attitude scores of the students having high ability in ability groups taught by differentiated instruction and the students having high ability in mixed ability group taught by traditional method of instruction are 270.52 and 265.10. The t value of adjusted mean attitude scores of the students having high ability in ability groups taught by differentiated instruction and the students having high ability in mixed ability group taught by traditional method of instruction is significant at 0.01 level (t = 3.64; p < 0.01). Thus differentiated instruction helped the high

ability students for a significant effect on attitude towards mathematics than the students in mixed ability classroom.

10. Differentiated instruction has a significant effect on attitude towards mathematics among the students in average ability group when compared with the average ability students in mixed ability group.

This finding is based on the following:

The F value from the analysis of covariance of the attitude towards mathematics of the students having average ability in ability groups taught by differentiated instruction and the students having average ability in mixed ability group taught by traditional method of instruction is significant at 0.01 level. (F_{yx} = 38.76; $p<0.01$).

The adjusted mean attitude scores of the students having average ability in ability groups taught by differentiated instruction and the students having average ability in mixed ability group taught by traditional method of instruction are 240.80 and 220.81. The t value of adjusted mean attitude scores of the students having average ability in ability groups taught by differentiated instruction and the students having average ability in mixed ability group taught by traditional method of instruction is significant at 0.01 level. ($t = 6.39$; $p < 0.01$). Thus differentiated instruction helped the average ability students for a significant effect on attitude towards mathematics than the students in mixed ability classroom.

11. Differentiated instruction has a significant effect on attitude towards mathematics among the students in low ability group when compared with the low ability students in mixed ability group.

This finding is based on the following:

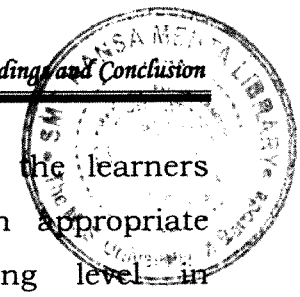
The F value from the analysis of covariance of the attitude towards mathematics of the students having low ability in ability groups taught by differentiated instruction and the students having low ability in mixed ability group taught by traditional method of instruction is significant at 0.01 level. (F_{yx} = 645.85; $p < 0.01$).

The adjusted mean attitude scores of the students having low ability in ability groups taught by differentiated instruction and the students having low ability in mixed ability group taught by traditional method of instruction are 220.33 and 166.10. The t value of adjusted mean attitude scores of the students having low ability in ability groups taught by differentiated instruction and the students having low ability in mixed ability group taught by traditional method of instruction is significant at 0.01 level ($t = 25.41$; $p < 0.01$). Thus differentiated instruction helped the low ability students for a significant effect on attitude towards mathematics than the students in mixed ability classroom.

5.17 IMPLICATIONS OF THE STUDY

The study emphasized on the need for differentiated instruction to address the learning difficulties in mathematics among the students. The findings of the study are relevant to draw implications to the mathematics instruction in schools in general, and mathematics learning among students in specific. Both of them throw light on the curriculum, teacher preparation and development, designing learning enrichment materials, appropriate assessment and evaluation practices especially in mathematics. Teachers, researchers, parents and policy makers can take some specific steps to improve learning of mathematics in our schools. Thoughtful analysis of individual difference and children will provide a useful method of instruction for improvement.

The present study underlined the need for differentiated instruction meeting the mixed learning needs for differently abled



students. Realizing the multiple learning styles of the learners based on their abilities, teachers need to design appropriate instructional strategies. Since the understanding level in mathematics and the pace of learning are very much different for high, average and low ability students, there is a need for differentiated classroom. The classroom environment can also be tuned to elicit the different abilities of high, average and low ability students with respect to mathematics learning. It is the learning strategy that makes learners active in the learning process and develops capacity for upward mobility from low ability to high ability group, as is the objective of education.

To teach a differentiated classroom is not an easy one. So teachers need to be trained to accommodate different learning needs of differently able students. Government and nongovernmental organizations can do much in this area. Also there is a need for a change in the theoretical foundations for mathematics education and the pedagogical analysis of mathematics. This will make the pre service teachers to accommodate the different learning needs of high, average and low ability students. Also teachers need to be trained to identify the high, average and low ability students.

The guidance and counseling centers of respective schools can also play a marked role in the area of differentiation. They can make students to understand the strengths and weaknesses in mathematics and to accept the difference. They can also guide the parents in this regard.

Parents also need to aware the different abilities of high, average and low ability students. They can reduce the excessive mental tensions of low ability students. Normally students are badly affected by the comparison to the peers by parents. So, parents also need to understand the different abilities of high, average and low

ability students. This will make students to achieve their goals in mathematics learning.

There is a scope for improving the mathematics curriculum for secondary school education. Curriculum can also address the different learning need of high, average and low ability students. Schools can develop mathematics subject classrooms and mathematics laboratory with a space for every child to learn at their own pace. Self assessment of the students is also necessary to make them responsible to their learning as well as to make appropriate choices in the learning process.

Also there is a need to study the background of high, average and low ability students. This will help teachers to address students in proper way. There is a need to study the different methodology of instructions for high, average and low ability students. This will enrich the teachers to acquaint with different learning styles.

5.18 RECOMMENDATIONS FOR FURTHER STUDY

Educators are facing with a enormous challenges providing appropriate differentiated instruction for all learners. A normal class room includes those needing remediation, and the highly able. In quest to continue on the journey of excellence, researchers interested in mathematics education may consider the following for further study:

- The similar study can be conducted in different geographical area and also at different levels.
- A Study can be conducted on the personality traits relate to different ability students.
- A Study can be conducted on the background of the different ability students.

- Attitude of teachers regarding differentiated instruction in mathematics can be another area of research since they are playing the vital role in the teaching-learning process.
- A study can be conducted on the attitude of school administrators towards differentiated instruction.
- A Study can be conducted on the different methodology of instructions for high ability students in mathematics.
- A Study can be conducted on the different methodology of instructions for average ability students in mathematics.
- A Study can be conducted on the different methodology of instructions for low ability students in mathematics.
- The self efficacy of the high, average and low ability students can be tested.

5.19 DISCUSSION

The classroom observations made by the researcher revealed that the mathematics class rooms are dull, bored and the majority of the students find it as a difficult subject. Since students learn at different rates, the instructions in mixed ability classroom are too easy for some and difficult for others. At any given time, students reflect differing levels of academic readiness in various aspects of mathematics subject. Researcher's observation of the student behavior indicates that while teachers teach to the middle ability level, they are not challenging the higher ability student or not addressing the lower ability student needs. Therefore, both groups demonstrate frustration, in attentiveness and lack of interest in mathematics. Students in mixed ability class rooms have many different learning styles and also have different emotional and social maturity level. Teachers generally gear their teaching to the

mythical average student on the assumption that this level of presentation will meet the needs of the most number of students. Lower and higher level of students become frustrated because the pace of the scope and sequence in the math curriculum does not challenge the higher level students or accommodate the needs of the lower level students.

This scenario is due to inappropriate methods of teaching mathematics and the lack of basic concepts. Differentiated instruction helped the researcher to cater the needs of all the ability level of students to an extent. Differentiated instruction in mathematics creates a classroom with appropriate challenges, a secure environment, and an opportunity to explore ideas and have fun learning for all ability level of students. Another important thing is that differentiated instruction allows all ability level of students to learn at their own pace. This benefits the increase in motivation. Thus attitude of students towards mathematics will change.

Differentiated instruction is found effective for enhancing the achievement of high ability students in mathematics when compared with the traditional method of instruction in mixed ability classroom. The researcher used constructivist approach as the differentiated instruction for high ability students, which proposes learning environments with multiple perspectives or interpretation of reality, knowledge construction, context-rich, experience based activities, helped the high ability students for this achievement. Also this approach helped the researcher to explore unique characteristics of high ability students. Another important thing is that differentiated instruction helped the high ability students to learn at their own pace. This benefitted in the increase in motivation. Thus attitude of high ability students towards mathematics is also changed.

There is a misconception among common people that the average ability students are static in terms of achievement. Most of the educationists are also in this line. But when average ability students grouped for differentiated instruction in mathematics, it was found effective in comparison with the traditional method of instruction. The analysis of the achievement scores of average ability students substantiated this fact. In a mixed ability classroom, the teachers normally teach to the average ability level, then also average ability students are not visibly committed to class and participate without enthusiasm. Integrated technology approach, which is used as the differentiated instruction for average ability students helped to stimulate the minds of average ability students. This made a marked change in attitude towards mathematics too. Integrated technology approach served as a bridge from concrete to abstract thinking, enable average ability students to observe and to think. The analysis of the achievement and attitude score of average ability students has a considerable potential for increasing the interest in, and improving the quality of, learning in mathematics.

Differentiated instruction found effective for learning enhancing the achievement of low ability students when compared with the traditional method of instruction. The researcher used scaffolding approach as the differentiated instruction for low ability students, which optimized low ability students learning by providing a supportive environment. Scaffolding approach as differentiated instruction, avoided the tension and anxiety of low ability students to allow them to perform well in mathematics. Differentiated instruction allowed low ability students a slow pace to learn, which avoided the frustration that they had in mixed ability classroom. The huge change in attitude of average ability students towards mathematics underlined this fact.

Teachers should play a great role in making the mathematics classroom interesting. Teachers should understand the different learning styles of different ability level students. In the teaching of mathematics emphasis should be more on the understanding of basic principles than on the mechanical teaching of mathematical computations. So they should come out with different instructional methods that suit to the different ability level students. To achieve this, governmental and nongovernmental organizations can help through in-service courses.

In tune with this, there is a need for change in the teacher education program too. Pre-service teachers also should engage with the different strategies for different ability level of students. Thus we can give a new face to the mathematics teaching and learning.

5.20 CONCLUSION

National Curriculum Framework, 2005 recommends different strategies for different learners (high, average and slow) but not on the basis of gender, class or caste. Grouping by ability - high ability students, average ability students and low ability students, have no threats to equity. The present study substantiated the recommendation of National Curriculum Framework, 2005 with the finding that, differentiated instruction had a higher significance over traditional method of instruction in academic achievement of mathematics of standard IX students in Kerala. The study stresses on construction of differentiated instruction based on the characteristics of ability groups and envisaged the need of differentiated instruction.

Attitude towards mathematics is also a necessary input for mathematics learning. This in fact acts as intrinsic motivation for the students to concentrate and acquire mathematical abilities. This study revealed that the differentiated instruction has a

significant effect on attitude towards mathematics among the students in ability groups. This change in attitude is due to the students involvement in the learning process and learning at their own pace.

One Size not fit for all. This is only a small walk towards that journey. The researcher found statistical significance for the importance of differentiated instruction, but some unanswered questions that this study did not address, remain kept open.