Chapter 2

REVIEW OF RELATED LITERATURE

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Research takes advantages of the knowledge, which has accumulated in the past as a result of constant human endeavor. Until you have learned what others have done and what remains still to be done in your area, you cannot develop research project that will contribute to know in your field. Thus literature in any field forms the foundation upon which all the future works must be built.

India has a long history of teaching and learning mathematics dating back to the Vedic Age (1500 to 200 BC). During the period AD 200 to 400, several works on astronomy and mathematics were composed, mainly based on indigenous knowledge. Jaina mathematicians made a noteworthy contribution during this period. The Jaina texts prescribed arithmetic as one of the most indispensable requirements for children's first education. During the period of AD 400 to 1200, a new branch known as Ganita came into existence with three separate components namely, arithmetic, algebra and geometry. But mathematics received prominence as a separate subject only in the 12th century, as referred to in the Leelavati of Bhaskaracharya. The situation with regard to mathematics education remained unchanged after AD 1200 though there had been epoch-making discoveries. In spite of political instability during the period up to the 18th century, the native system of education maintained its traditional structure up to the advent of British.

In post-independent India, great emphasis has been placed on mathematics teaching and learning. The Education Commission (1964-66) recommended mathematics as a compulsory subject for students at school level. The commission seemed to have been influenced by international opinion at that particular time and

favoured 'new mathematics', which later pervaded secondary education. That was the era of sets, and the algebra of sets.

The science of `mathematics education' is still in its infancy. In any curriculum, content and presentation of content are the two most important and inseparable components. The application of learning theories in content presentation is of very recent origin. Research evidence is inadequate to say anything definite about which method is going to be the most effective for presentation of a particular type of content. However, methodology also involves the arrangement of the content in a hierarchical manner. The entire process is composed of complex psychological principles. The commission points out that, 'In the teaching of mathematics emphasis should be more on the understanding of basic principles than on the mechanical teaching of mathematical computations'. Commenting on the then prevailing situation in schools, it observed that in the average school today instruction still conforms to a mechanical routine, continues to be dominated by the old besetting evil of verbalism and therefore remains as dull and uninspiring as before'.

The National Policy on Education (1986) highlighted the importance of mathematics in general education and suggested that 'mathematics should be visualized as the vehicle to train a child to think, reason, analyze and to articulate logically. Apart from being a specific subject it should be treated as concomitant to any subject involving analysis and reasoning'. In the recent past there have been tremendous developments in theories of learning and the science of teaching. Though mathematics occupies a place of importance, the re- searches in this area have been scanty.

The studies done in national and international level are presented under the following heads:

- Studies on Achievement in Mathematics

- Studies on Ability Grouping and Differentiated Instruction
- Studies on High Ability Students
- Studies on Average Ability Students
- Studies on Low Ability Students

The related literatures discussed here are 52 in number and are arranged chronologically in each section.

2.1 STUDIES ON ACHIEVEMENT IN MATHEMATICS

Jennifer and Kelly (2009) conducted a study on increasing student effort in complex problem solving through cooperative learning and self-recording techniques. The purpose of this study was to determine if incorporating cooperative learning and self-recording strategies had an impact upon student effort on complex problems. Results indicated that student effort on complex problems increased over the Intervention and Post-Intervention periods from the original Pre-Intervention effort scores. The researchers concluded that cooperative learning and self-recording strategies did make an impact on student effort on complex problems in the math and science classrooms.

Jenna, Sarah and Stephanie (2009) conducted a research to increase high school students' achievements in mathematics with the use of collaborative teaching strategies. The researchers' planned three different interventions including incorporating multiple intelligence based lessons, offering positive reinforcement for homework, and involving the students in more regular group work. They found that offering positive reinforcement to increase homework completion had a negative effect on the students. The decline in the average homework completion was 0.68% in one class and 6.22% in the other mathematics class. There were mixed results from both classes regarding the average test scores. Overall,

the majority of the students felt that being in a collaborative setting helped to improve their learning in mathematics.

Michael (2008) conducted an ex post facto study of the relationship of selected personal traits and experiential characteristics of developmental mathematics faculty with student success rates. Results indicate associations of both the personal traits and experiential characteristics of faculty with student success in developmental mathematics.

Dennis and Eugene (2007) examined what extent 5th-grade mathematics students perceive teacher instructional efficacy to be involved in the mathematical skill acquisition. In addition, the study attempted to determine the relationship between the students' perception of instructional efficacy as it relates to mathematical skill acquisition and the students' cumulative mathematics grade point averages. The results of the survey indicated that 80% of the students had a high level of instructional efficacy agreement and 20% of the students had a medium level of instructional efficacy agreement. This researcher calculated a statistical weak correlation between the students' level of agreement and students' cumulative mathematics grade point averages. In addition, since the students' cumulative mathematics grade point averages and their levels of instructional efficacy agreement are both high, it was difficult for this researcher to determine the strength of the relationship between the two variables.

Kimberly (2004) examined the effects of constructivist pedagogy when addressing the issues associated with below proficiency scores in basic skills in mathematics on the state exit exam. Collaborative learning, cooperative learning, and computer-assisted

instruction were used for a 16-week period. Results indicated that the applied dissertation program utilizing constructivist teaching strategies to improve mathematics outcomes for high school students was effective in two of the four identified outcomes. The program was effective in improving the scores of students repeating the state mandated exit exam and improving student motivation, however, the program was less effective in improving in-class achievement test scores.

Marian (2003) described a program for increasing math achievement through the use of musical interventions including repeated exposure to Mozart classical music and School House Rock, and introduction to teacher-made songs that introduce mathematical concepts in the music classroom. Post intervention data indicated a significant increase in students' mathematics achievement in the targeted skills for both second and fourth grades, including students with disabilities. Motivation and classroom climate were also noted.

Elizabeth, et. al. (2002) conducted a research on the improving student achievement through inclusion of problem solving in the math curriculum. This paper reports on the processes and results of a project on the instruction and practices of mathematics problem solving and strategies. Students in the second, third, and fifth grades were targeted to increase achievement in the area of math problem solving. Problem solving achievement was measured using performance tasks, rubrics, and tests and found that the inclusion of problem solving in math curriculum for improving student achievement was effective.

Joyce (2002) described a program for increasing students' learning in mathematics and science through the integration of visual art.

The researcher focused on the solution of integration of these subjects with a variety of teaching methods and the use of alternative assessments. During the intervention of visual art integrated into science and mathematics, data was collected from journal writing and portfolio assessments as well as artwork progress. At the end of the research intervention period, a post-test was administered to measure growth. Final achievement was assessed by the comparison of the pre- and post-test to determine growth of student learning with this intervention. Intervention data indicated a substantial increase was gained in each subject area. Students' knowledge of the concepts taught increased 72% in mathematics, 90% in science, and 68% in art.

Jamie and Lisa (2001) described a program for motivating students in mathematics in order to improve achievement at the high school level. The literature of solution strategies was reviewed and the problem setting was analyzed. This resulted in the selection of two major categories of intervention: a modification of the curriculum to include application and real-life math problems, and a restructuring of the teacher's daily lesson plans to implement a variety of teaching strategies. Post data was gathered to determine whether the intervention improved student motivation. It was discovered that the implemented strategies improved positive behaviours in the classroom. Slight improvements were also observed in student attitudes towards mathematics.

Staci (2001) described a program for enhancing direct teaching using creative memorization strategies in order to improve retention and quick retrieval of math facts. The targeted population consisted of first and second grade students in two separate districts in middle class communities. Post intervention data indicated a substantial increase in student retention and retrieval of math

facts, a decrease in student use of manipulative to solve math equations, and fluctuation in parent survey results.

Sumangala (1995) has studied 750 students of class IX in Kerala and found all components of mathematics aptitude, i.e., numerical ability, numerical reasoning, ability use symbols, spatial ability and abstract reasoning abilities, to be significantly correlated to achievement in mathematics. This implies that those who possess these aptitudes are quite likely to do well in mathematics. Perhaps this can be used as a good indicator for nurturing the mathematically talented students.

Jean, et.al. (1994) describe a program for improving higher-order thinking skills in mathematics of sixth-grade students in a middle class community. Three interventions were chosen: (1) cooperative learning to develop student self-confidence and to improve student achievement, (2) the instruction of students in mathematical problem-solving strategies, and (3) curriculum revision with the addition of a supplementary program on mathematical problem solving. All strategic solutions were related to improving student cognition and advancing student achievement on higher-order thinking skills. All of the components that contributed to the original problem were reduced as projected: student acquisition of mathematical problem-solving strategies became evident, student confidence levels in mathematics increased, and student achievement on non-routine problems requiring higher order thinking skills improved.

Rangappa (1992) investigated in to the relationship between self concept, reading ability and achievement in mathematics. Researcher found that there was no significant difference in the achievement of students having different levels of self concept.

There was a significant difference in the performance of the rural and urban schools. There was a significant difference in the achievement of students having different levels of reading ability.

Bhaskaran (1991) studied the relationship among achievement motivation, attitude towards problem solving and achievement in mathematics. Researcher concludes that there is a positive relationship between the attitude towards problem solving and achievement in mathematics.

Ngailinkin (1991) attempted to identify variables associated with achievement in mathematics. The result indicates that there was a significant association between attitude towards mathematics, educational aspiration, numerical ability and abstract reasoning, and achievement in mathematics.

2.2 STUDIES ON DIFFERENTIATED INSTRUCTION AND ABILITY GROUPING

Bracha and Shlomit (2008) conducted a case study on secondary school organizational efforts in search for alternatives to ability grouping and his findings suggests that ability grouping is difficult to eliminate, but there are alternatives that may reduce its social and emotional harmful effect.

Jamie, et.al. (2008) experimented in improving the student motivation in mixed ability classrooms using differentiated instruction and showed fewer students distracted during work time and a decreased number of off-task behaviors, however more students appeared bored.

Carrie Ann Hyde (2007) tried to discover and implement multiple strategies for differentiation that would engage and motivate

Talented and Gifted (TAG) learners. Six TAG students from a third grade general education classroom setting participated in this study. Findings indicated that there was a slight increase of student engagement and motivation with the use of a project choice board and Math Exemplars for both general education and Talented and Gifted students. Educators need to plan curriculum that allows student choice and utilizes authentic tasks in order engage and motivate students.

Daniel (2007) searched for a way to improving mathematics skills using differentiated instruction. The purpose of the research was to increase mathematical performance in a varied ability math classroom. To address varied ability levels in the classroom, the researcher implemented differentiation instruction and modified three areas of instruction: curriculum, strategies, and student work. The researcher encountered academic achievement that ranged from high, medium, and low. It concluded that the positive change in student performance led to that the interventions were effective in some way. Also the cooperative learning positively impacted student progress. With the varied abilities in today's classroom it is necessary to adapt teaching methods to meet different needs.

Yvette (2007) in his study on experiencing mathematics classes with respect to ability grouping, gender and the selective development of participative identities and reached the conclusion that pedagogic practices of ability grouping do indeed play a major part in the development of participatory identities for some pupils but not for others.

Maureen (2007) studied the socio-affective impact of acceleration and ability grouping and concludes that benefits for gifted students but may be harmful to the rest of them.

Ulrich, et.al (2006) found, in their study on using group composition and status to predict self-concepts and interest in ninth grade mathematics that students' math self-concepts and math interest differ as a function of the achievement of their reference group, their own achievement, and their teacher -assigned grades.

Mohammad, et.al. (2005) enquired about the effects of within-class ability grouping on social interaction, achievement and motivation and found that low ability students achieve more and are more motivated to learn in heterogeneous groups. Average ability students perform better in homogeneous groups whereas high ability students show equally strong learning outcomes in homogeneous and heterogeneous groups.

Janet, et. al. (2002) in their research project described strategies for improving student motivation and achievement in mathematics through multiple intelligences. Probable cause data indicated that students learned best when instruction was geared to their multiple intelligences. Too often, multiple intelligences strategies were lacking, thus causing underachievement in mathematics. Math interest was not inherent in some students. Poor attitudes in mathematics were likely to foster lower student achievement. Research indicates that students have an inability to transfer math concepts into real life situations.

Kamalamani (2001) in her investigation in to the profiles of high and low achievers at higher secondary level in Coibatoore District

found that students have not been much benefited by heterogeneous grouping.

Nora's (2000) paper presents different perspectives on homogeneous and heterogeneous ability grouping of students on an elementary school level. The teachers and administrators were surveyed to discover their preferences and attitudes toward homogeneous and heterogeneous class design and ability grouping within the classroom. Additionally, three ability groups (high, middle, and low) were examined to see whether each individual group benefited from heterogeneous or homogeneous grouping. Results found that the lower ability group benefited the most from heterogeneous designs and ability grouping.

Erika (1998) investigated practitioners' rationale for using tracking and explores the effects of tracking in the classroom and on students. The results partially support the literature that suggests that teachers prefer tracking because it facilitates instruction. Further analysis suggests that tracking may appear to have degenerating effects on children, particularly on their self-perceptions. However, due to the limited scope of the study most of the findings remain inconclusive. Recommendations are proposed for future research of the tracking issue. Tracking is a predominant method used by American public schools to instruct children of multiple abilities.

Sherry, et.al. (1998) described a program for increasing enthusiasm for math. It consisted of whole group instruction, compacting, and small group work. The goal of this program was to enhance motivation and enthusiasm during math. Whole group instruction introduced or reacquainted students with math concepts and vocabulary. Compacting helped meet the needs of every student.

Small group work provided students the opportunity to work in heterogeneous groups. Implementation of the solution strategies increased motivation for math while decreasing inattentive behaviours. The use of curriculum compacting helped differentiate instruction. Through whole group instruction and cooperative learning, students were given a feeling of belonging. These solution strategies contributed to improving students' enthusiasm for math.

Esther and Moshe (1999) evaluated the effects on gifted children of participation in homogeneous classes or mixed ability classes with a part-time gifted extension program. Results from 1,020 Israeli gifted intermediate-grade students show more positive personal-social adjustment for those in the mixed ability classes and a more positive view of the school environment for those in homogenous classes.

Pia and Beth (1998) described a program for implementing specific cooperative grouping patterns in order to increase students' academic performance. The targeted population consisted of junior high and high school students located in the northwest and southwest suburbs of a large metropolitan area. An instructional strategy in which both like-gender and mixed-gender grouping patterns were used in Spanish and math classroom cooperative activities is outlined. Findings indicate that single-gender groups achieved higher scores, received more favourable evaluations, and generally had more positive group interactions.

Barbara Georgeson (1997) examined the effects of grouping students by ability or achievement on middle school students' academic achievement. Mathematics achievement results indicated that there was no significant difference between math scores in the third grade ability-grouped setting and the sixth grade inclusive

setting. Teacher survey results revealed that while most teachers have moved away from rigid forms of ability grouping, some still group for subjects such as reading and mathematics. Those who still group students by ability revealed that they continue this practice because they believe that delivery of instruction is easier when students are on the same instructional level. Students' previous grades, current test scores, and teacher perceptions were used to group students by ability. Teachers who had moved away from grouping indicated that the transition was made easier by employing alternative methods and styles of instruction--especially a multisensory approach--but also including cooperative learning and mastery learning.

Kantroo (1997) did a comparative study on personal and social adjustments of high, average and low creative pre-degree students of Dakshina Kannada district. The findings were there is significant difference between means of high creative, average creative and low creative pre-degree students with reference to personal adjustment and there is significant difference between means of average creative and low creative pre-degree students with reference to social adjustment.

2.3 STUDIES ON HIGH ABILITY STUDENTS

Judith and Susan (2008) studied the relationship with achievement and ability grouping in schools with respect to academic self-concepts in adolescence and found that with students in high ability groups having significantly higher self-concepts in English, mathematics and science than students in low ability groups. Student's intentions to learn in future were affecting by self-concept than by achievement.

Tontaleya (2007) conducted a study on improving mathematics achievement of exceptional learners through differentiated and peer-mediated instruction with the objective to determine if the interventions produced significant differences in mathematics achievement of exceptional learners and to provide a context in which the selected interventions invoked student behavioural response. The findings revealed that the differentiated and peer mediated instruction was effective for exceptional learners for improving mathematics achievement.

Haiven (2006) examine the effect of ability grouping on middle school student's mathematics achievement. On group placement provided, some evidence that students were not always assigned to different ability groups based on their achievement and potential to learn. Also non-academic factors, ethnicity and socio-economic status were not significant predictors of either high or low group placement. The result on grouping effect shows that students in high ability group substantially better achievement than their ungrouped and middle grouped counter parts.

Gourikuttiyamma (1993) in her study on certain ability correlates of secondary school mathematics achievement measures using bloom's taxonomy – cognitive domain found that higher ability to be highly correlated to higher levels of mathematics achievement.

Shankaranarayanan (1990) has found that guided discovery learning is always better than learning under reception conditions. However the students with high ability perform better and the students with anxiety perform worse under both systems.

In a study conducted by *Gurumurthy* (1990) the guided discovery approach was found superior to the performance when it came to the development of cognitive abilities and practical skills.

2.4 STUDIES ON AVERAGE ABILITY STUDENTS

Franziz, et.al (2008) tested the gender differences in gifted and average ability students by comparing girls' and boys' achievement, self-concept, interest and motivation in mathematics and result support the assumption that gender differences in self-concept, interest and motivation in mathematics are more prevalent in gifted than in average ability students.

Judith, et.al. (2005) examined student perceptions of teacher behavior in three motivational variables (self efficacy beliefs, intrinsic value, and text anxiety) and the results show that perceptions of teacher proximity and influence have implications for average students but are not significant in students with learning disabilities.

Hafner (2004) conducted a study on eighth grade mathematics using computer, software program called cognitive tutor. The study revealed that the computer assisted instruction was effective in improving the student's achievement in mathematics.

In a study conducted by *Pfaffman* (2003), it was found that adolescents engaged in using computers have better achievement and attitudes towards learning.

Jiby (2002) studied the effectiveness of computer assisted model and lecture method in geometry. The study revealed that the computer assisted instruction was more effective than lecture

method in terms of immediate post-test achievement, delayed memory and retention power.

Joseph, et.al. (2001) described the effect of integrating math and science and employing technology to bridge the gap. Analysis of probable cause data revealed that low student achievement in math skills was evident in the daily work, portfolios of students, and tests by teachers. Students were not motivated to learn math and science skills in a traditional classroom setting. Teaching strategies utilized technology, thematic units, and an integrated math and science course in order to make learning relevant to the students. A review of solution strategies such as literary articles, surveys, and an analysis of the problem setting resulted in the creation of an integrated math and science course, the utilization of thematic units, and increased usage of technology. These strategies were implemented to improve student motivation and achievement. Post intervention data indicated strengthened mathematical computation skills, increased problem solving skills, and increased student interest.

William (2001) studied the relationship between computer based training – learning style and cognitive style. The study revealed that learners' successful performance may not be associated with the learners' particular cognitive style or learning style, but more with the learners' learning environment motivation level, knowledge of the computer based training capabilities and instructional strategies incorporated during the learning process.

Singh (1992) studied the relative effectiveness of computer assisted instruction and traditional methods of teaching mathematics. Computer assisted instruction was found to be superior in terms of

achievement and in developing positive attitude in students towards mathematics.

2.5 STUDIES ON LOW ABILITY STUDENTS

In a study conducted by *Changhui* (2007) on classroom peer effects academic achievement and quartile regressions reveal that week students interact more closely with other weak students than with strong students; hence their learning can be delayed by the presence of worst performing peers.

Haliyon (2004) investigated an activity-based approach in conjunction with increased personal teacher-student interaction for teaching mathematics students focusing on changes in their educational achievements, motivation and beliefs. He proved that achievement was influenced by collaborative work, opportunities to communicate and assessment that valued student effort Factors that contributed to a change in motivation included the use of real world activities and the use of activities that built on students' interests. Factors that influenced student beliefs were repetition or review topics and the daily use of activities.

Maria Jose (2004) investigated the likely causes for low performance in mathematics. This study 1) compared Chile to three countries and one large school system that had comparable economic conditions but superior mathematics performance, and 2) examined how important characteristics of the Chilean educational system could account for poor student achievement in mathematics. The results showed that, compared to South Korea, Malaysia, the Slovak Republic, and Miami-Dade County Public Schools, Chilean 8th graders had parents with fewer years of schooling and with fewer educational resources at home. At school, Chilean students were taught by teachers who felt less prepared to teach, and who

covered fewer advanced mathematics content in class than teachers in other countries. Analyses using a series of hierarchical linear models show that, in Chile, school assets were unequally distributed across social classes. Schools in socially advantaged areas had more instructional resources and better prepared teachers; these teachers, in turn, emphasized more advanced mathematics content.

Dhall, et. al. (2000) conducted a study on the effect of using remedial materials in mathematics on achievement of slow learners and found that teaching of students of low achievement with remedial materials, prepared after diagnostic test increased their achievement.

Panchalingappa (1995) investigated the causes of underachievement in secondary schools mathematics and found that poor attitude towards mathematics is a cause for under achievement.

Rajyaguru (1991) studied the achievement in mathematics, personal characteristics and environmental characteristic of over achievers and under achievers. The findings were there was positive and significant correlation between intelligence and achievement, achievement in mathematics and numerical aptitude, and intelligence and numerical aptitude. Over achievers and under achievers did not differ in intelligence, numerical aptitude and locus of control.

Chitkara (1985) found that lecture demonstration strategy is more effective for the low ability group.

2.6 IMPLICATION FOR THE PRESENT STUDY

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) had 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 would differentiated instruction based on ability grouping effect the academic achievement in mathematics among the students in school education'.