Chapter II

Review of Related Literature

CHAPTER II
REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter is an attempt to give a brief sketch of the researches done in the field of mathematics education in India and abroad. The studies have been taken from 1970 to 2000. The sources used were: Fifth Survey of Educational Research 1988-92, Fourth Survey of Research in Education 1983-1988, Dissertation Abstract International, Indian Educational Abstracts, Experiments in Education, Perspectives in Education.

The research scenario is given based on studies reported in Fourth and Fifth Survey. A brief analysis about the variables, levels, areas is also given. The research gaps identified in Fourth and Fifth Survey is also mentioned. Implications to the study is discussed along with the concerned study. Indian and foreign studies are given separately. Studies dealing with diagnosis and remediation, both Indian and foreign studies, are dealt separately.

2.2 Research Scenario

The Fourth Survey gives a comprehensive report about research in mathematics education. Though mathematics occupies an important place, the researches in the area have been scanty. The momentum in mathematics education picked up only in 1970-1980. Fourth Survey has included studies of Third Survey also. Research in mathematics education has been given as a separate area of research in the Fourth Survey. There are about seventy studies cited under mathematics education in Fourth survey. Below is given a brief analysis of the research studies cited in Fourth and Fifth Survey.

2.2.1 Brief Analysis of Fourth Survey of Research in Education

The Fourth Survey reported about the studies from 1970 to 1988 in the field of Mathematics Education. It reported about sixty-eight studies, in four different

categories: (a) Teaching and teacher behaviour – twenty-two studies, (b) Curriculum and text-books – thirteen studies, (c) Factors affecting mathematics achievement – twenty studies, (d) Diagnostic and other tests in mathematics – nine. Table (2.2.1.1) shows the decadewise growth of Research in Mathematics Education.

The survey has pointed out the large number of students failing in mathematics, according to NCERT analysis. The research gaps identified are given below:

i) Research based development curriculum
ii) Studies in the area of diagnostic testing.
iii) Developing a major intervention programme to streamline mathematics education
iv) Designing more effective programmes for preparing teachers of mathematics.
v) Experimenting on models of teaching.
vi) Text-book analysis to find out their relevance to objectives, content, methodology, feedback.
vii) Standardizing tests
viii) Investigate into how the attitude towards mathematics is formed.

Majority of the studies have been devoted to teaching and teacher behaviour and factors affecting mathematics achievement. The survey has given the decade-wise growth of research in mathematics education.

Table 2.2.1.1

Decade-wise Growth of Research in Mathematics Education

Decade	Ph.D. Thesis in		Research Projects	Total
	Education	Other Subjects		
1941-50	1	0	0	1
1951-60	0	0	0	0
1961-70	2	0	5	7
1971-80	21	0	10	31
1981-88	28	0	1	29
Total	52	0	16	68

The research scenario of mathemaitcs education is not very different from other subjects in terms of the boom of research activity period i.e. 1970 onwards. However, mathematics, having higher utilitarian value, more research is expected in this area. The number of research projects also saw a slump in the 1980s. State Boards, NCERT, SCERTs could take up projects to identify causes of low achievement and high rate of failure in mathematics, also poor knowledge of basics of mathematics at various levels.

The research studies spread over a wide range of teaching methods, it was found that all teaching methods did not suit all learning styles. It also depended on the intelligence. Programmed instruction was found to be effective than traditional teaching. However, it was also dependent on urban and rural setting. Studies on Ausubel's advanced organiser and Bruner's concept attainment model found the models to be superior to traditional methods. Mastery learning model was also found to be superior to the traditional method as it enhanced mathematics achievement, attitude towards mathematics, and improved self-concept.

All these studies on teaching have shown the superiority and effectiveness of various methods. Teachers need to choose the methods rather than use same methods for all topics, academic levels, intelligence levels, locales.

The survey has noted the dearth of studies on teacher preparation. Studies on developing instructional competence in mathematics teachers through micro-teaching technique would be beneficial. Studies also cite reluctance on the part of the teachers to take up non-conventional methods.

Factors affecting mathematics achievement were found to be both cognitive and affective. Variables like SES, intelligence, language mastery, attitude towards mathematics, numerical reasoning, numerical ability, were found to have significant effect on mathematics achievement. ***Causes of under and low achievement in mathematics vary from defective text-books, blind use of rules, insufficient drive work, absence of methodical approach, lack of motivation***. Studies conducted on the mathematically gifted than to be found having high intelligence numerical ability, abstract reasoning. The factors have been abundantly identified. Studies on how these factors can be taken care of to increase achievement in mathematics are needed.

The studies on curriculum were very few. There were studies comparing mathematics curriculum of India and other countries, utility of mathematics content in professional courses, objectives of mathematics, teaching and relevance of modern mathematics in developing students abilities. ***Only five Indian state had research in the area of text-book and syllabus***. One of the studies developed criteria for writing and evaluating text-books in mathematics. Other studies found teachers not using new teaching methods given in the text-book while still other studies found lack of relationship between course-content in the syllabus and the text-book. There seems to be an urgent need to look into the content, presentation and use of methods in teaching of mathematics. The relevance of mathematics course-content is also of utmost need. The various state boards could take up text-book analysis and finding the relevance of mathematics course-content vis-à-vis various professional courses.

Out of the nine studies in the area of diagnostic and other tests, only four studies were on construction of diagnostic tests and remediation. All of them found remedial measures effective studies on attitude towards mathematics developing

atttitude scale to measure attitude towards mathematics, constructing tests in mathematical creativity were some of the other studies.

The survey observed that there is dearth of researches in developing and standardizing tests. Also, studies on how attitude is formed towards mathematics was essential. The survey had identified major issues before teacher educators in mathematics as in-depth study of the mathematics curriculum, curricular renewal, refining teaching methods in mathematics with regard to advances in pedagogy and educational technology.

2.2.2 Brief Analysis of Fifth Survey of Educational Research

The Fifth Survey reported about the studies from 1988 to 1992. A total of forty-seven studies have been reported. The categories were; (a) High failure in mathematics – three studies, (b) Improvement of learning and teaching of mathematics – twenty six studies, (c) Improvement of teaching and learning of geometry – seven studies, (d) Evaluation of curriculum – three studies.

The survey has cited seven studies dealing with the areas of high rate of failure in mathematics, errors committed, diagnosis and remediation in geometry. ?? The number of studies in mathematics education is not very impressive and more so in diagnosis and remediation, underachievement, attitude towards mathematics. Fourth survey had identified several research gaps.

Fifth Survey also identified twenty three research gaps. The research gaps identified in the Fourth Survey have not been satisfactorily addressed in Fifth Survey.

Looking at the gravity of the problem of failures in mathematics, under-achievement in mathematics, at different levels and particularly at secondary level, the number of studies is less. Out of the twenty six studies in improvement of learning and teaching of mathematics, two studies are on attitude towards mathematics and two on errors committed by students in mathematics

It was surprising to find an area on improvement in learning and teaching of geometry. The survey itself has commented about the difficulty found in algebra than in geometry. The inclusion of new area of high failure rate in mathematics, itself shows the alarming situation. Hence, it should have also identified (i) diagnosis and remediation, (ii) teaching strategies, rather than a broad area like improvement in learning and teaching in mathematics.

The survey has given another new area of research, as identified by the Fourth Survey as research gap i.e, Evaluation of Curriculum, even though number of studies are few. Another area that could be identified is attitude towards mathematics. This has been found to be a determining factor in mathematics achievement.

Total number of researches – 29 theses, 9 M.Phil dissertations, 5 Research report, 4 Research articles. The total number of researches were 47. This is an encouraging indicator when compared to the research situation till 1988. In order to combat problems like high failure rate, wide spread low achievement in mathematics, there needs to be more of research projects than individual researches.

The survey has cited studies pertaining to mathematics under correlates of achievement. A few of them have been cited in the present study. It is essential though, to have studies pertaining to relavance of mathemactics curriculum vis-à-vis professional, academic courses. The very existance of high rate of failures, large number of errors should pose the urgency to investigate the evaluation methods and teaching methods. Teacher education is also another area where one fields dearth of studies.

The analysis clearly revealed the kind of researches reported in the Fifth Survey. It showed that researches were done in some parts of the country and in certain areas of mathematics only. It did not seen that the research gaps identified by the Fourth Survey had been taken care of. Some had been done abroad too. Very few studies had been identified in the area of teacher education, diagnosis and remediation. No studies were on text-book analysis. Studies like, Srivastava (1992)

about learning outcome in terms of objectives ex mathematics, would give basis for curriculum framers. Studies like Sarangpani (1990) would pose questions about the suitability of the level of the learner and the tasks and objectives. While the number of researches cited under correlates of achievement have increased, the number for diagnosis and remediation was low.

Fifth Survey points out that even though the number of research studies have increased, considering the large number of problems, the number is not impressive. Though mathematics education is probably the most important area concerned with school education only 23 departments of education in the country out of 100 such departments have developed any research study in mathematics education. It has also pointed out the dearth of financial assistance in the area of mathematics. Though the quantity of research studies is less, the quality of the studies is good, unlike other research areas, the Survey pointed out. ***Lack of coordination and follow-up in the field of mathematics, need for utilization of research, were some of the comments given by the Survey.***

Twenty-eight research topics were identified by the Survey. Some of the topics that were found to be relevant were;

i. Teaching of applications of school mathematics to school students.
ii. Use of mathematics applications projects to create interest in applications of mathematics.
iii. Evaluation of present in service programme from the point of view of their effectiveness and adequacy.
iv. Alternative methods, including distance education, for training of mathematics teachers.
v. Role of mathematics clubs and recreational mathematics in the teaching of mathematics.
vi. Enrichment of school mathematics through problems from industry.

2.2.3 Research Gaps

Research is being done in mathematics education since 1941. Much has been achieved. Looking at the researches being done and still many areas remaining untouched, there is a need to point at the research gaps. The Surveys have thoroughly identified the research gaps. It seems it goes unseen.

The following areas were identified by the investigator as research gaps in Mathematics education.

i. *Teacher education*: The curriculum, the practicum in particular, inclusions in the theory, relevance with respect to school education, change in the teaching methods vis-à-vis technology and pedagogy.

ii. *Evaluation*: Examinations, continuous assessments, which encourages thinking and reasoning rather than rote memorizing.

iii. *Text Book*: Relevance of syllabi vis-à-vis the need of common citizenery, various professions, irrelevant out-dated topics, appropriate logical and psychological sequence within a textbook and between textbooks, self-explanatory, and user friendly approach, criteria for writing a textbook.

iv. *Diagnosis and Remediation*: Construction of diagnostic tests for various topics and various levels, Remediation programmes and their outcomes, feasibility studies for remedial programmes within school curriculum.

v. *Attitude towards Mathematics*: Attitude of teachers towards mathematics, attitude of students towards mathematics and the causes, effect of teacher's attitude towards mathematics on students achievement.

vi. *Survey of inservice programmes*: Devise training programmes to introduce new teaching strategies, study feasibility of inservice programmes, experimenting on distance education for inservice programmes.

vii. *Application of Mathematics*: Projects to find mathematics in daily life and use of school mathematics in daily life, industry, other sectors, role of mathematics in advancement of mankind, mathematics in different cultures.

viii. *Teaching of Mathematics*: Innoviative methods of teaching by using technology, students constructing their own knowledge, using inputs from culture and context.

2.3 Indian Studies

The studies from First Survey, Second Survey, Third Survey, Fourth Survey, Fifth Survey, Indian Educational Abstracts, Perspectives in Education, Experiments in Education, have been discussed here. They have been categorised as Achievement/ Learning, Correlates of Achievement, Diagnosis and Remediation, Attitude towards Mathematics.

2.3.1 Achievement / Learning

Lalithama (1975) studied some factors affecting achievement of secondary school pupils in mathematics. The study was conducted on 732 pupils of standard nine selected on a stratified random basis. The tools used were a standardized achievement test in mathematics, a study habit inventory and Raven's standard progressive Matrices. ***Major findings of the study were: (i) achievement in mathematics was positively related to intelligence, interest in mathematics, study habits, socio-economic status. (ii) studying lessons daily, repetition in learning, influenced the achievement in mathematics positively.***

Sharma (1978) studied achievement in mathematics of pupils of secondary schools with particular reference to the state of Assam. The sample included 1295 pupils from ten schools. The study was confined to the areas of arithmetic and algebra of school mathematics. A battery of sequential achievement tests were constructed for standard five to ten. ***The major factors found responsible for low achievement in mathematics were imparting of limited knowledge, blind use of***

rules, heavy syllabus, lack of natural urge, in sufficient drill at primary and absence of methodical approach of classroom teaching.

Manika (1983) tried to investigate the relationship between acquisition of concept in mathematics and some personal and environmental variables of the pupils at primary school level in Bombay. The data was collected from 524 pupils from different schools of urban area from grade one through grade five. Some of the tools used were Raven's coloured progressive matrices, mathematical concept test. The study revealed that: (i) the majority of the pupil who were promote to the next graded did not show acquisition of concepts of the lower grade. ***(ii) pupils did not acquire any concept to the fullest form in one grade but the growth of concepts took place at all levels with different degrees of individual differences among the acquisition of mathematical concepts at primary school level.*** (iii) concepts of higher mathematical hierarchy could not be developed unless lower concepts were acquired. (iv) for the better development and acquisition of mathematical concepts, individualized instruction was found useful.

Shah (1985) made a psychometric exploration to study relationship between achievement in arithmetic and three psychological factors viz. intelligence, problems faced by children, parent-child relationship, in few primary schools in Choryasi Block for first grade. The sample was selected through the purposive sampling technique. A total population of 897 children was included from twenty two primary schools of choryasi block. Data was collected using Arithmetic Education Test, Interview Schedule for the parents, student problem inventory, Individual Intelligence Test. The major revelations were: (i) inattentiveness of parents towards children. ***(ii) schools had no special programmes for finding out academically backward children. None of the schools had schedule for remedial teaching.*** (iii) it was found some teachers were not qualified to teach arithmetic. They had to teach all subjects and they had not undergone any special training in teaching of mathematics.

Mohapatra (1990) looked into the critical appraisal of the secondary school mathematics curriculum of Orissa. The sample consisted of two hundred and twenty secondary school teachers and five hundred and fifty six students. The tools used were questionnaires for students studying mathematics and for teachers teaching mathematics. The mathematics teachers were conservative in their outlook as far as the objectives of teaching mathematics were concerned. They emphasised the fundamental mathematical operations, familiarity with mathematical concepts and terms, development of mathematical skills, objectives like development of discipline, determination and a sense of proportion were given the least importance. ***The students were, by and large, pragmatic in their approach and considered mathematics to be a utilitarian subject. The teachers provided high ranking to the traditional topics and resisted the instrusion of new topics.***

Sarangapani (1990) used the Piagetian view for analysing curriculum design and materials for critical evaluation of the NCERT primary mathematics series. Document analysis was used in the study. The concept of specific learning objectives and minimum levels of learning put forward by the National Curriculum Framework were found to militate against child-centredness. ***There was overall mismatch between the various tasks and objectives prescribed and the operational level of the age-group for which they were meant.*** Problems were either numerical computation or involve situations removed from the child's reality and did not encourage operativity. All the concepts were sequenced logically rather than psychologically. ***There was also a high level of algorithmisaton which may help children in coping with what has to be learnt, but which will also impede conceptualisation, as it rules out the scope of children inventing conceptual links.***

Rajya Guru (1991) studied the achievement in mathematics, personal characteristics and environmental characteristics of over-achievers and underachievers. The sample of one thousand and ninety three was selected by stratified, proportionate and cluster sampling. The subjects were selected from six urban, six semi-urban and thirteen rural schools. The total number of overachievers was one hundred thirty three and underachievers was one hundred and fourteen. The

tools used were Desai-Bhatt Group Test of Intelligence Bhausar Numerical Aptitude Test, Mathematics Achievement Test developed by the researcher, Mathematics Anxiety Scale by Patel T.Z., Study Habit Inventory by Patel B.V., Mathematics Aptitude Scale by Desai, H.G., Interview Schedule and Rotter's Locus of Control Scale adopted by Bhogayata (in Gujarat). There was positive and significant correlation between (a) intelligence and achievement in mathematics, (b) achievement in mathematics and numerical aptitude, (c) intelligence and numerical aptitude. Overachievers and underachievers did not differ in (a) intelligence, (b) numerical aptitude, (c) locus of control. ***Overachievers had (a) better study habits, (b) more positive attitude towards mathematics*** and (c) less mathematics anxiety. There was no association between achievement in mathematics and (a) sex, (b) with order of the students, (c) income of fathers, (d) locality. There was found association between achievement in mathematics and (a) fathers' academic achievement and (b) their receiving external help or not.

Sashidharan (1992) investigated about learning intellectual skill as an educational outcome in relation to student entry characteristics and quality of instruction. The sample consisted of fifteen secondary schools of Palghat district. A total of 2432 students of standard ten were included, as sample. The data was collected using the tools constructed by the researcher and also the tenth standard results of June, 1990. The major findings were: ***(i) the average academic achievement was less than pass mark. In the case of mathematics achievement results were still lower***. (ii) most of the students are not cognitively prepared to learn mathematics. (iii) instruction is directed towards the better equipped among students. ***(iv) the prevailing promotion policy gives opportunities to children to attend tenth class even through they cannot perform basic operations in mathematics. The initial deficiencies have a long-term damaging effect because the content of education is organized in such a way is that learning in each class is dependent on prior learning.***

Srivastava (1992) studied the learning outcomes in terms of objectives in mathematics. The sample consisted of one thousand and thirty students selected at

random by multi-stage random sampling technique. The tools used in the study were: an Achievement Test in Mathematics, the Socio-economic Status Scale by S.P. Kulshreshta and the Culture Fair Test of Intelligence (Form A) by R.B. Cattell. Intelligence and socio-economic status both were such which contributed significantly and positively to the development of learning outcomes in mathematics in terms of knowledge, understanding, application and skill. Male and female students of urban schools showed better gains in all types of learning outcomes in mathematics than their counterparts of rural areas. Male and female students belonging to high socio-economic status group were better in all the four types of learning outcomes in comparison to low socio-economic status group.

Dandapani (1992) identified the process variables and the characteristics of mathematics teachers which contribute to the effective teaching of mathematics. The sample consisted of six hundred and eighty nine teachers of high schools and higher secondary schools of Tanjore district in Tamilnadu. The tools used to collect data developed by the investigator included a Teacher's Perception Scale of Effective Teaching of Mathematics and Characteristics of Effective Mathematics Teachers Description form. It was found that female teachers had a significantly higher perception than the male teachers. Teacher's perception had been found to vary with their years of experience. The perception of teachers did not differ because of their qualification, place of work, type of management, type of school and number of periods of teaching mathematics.

2.3.2 Correlates of Achievements

Pal (1989) attempted to find the affective outcomes of students as predictors of their mathematical ability. The sample consisted of six hundred students from rural and urban schools. The tools used were a test on Self-concept in Mathematics, a test of Attitude towards Mathematics, a test of Anxiety towards Mathematics and a questionnaire on Academic Motivation. It was found boys showed higher self-concept than girls. ***There existed significant correlation between mathematics self-concept, between mathematics and anxiety, between mathematics and attitude, between mathematics and academic motivation.***

Ngailiankin (1991) attempted to identify variables associated with achievement in mathematics. The sample consisted of all class ten students studying in the Central Schools located in the states of Nagaland, Meghalaya, Manipur. The tools used were Achievement Test in Mathematics, Attitude Scale to measure attitude towards mathematics, Educational Aspiration Scale by Sharma and Gupta, occupational Aspiration Scale of Grewal, Differential Aptitude Test, and Cattell's 14 High School Personality Questionnaire. ***There was a significant association between (i) attitude towards mathematics (ii) educational aspiration (iii) numerical ability (iv) abstract reasoning and achievement in mathematics.***

Baskaran (1991) studied the relationship among achievement motivation, attitude towards problem-solving and achievement in mathematics. The sample was selected by stratified sampling technique. Among the total of two hundred students, hundred were boys and hundred were girls. The researcher prepared a tool with three parts in it having achievement. Motivation Inventory Test as the first part, Attitude Scale as the second part, and Achievement Test in Mathematics as standard tenth as the final part. ***There was a positive relationship between the attitude towards problem solving and achievement in mathematics***. Urban and rural students did not differ in their (a) achievement motivation, (b) attitude towards mathematics. Urban and rural students differ significantly in their mathematics achievement in mathematics.

Setia (1992) addressed to the theoretical understanding of the achievement of learners at the senior secondary stage in modern mathematics in relation to socio-psychological and educational factors. The sample consisted of five hundred and ten senior secondary students and forty two teachers. The tools used were the Group Test of General Mental Ability of Tondon, the Socio-economic Status Scale of Trivedi and Udai Pareek, the Modern Mathematical Concept Test, Classroom Behaviour Questionnaire. The study found the intellectual level of rapid and average learners, SES of slow learners, personality traits of rapid average and slow learners and adjustment of rapid learners correlated significantly with their achievement in modern mathematics.

Rangappa (1992) investigated into the relationship between self-concept, reading ability and achievement in mathematics. The sample of thousand students of standard seven were selected by using stratified random sampling technique. The tools used were self-concept inventory developed by the researcher, a standardised reading test by Deve Gawda and Shivananda and Achievement Test in Mathematics. 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 students of rural and urban schools. There was a significant difference in the achievement of students having different levels of reading ability.

Gupta, R., Mukerjee, M., & Chatterji, S. (1993) attempted to identify the factors affecting the academic achievement of adolescents studying in Class X in the State of West Bengal. The sample of the study comprised 1,453 subjects who were selected by stratified sampling procedure from 64 schools registered under West Bengal Board of Secondary Education. These students were all studying in Class X. Raven's Standard Progressive Matrices (SPM), Achievement Motivation Test (AMT) of Prayag Mehta and Prolonged Deprivation Scale (PDS) of Tripathi and Misra were used as tools to collect data for the study. Out of the four groups, urban girls had the least deprived average followed by that of urban boys. The most deprived group was the group of rural boys. The rural girls were more motivated for achievement than other three groups. ***Intelligence was found to be most closely positively related to academic achievement but not to achievement motivation. The prolonged deprivation had negative relation with academic achievement.*** It was observed that girls, both of rural and urban origin were more motivated than boys. Girls in general were found more serious than the boys, possessed self respect which generated achievement motivation.

Thampuratty (1994) examined the interaction effects of creativity, attitude towards problem solving and social position on the achievement on mathematics of secondary school pupils. The study was conducted on a sample of seven hundred seventy school pupils. The tools used were the Test of Achievement in Mathematics by Sumangala and Thampuratty, a Comprehensive Test of Creativity for Secondary

school pupils by Sumangala, Scale of Attitude. Towards problem solving by Pillai and Scale for Social Position by Sumangala and Thampuratty. Significant differences existed in the mean scores of achievement in mathematics between the three group pairs of creativity. Significant differences existed in the mean scores of achievement in mathematics between three group pairs of attitude towards problem solving. ***Positive, high and significant relation existed between attitude towards problem solving and achievement in mathematics.***

Sumangala (1995) studied some psychological variables discriminating between high and low achievers in mathematics. The study was conducted on a stratified sample of 750 (362 boys and 388 girls) students of Standard IX drawn from twenty schools of five revenue districts of Kerala. Tools used included Test of Mathematics Aptitude by Sumangala and Malini, Scale of Attitude towards Mathematics by Sumangala and Sunny, Scale of Self-concept in Mathematics by Sumangala and Malini and Generalized Test of Achievement in Mathematics by Sumangala and Jayasree. Mathematics Aptitude and its components viz., Numerical Ability, Numerical Reasoning, Ability to use Symbols, Spatial Ability and Abstract Reasoning, Attitude towards Mathematics and Self-Concept in Mathematics discriminated significantly between high and low achievers in Mathematics. The relation among the independent variables, Mathematics, Aptitude and its components viz., Numerical Ability, Numerical Reasoning, Ability to use Symbols, Spatial Ability and Abstract Reasoning, Attitude towards Mathematics and Self-Concept in Mathematics with Achievement in Mathematics were significant and positive.

Naga Lakshmi (1996) examined the construction of a problem-solving ability test in mathematics and also examined the problem-solving abilities of students of Class X in twin cities of Hyderabad. This study was conducted on one thousand students of Class X selected from schools of twin cities in and around Hyderabad using normative survey method. Tools used to collect the data included problem-solving ability test in mathematics and a personal data blank. There was a significant difference in the problem solving ability in mathematics of students of rural and urban areas in favour of the latter group. There was no difference between the

performance of boys and girls regarding problem-solving ability in mathematics. ***The higher qualifications of the parents, the better was the performance of the students with reference to problem-solving ability in mathematics. The school climate influenced the performance of the students.***

Verma (1996) explored the main and interaction effects of intellectual ability and test anxiety on achievement in four school courses viz., English, mathematics, general science and social studies. The sample of the study comprised 500 students studying in Class X in ten government secondary schools of Delhi. These subjects were selected by random cluster sampling technique. The tools used to collect the data were the Group General Mental Ability (Hindi) by Jalota and Test Anxiety Inventory (Hindi) by Sharma, Sud and Spielberger. Achievement marks were noted from official', records of the concerned schools. It was found that there were significant main effects of both intellectual ability and test anxiety on achievement of students in all the four school courses. However, interaction between the two variables was obtained in case of mathematics and general science only. In case of interaction, it was observed that in mathematics and general science, high intellectual ability students on the average performed worse under high test anxiety condition but there was no significant difference in academic performance of low intellectual ability students under high and low test anxiety conditions in each of the two above mentioned courses.

2.3.3 Diagnosis and Remediation

Lulla (1966) investigated the academic causes of backwardness in mathematics at the primary stage. A questionnaire was prepared and administered. The major findings were: (i) the syllabus was out-dated, lopsided, impractical, and far away from the realities. (ii) some content in the syllabus was difficult to teach. ***(iii) overcrowded classes, frequent transfer of teachers, irregularities of attendance contributed a lot to the low achievement of the pupils.***

Das and Barua (1968) tried to find the effect of remedial teaching in arithmetic for grade four pupils of Assam. For the purpose of diagnosis of individual

differences, F.J. Schnoll's Diagnostic Arithmetic Tests were adopted. Pretest-post test experimental control group design was followed. In each group there were thirty grade four pupils. ***The major conclusion of the study was that remedial teaching has definitely improved the achievements in arithmetic.***

S.I.E. Guj. (1969) studied the basic arithmetic skills of computing addition, subtraction, multiplication and division by a diagnostic test. The sample for the study consisted of 131 pupils of standard five, 127 of standard six and eighty three of standard eight. A diagnostic test was prepared, consisting of addition, subtraction, multiplication and division of integers and fractions for pupils of standard five, six and seven and to provide remedial teaching in the light of mistakes. It was found that: ***(i) when mistakes were diagnosed and remedied pupils progressed well in mathematics***. (ii) Pupils did not know the entire process of addition, subtraction, multiplication and addition.

Gupta (1972) studied backwardness in mathematic skills. The purpose was to provide a standardized tool to the teachers and researchers to be able to diagnose the weak areas in mathematics. The pretreatment tests were administered to 294 boys and 265 girls of grade eight out of which 180 boys and 176 girls were selected for final study. Diagnostic tests in basic arithmetic was constructed to measure command over basic skills. The achievement in mathematics was measured by the mathematics Achievement Survey test prepared by NCERT.

Ashar (1972) constructed and standardized a diagnostics test in basic algebraic skills for Gujarati medium pupils of secondary schools. The sample consisted of 268 students in all of eight, nine, ten grade, from five different schools. Norms in terms of standard scores, percentiles, stanines were established. Some of the findings were: (i) pupils committed errors due to lack of systematic approach. (ii) the errors of conceptual type predominated the computational type. ***(iii) trends of errors continued to a greater extent in the higher grades.***

Bhirud (1975) constructed and standardized a diagnostic test in algebra. The main purpose of the study was to construct and standardize a diagnostic test related to some selected units of factorization of grade nine. The try out test was administered to 370 pupils. Final test consisted of fifty-four items. It was administered to 1,044 pupils. Remedial exercises has been developed and outlined. ***The study revealed that weakness about signs, coefficients and indices were some of the basic hindrances to understand and perform algebraic factorization.***

Jain (1979) conducted a study of the significant correlates of high school failures in mathematics and English. The data was collected by the use of measuring devices English ability test, mathematics ability test. Two groups of students, successful and failures in both the subjects were isolated and selected. ***The major finding was that factors affecting learning mathematics were intelligence, abstract reasoning, numerical ability, mathematical background, knowledge of mathematical concepts, rules, principles.***

Thakore (1980) constructed diagnostic tests and prepared remedial material as well as testing its effectiveness on fractions and decimals for the students of grade five of Gujarati Medium schools in greater Bombay. The major aim was construction of diagnostic tests followed by preparation of remedial material and testing its effectiveness. The major findings were: (i) the students of grade five did not have clear concept of fractions. Simplification was found to be a difficult process for them. ***(ii) Students did not understand the place values of respective figures in decimal fractions. (iii) they did not understand addition, subtraction, multiplication and division of decimal fractions.***

Bhattacharya (1982) conducted a study pertaining to diagnosis and prevention of learning disabilities of primary school students in arithmetic. A diagnostic tool in common fraction was administered in 450 students of grade five and 500 students of grade six in case of decimal fractions. The major findings were: (i) the experimental group had achieved significantly more than the control group, wherein the experimental group was taught by audio-visual materials. ***(ii) the***

experimental group showed better results and prolonged memory of the learned materials than the control group.

Rastogi (1983) attempted to diagnose weakness in arithmetic, related to basic arithmetic skills and their remedial measures of standard eight students. The design of the study was experimental in nature. A diagnostic test in basic arithmetic stills was constructed and standardized. The final sample consisted of 406 students of grade eight, of nine different schools of Arunachal Pradesh. The study revealed that: (i) one of the important causes of backwardness in mathematics was the poor command over basic arithmetic skills. ***(ii) when command over basic arithmetic skills improved, attitudes towards mathematics became favourable and achievement in mathematics increased. (iii) basic arithmetic skills could very quickly and conveniently be mastered the course of self-help in basic arithmetic skills as developed during the study***.

Bhardwaj (1987) standardized a comprehensive diagnostic test and prepared remedial material for middle school students of Haryana. Test was standardized on a sample of 1146 students. It was found that there was significant improvement in achievement of the students after they had gone through the remedial exercises.

Jain & Burad (1988) studied the problem of low results in compulsory mathematics at the secondary level examination in the state of Rajasthan. The sample of the study comprised of rural and urban boys and girls of 100 government and private schools with lower results than those of the private students of Rajasthan. The heads of the institutions were also involved. The tools used to collect data included questionnaires, for subjects experts for heads, for heads of the institutions, for subject teachers and for students. Non-availability of mathematics teachers due to late appointment and frequent transfers, lack of appropriate classrooms, blackboards and other physical facilities, irregular attendance of students, teachers habit of leaving the headquarters daily and lack of residential facilities in some difficult areas were the administrative causes. ***A low standard in the lower classes non-availability of text books, lack of timely correction of homework, an overburdened and***

uninteresting curriculum, lack of child-centred training, overcrowded classrooms, lack of sufficient periods for the subject, use of guidebooks by students, lack of proper supervision were the academic causes.

Chel (1990) attempted to diagnose and suggest remediation of underachievement in the compulsory mathematics of the madhymik examination in W. Bengal. The sample comprised urban, semi-urban and rural students of Class VI to X of W. Bengal. The case study method was used in collecting the data. The main difficulties faced by students included content gaps, confusion in understanding mathematics language, stereotype way of presenting contents and lack of openness in training. The major mistakes found in the performances of students and teacher trainees in the area include mathematisation of verbal problems, interpretation of mathematics results and learning new topics in mathematics. ***Underachievement was caused due to lack of understanding of mathematics concepts of the earlier stage and the abstract nature of the mathematics.***

Sarala (1990) surveyed the conceptual errors of secondary school pupils in learning select areas in mathematics. The sample comprised of eight hundred pupils from secondary schools in Trivandrum revenue district. The text used were diagnostic tests in sets, trignometry and in statistics, the Non-verbal test of Intelligence by Nafde, personal data sheet. ***The major findings were that the number of conceptual errors committed by secondary school pupils in the areas selected for the study was very high***. Conceptual errors in mathematics were seen to be influenced by sex, locality of school, management of school, intelligence, study habits, socio-economic status and caste.

Kasat (1991) attempted to identify the causes of the large failures in mathematics at SSC examination marathi medium high school students in Palghar Tahsil. The sample of the study comprised of 200 students (100 B&G) of 25 marathi medium high schools of Palghar Tehsil between October 88 and October 89, who had failed in mathematics. Standardised tests of numerical ability and a self-made questionnaires for teachers were used to collect data. ***Low intelligence, poor numerical ability, poor comprehensive and recall ability, no interest in***

mathematics and poor study habits were the causes of the large failures of boys and girls. Percentage, rational, algebraic expression, variation, probability and statistics were difficult topics in mathematics. The parents being illiterate could not help the children at home. There were no finances for A-V order in the school.

Kapur & Rasario (1992) conducted intervention trageties for students with problems in learning arithmetic. The sample consisted of twenty five students in the age group of eight to eleven years of class fosur, having significant problems in learning arithmetic. Tools used in the study were the Wesheler Intelligence Scale for children and a short form of arithmetic test based on Schonell Diagnostic Arithmetic Test. It was found that: (i) despite having average intellectual abilities and having regular classroom coaching, many students fail to perform well in arithmetic. ***(ii) students with problems in learning can be helped through remedial education which has varied instructional objectives.***

2.3.4 Attitude Towards Mathematics

Rosaly (1992) attempted to find out whether high school students have a favourable attitude towards learning mathematics and whether their attitude affect their achievement in mathematics. The sample comprised of two hundred students of standard tenth in eight high schools in Dindigul, Tamil Nadu. A Mathematics Attitude Scale and an Achievement Test in Mathematics were constructed and used in the study. It was found that the attitude of high school students towards learning mathematics and their achievement in mathematics were related. Urban boys and girls had a more positive attitude towards mathematics than rural boys and girls.

Singh, Ahluwalia, Sudarshan & Verma (1994) attempted to study the attitude towards mathematics as a function of some individual characteristics like sex, age and intelligence. The sample comprised 220 students of Grade IX studying mathematics in different schools of Education Department of Bhilai Steel Plant, Bhilai (Madhya Pradesh). They were divided into, High Intelligence Group (HIG), Average Intelligence Group (AIG), Low Intelligence Group (LIG), male and female groups 13+, 14+ and 15+ year groups. The tools used were the General Intelligence

Test developed and standardised by S.M. Mohsin and the Attitude Towards Mathematics Scale developed and standardised by Suydam, M.N. The students of high intelligence group had more favourable attitude towards mathematics compared to the students of both average and low intelligence groups. ***The students of average intelligence had a more favourable attitude towards mathematics than the students of low intelligence.*** The males did not have a more favourable attitude towards mathematics than females.

Wangu & Thomas (1995) assessed the attitude towards the achievement in mathematics among high school students of tribal town of Aizawl. The sample of the study comprised 300 students, covering both boys and girls, studying in Class IX of high schools of Aizwal. They were selected on the basis of stratified random sampling technique. The tools used to collect the data included the Achievement Test in Mathematics for Class IX of Ram, and the Attitude Towards Mathematics Scale. ***It was found that there was a significant positive correlation between the scores of attitude towards and achievement in mathematics for the total sample as well as the sub-groups.***

Stella, Anthony & Purushothaman (1995) attempted to study the attitude of the underachievers in mathematics with reference to sex, locale, IQ and achievement level. The sample of the study comprised 30 underachievers from each IQ category, high, average and low students studying in Class IX who were selected from three Tamil Nadu State Board Schools belonging to rural and urban areas. Tools used to collect the data included Culture Fair Intelligence Test, Scale 2, Form B of R.B. Cattell and A.K.S. Cattell, and the Mathematics Study Attitude Scale of Sundararajan and Srinivasan. ***It was found that there existed a significant difference between the mathematics study attitude of high and low achieving underachievers rural and urban students, and high and low IQ groups.*** The boys and girls did not differ significantly on their mathematics study attitude.

2.3.5 Summary

From the studies in achievement in mathematics, it can be interpreted that achievement in mathematics is related to various factors like intelligence, study habits, attitude towards mathematics. Sharma (1978) found insufficient drill at primary and absence of methodical approach of classroom teaching while Manika (1983) concluded that unless lower concepts are developed higher mathematical hierarchy cannot be developed, as factors for low achievement in mathematics. Lack of acquisition of concepts of the lower grade was yet another factor found by Manika (1983). ***These conclusions lead to a fact that acquisition of concepts at the lower grade and methodical approach of classroom teaching are essential for acquisition of higher concepts of mathematics***. Shah (1985) found some psychological factors like inattentiveness of parents, lack of remedial teaching and teachers not qualified to teach arithmetic and lack of special training in teaching of mathematics.

In a highly literate state like Kerala, Sasidharan (1992) found lack of prerequisites even in tenth standard students, with regard to the basics in mathematics. ***Kapur and Rosario (1992) found that despite having average intellectual abilities and having regular classroom teaching, many students fail to perform well in arithmetic***. The study also reported that remedial education with varied instructional objectives can help pupils with problems in learning. Dandapani (1992) found that the female teachers had a significantly higher perception then the male teachers and the teacher's perception about effective teaching varied with experience. ***Though Mohapatra (1990) did critical appraisal of secondary school mathematics curriculum, found that mathematics teachers were conservative in their out look as far as the objective of teaching and gave least importance to objectives like discipline, sense of proportion***. Very few studies were devoted to teaching of mathematics. However, these findings show the factors that are not usually considered with respect to achievement or learning in mathematics. Rajya Guru (1991) found that while overachievers and underachieved differed with respect to study habits, attitude towards mathematics are anxiety, they did not differ due to sex, locality. Intelligence did play a role in achievement in mathematics. Hence, emphasis could be made on improving study habits, attitude and lowering of anxiety

rather than only changing text books and teaching methods. ***Sarangapani (1990) analysed the curriculum design of the NCERT primary mathematics using Piagetion view and found mis-match between various tasks and the operational level of the target age group***. He also found the concepts were sequenced logically rather than psychologically. These kind of studies at all levels would also help improving achievement in mathematics. It shows the haphazard manner in which curriculum is being developed. The studies on correlates of achievement brought out factors influencing achievement in mathematics. ***The achievement in mathematics was found to be related to, attitude towards problem solving, Baskaran (1991), reading ability, location Rangappa (1992), prolonged deprivation Gupta et al (1993), self-concepts, mathematical aptitude Sumangala (1995).*** Hence, any effort to enhance mathematical achievement must also consider these factors. These differences cannot be ironed out nor neglected. Verma (1996) found high intellectual ability students performed worse another high test anxiety while low intellectual ability students did not any show significant difference. Gupta et.al. (1993) found girls in general (rural and urban) were more serious and more motivated than boys. However there was no difference in the problem solving ability between boys and girls. Nagalakshmi (1996) also found problem solving ability in favour of urban boys and girls. These findings reveal time of the vital factors influencing achievement in mathematics. Rastogi (1983) found attitude towards mathematics related to achievement in mathematics. ***Stella, Anthony and Purushottaman (1995), Wangu and Thomas (1995), Singh Ahluvalia, Sudarshan, Verma (1994) also found such relations. Stella, Anthony and Purushottaman (1995) found mathematics study attitude as a deciding factor of high and low achievers***. Singh Ahluwalia, Sudarshan and Verma (1994) found high intelligence group more favourable attitude towards mathematics compared to average and low intelligence groups. Rosaly (1992) found urban boys and girls had more positive attitude towards mathematics.

Setia (1992) found separate factors correlated significantly to mathematics achievement i.e. intellectual level of rapid and average learners, personality traits of rapid, average and slow learners. Pal (1989) found relationship between self concept and mathematics. Rajya Guru (1991), Sumangala (1995) and Thampurati (1994) also

found positive relation between attitude towards mathematics and mathematics achievement.

Attitude towards mathematics found to be a deciding factor of mathematics achievement. What needs to be known is the causes of positive or negative attitude towards mathematics. Rastogi (1983) found when command over basic arithmetic skills improved attitudes towards mathematics became favourable and achievement increased. Such similar findings would reveal the causes of positive or negative attitude towards mathematics.

About eighteen studies have been reported regarding diagnosis of mathematical backwardness. The various studies in this area have shown low achievement in mathematics due to poor command over basic arithmetic skills. ***Gupta (1972), Rastogi (1983). Ashar (1972) found that pupils committed errors due to lack of systematic approach while Bhirud (1975) found weakness in performing algebraic factorization due to weakness in understanding basics.***

It was found that when mistakes were diagnosed and remedied pupils progressed well in mathematics, S.I.E. Guj (1969), Rastogi (1983), Bhardwaj (1987) and Das and Barua (1968), Kapur and Rosario (1992).

Similarly Sarala (1990), Wagh (1991), Chel (1990), Jain and Bhurad, (1988) and Kasat (1991) also attempted to diagnose mathematical errors and high number of conceptual errors committed by secondary school students while Wagh (1991) found students of standard eight committed errors in fractional numbers and their operations. This could be compared to the study by Bhirud (1975). In the cross sectional study by Chel (1990) be found difficulties faced by students included content gaps, confusion in understanding mathematics language, stereo type way of presenting contents. Similar findings were that of Manika (1983), S.I.E. Guj (1969), Sharma (1978). In their study about low results, Jain and Burad (1988) found lack of infrastructure, non-availability of teachers, lack of child centred training,

uninteresting curriculum as some of the factors responsible for low results in mathematics. A very similar finding was that of Lulla (1966).

2.4 Foreign Studies

The studies cited here are taken from Dissertation Abstracts International. The studies being of uniquely different categories could not be put under any common category.

Tzeng Shwu-Rong (1987) studied the relationships among gender, attitudes towards mathematics, and mathematics attributions of sixth grade high, average, and low achievers in Taiwan, Republic of China. Numerous researchers have tried to understand variables that affect a student's achievement in mathematics. The intent of this study was to examine the role of certain affective and attributional factors on the mathematics performance of Chinese (Taiwanese) students. The sample consisted of four hundred and thirty-two sixth grade students were classified to three levels – high average and low. The Fennema-Sherman Mathematics Attitudes Scales and the Mathematics Attribution Scale were used to measure students' attitudes toward mathematics and attributions of success/ failure in mathematics. The results showed that: (a) ***the higher the achievement, the more positive were attitudes towards mathematics***, (b) there were no significant differences between male and female students in attitudes toward mathematics, except for the females' less-stereotyped perceptions of mathematics as a Male Domain; (c) ***the higher the achievement, the more attributions of success were due to having ability, to effort, to easy/ interesting tasks, and to effective teachers or facilitative peer groups. The lower the achievement, the more there were attributions of failure to not having ability, to task difficulty, and to lack of effective teachers or facilitative peer groups***; (d) there were no significant differences between male and female students in attributions of success/ failure in mathematics, except for the variables of "success-effort" and "success-environment," where female students were more likely to attribute their success to spending time studying, effective teachers, or facilitative peer groups; and (e) in general, there were significant positive relationships among the variables under "attitudes toward mathematics", among variables of attitudes

toward mathematics and variables of mathematics success attribution, and among the variables under "mathematics failure attribution." However, the relationships among variables of attitudes toward mathematics and variables of mathematics failure attribution were significant and negative.

Aviles' (1989) studies the environmental and educational characterization of low-achievers' experiences and attitudes towards mathematics performances using case studies. This study investigated the relationship of attitudes towards mathematics performance to the familial and academic environments of eight students identified as mathematics low achievers admitted to Puerto Rico Junior College. The aspects considered in the study were prior experiences in the familial and/ or academic environments. The study was based on personal, familial, and academic observation and interviewing. The study also considered visits to the familial and former high school environments. Moreover, written documents, such as academic records and autobiographical statements, were carefully analyzed. In the development of the study, eight questions were addressed in relation to performance, kind of family life, quality of schooling received, and self-concept related to family and academic events. These questions were not individually discussed, as they were interrelated. The study followed a naturalistic approach; students were observed in their natural environment; homes and former high schools were visited and observed in order to obtain a real view of these environments. The findings of the investigation revealed that many students are misclassified. ***Familial and academic environments are closely related to the development of attitudes toward academic performance. When even one of these environments is improved, the level of achievement is improved.***

Rose (1991) studied strategies and skills used by middle school students during the solving of non-routine mathematics problems. This study has edified the role of the teacher in mathematics learning and the need for non-routine mathematics problems as a regular part of school mathematics. This study was conducted to determine the processes and strategies selected middle school students use during the solving of non-routine mathematics problems. Qualitative research methods were

used to identify the cognitive and metacognitive skills and processes used in problem solving and to determine the affective influences on the problem solving processes. Six middle grade students were selected to particilate in the study. Each student was interviewed four time. The transcriptions were analyzed using a constant comparative method. Themes emerged from the data analysis, and findings were identified. The themes and findings led the researcher to the following conclusions. (1) Students are not aware of the various alternatives available to help them understand a non-routine mathematics problem when they first read it. (2) The only skills which students perceive as mathematics skills are the basic computations of addition, substraction, multiplication, and division. ***(3) Students model the problem solving strategies and behaviours of their teachers.***

Kalamaros (1991) tried to study instructional method and decreased student errors on math worksheets. Teachers often express concern about students' poor performance on classroom math worksheets. Performance deficits may be attributed in part to personal internal variables and/ or to external factors such as materials or instructional methods. Unfortunately, students' math ability often is evaluated based on performance on math worksheets, regardless of the many factors that may be impacting the individual. The purpose of this study was to explore the effect that instructional methods have on student performance on math worksheets. A multiple baseline single organism study was completed with 11 third grade subjects. The subjects were referred for participatuion by their classroom teacher based on the teacher's belief that the student had "difficulty following written directions." Teachers need to be aware of the potential relationship between reading ability and math performance. When teachers are interested in determining students' skills in math, the effects of reading must be taken into account. ***Teachers must evaluate the types of errors students made and take the time to show students explicitly how to correct those errors. Without this effort, errors are likely to be repeated. Teachers should always consider the impact that attitudes and beliefs about math ability have on student performance.*** Controlling for these influences increases the likelihood that students will demonstrate their true math skills.

Winter (1991) found to be forward looking with respect to the need for mathematically literate persons in the future. This study gives an alternative approach to supplement current teaching practices with a curriculum interrelating the studies of mathematics targeting students of grades five through eight. The was to encourage reluctant learners to comprehend the contributions of mathematics to world culture and stimulate interest in mathematical study. An interdisciplinary visual and tactile constructivist approach to develop all facets of students capabilities.

The study was based on the ideas of many psycho in relation to personal and academic children of the low achieving student. The eight questions addressed to in the study in relation to performance, kind of family life, quality of schooling received, academic events. This gave a proper direction to the major areas that would have an impact on low achievers. Later these were incorporated in the background variable questionnaire for the present study.

Glaring deficiencies in the mathematical achievement of American people evidenced by national and international studies, indicate that demand for mathematically literate persons will continue to exceed the supply unless wide-ranging educational changes are instituted. Education must develop innovative and creative intervention programs to students in growing mathematically. To this end, we explore an interdisciplinary approach which would supplement current teaching practices with a curriculum interrelating the studies of mathematics and students in grades five through eight are targeted for the project. Developing the curriculum model, we review interdisciplinary, cultural and motivational considerations in the first three chapters. Research is cited from the fields of physics, education, psychology and medicine. These studies lend support to the premise and teaching in mathematics through art is not only feasible but educationally sound. Both cognitive and affective objectives are included, thus recognising the importance of developing all facets of a student's capabilities.

To encourage reluctant learners to comprehend the contribution of mathematics to world culture, thus stimulating pupil interest in mathematical study. ***Appropriate components are included to enhance students experience with reading and writing in the language of mathematics. Activities facilitate the growth of mathematical communication. Connections among mathematics, other school subjects, culture, and practical applications in everyday life are reinforced.***

Karen (1998) studied student attitudes toward mathematics projects. The purpose of this study was to examine if mathematics anxiety, learning preference, exposure to projects, the teacher, gender, and ethnicity are related to student attitude toward projects. This study tested 17 hypotheses and both qualitative and quantitative methods were employed. The 304 students in the study completed an attitude survey, a mathematics anxiety survey, and a learning style inventory. The qualitative portion of the study revealed that sixty one percent of students had a positive attitude toward projects and were willing to take another project class. Over forty percent of students stated that they enjoyed working groups. Students also disliked many things, including: negative group experiences, the extent of writing, the amount of work involved, and a desire for more time when working on a project. Students recommended that more time be given in class to work on projects, and that projects be consistently interesting and creative. Over fifty percent of students stated that their attitudes toward projects were also affected by the teacher, the group, and the content of the project.

Greg (1998) studied attitudes toward mathematics and knowledge of mathematical concepts of preservice elementary, early childhood, and special education teachers. The advent of the National Council of Teachers of Mathematics (NCTM) Professional Teaching Standard requires that teachers of mathematics be competent, value mathematics, and stress the importance of solving real-world problems in teaching mathematics to successfully prepare students for the technological world of the twenty-first century. Studies (Dutton, 1951, 1964; Smith, 1964; Kelly & Tomhave, 1980; Becker, 1982) have shown that teachers of elementary mathematics tend to suffer math anxiety and are weak in math content

skills. Because of the tendency, the preparation of preserve elementary teachers needs to address the level of math anxiety and the achievement of appropriate content knowledge and work toward developing a more positive attitude in mathematics and increase the achievement in mathematics content. This paper addresses the attitudes toward mathematics and achievement in math content knowledge of preservice elementary, early childhood, and special education teachers and the changes through standards espoused methods in preservice mathematics content courses are used. Students enrolled in required mathematics courses for elementary education were given an attitude instrument in fall 1997 at the beginning and end of the semester to determine their self-efficacy in mathematics, their feelings about problem solving, and how they value mathematics. Fifteen students were interviewed to determined their attitudes toward mathematics and when these attitudes were developed. An achievement test based on the Third International Mathematics and Science Study (TIMMS) Population Two items was administered in spring 1998. ***Results of the attitude test show that students tend to improve their attitudes toward mathematics when taught by instructors who model appropriate strategies. Results of the achievement test indicate that students are weak in mathematical content.***

Lee (1999) studied why Asian students fall behind in maths. Asian students' strong achievement in mathematics has long been recognized. However, not all Asian children excel at math. The present study examines Chinese second-grade high-math achievers (HMAs) and low-math achievers (LMAs) who are at risk of developing mathematical learning disabilities (MLD). Both groups had average or above-average intelligence, normal sensory functioning and no emotional disorders. This study aims to identify why LMAs are poor in math. The results show that, when compared to HMAs, LMAs showed a wide range of weakness in the areas of short-term memory, working memory and long-term memory. LMAs were slower to solve number facts than HMAs in addition, they tended to use less mature and less efficient strategies to solve these problems (e.g., they use "counting all" or "counting on"), and their place-value concepts were also less matuer and complete. LMAs had more difficulty solving 3-digit as opposed to 2-digit problems, which may result from their less mature understanding or place value and weak WM as compared to HMAs. A high

frequency of LMAs errors in the multi-digit problems involved trading procedures such as increasing or reducing place value. Over the school year, although LMAs made progress on fact retrieval automaticity and place-value tasks, their achievement remained poorer than that of HMAs. ***An analysis of errors and better understanding the underlying cognitive processes involved in arithmetic competence can provide valuable insights for us to design programs tailored to each child's individual needs.***

Timmel (1999) studied the factors impacting the achievement and participation of high school girls in mathematics. The purpose of this study was to compare the factors of teacher, impact, student self-esteem, school culture/ organization, and parental support on the participation and achievement of high school girls in higher mathematics courses in two suburban Westchester, New York, high schools. Factor analysis of the data did not lend support to the possibility that males and females differ in the cognitive level of their mathematics achievement. Data analysis confirmed the importance of parental encouragement, self-esteem, and mentoring and encouragement of a teacher as significant factors in girls, mathematical success and continuance to study mathematics. Neither all factors nor all dimensions studied were significant predictors of achievement and participation of girls in mathematics. ***Recommendations included further use of classroom processes that promote gender equity, increase student self-esteem, and in turn mathematics achievement.*** Also recommended was further research in a low socio-economic environment, in a single-sex classroom, in a male-dominated school culture/organization, in elementary and middle school, and finally, in other subject areas.

Smith (1999) did an analysis of the role of language and representations in children's mathematical reasoning. The central goal of the study was to understand the processes and tools of children's mathematical reasoning. The study examined the question. How do language and representations children employ enable and constrain their doing of mathematics ? The role of various factors while doing mathematics was considered: (a) child's view of self, (b) the use (formal and

informal) of language, (c) the context in which the mathematics was situated (the "stories"), and (d) different forms of self-monitoring. Also considered were bases on which the children made decisions and the role those decisions played in doing mathematics. Four third graders' reasoning in and about mathematics was elicited by creating activities that engaged them in mathematics on or near the boundaries of their knowledge and understanding. Students' attitudes toward themselves and their beliefs about the nature of the discipline largely shape their use of the contexts of the problems, affecting their engagement with the mathematical issues entailed. This study presents a research methodology unique in its ability to elicit the reasoning of children as they do mathematics. ***By probing their understanding and then designing tasks that draw children near the boundaries of their understanding, the protocols made their decision-making and tools, as well as their language and representations, visible.***

Ridlon (1999) studied the effect of problem centred learning on the mathematics of sixth graders. This study described the effects of a problem centred approach to mathematics on the attitudes, actions, and achievement of sixth grade students at a middle school in the south-east. Two groups of sixth graders were randomly selected to participate in a nine-week study. Both classes had students of varying ability and diverse demographics. The regular classroom teacher taught the control group of 25 students using a traditional textbook and methods. The researcher presented the experimental group of 27 students with meaningful problem tasks that were solved in small groups and then presented to the class of validation. Data sources from both groups included a pre-test and post-test, student and parent surveys, student writings, and observations by the researcher and regular teacher who were both present at all times. Additional data were collected from the experimental group through interviews of students and their parents, student journals, and student work. A quantitative and qualitative analysis of all the results showed that Problem Centred Learning was indeed effective in the opinion of the involved stakeholders. ***They came to view mathematics in a more positive light, enjoyed the class, and felt they had learned more than usual. They believed attitude and achievement were measurably increased. The test scores gave strong evidence to support these***

convictions because the problem centerd group had a highly significant increase in achievement compared to the traditional curriculum. Thus, Problem Centred Learning appeared promising and worth further investigation.

Dupree (1999) studied mathematical empowerment: A case study of relational classroom learning. This is a study of the relationships that developed among the students in a small class of Mathematics for Critical Thinking. The organization of the class was based on the social constructivism of Vygostsky. There was an attempt to create an atmosphere that was sensitive and nurturing in which students could trust their classmates to be supportive of their efforts to solve mathematics problems. We worked together to establish the sociomathematical norms that would enhance the development of mathematical power within the students and promote the evolution of problem-solving skills. The findings indicate that the relationships within the classroom enhanced the development of viable relationships with mathematics. There were also indications that the fact that the students were all females may have contributed to the workable relationships with mathematics. ***There are strong implications that mathematics can be made more accessible to more students by restructuring the mathematics curricula to accommodate the different ways that students approach the construction of their mathematical knowledge***. My findings call for college and university mathematics departments to re-examine the traditional lecture method for disseminating mathematics to large numbers of students in a lecture hall and consider more opportunities for students to engage in mathematics at a personal level. This could revolutionize mathematics education in ways that would empower all students.

Bellisio (1999) studied student's ability to work with algebraic notation and variables. For many students, algebra is a major stumbling block that prevents them from continuing their study of mathematics. ***Many students have difficulty making the transition from working with numbers in arithmetic to dealing with letters that represent numbers in algebra***. Consequently they are unable to work with variables and notations to represent variable ideas which in critical to an understanding of algebra. The research was based on the premise that children can deal with algebraic

ideas at an early age. The focus of this study was to examine the notation and letters used by children to write general rules when they are given open ended investigations that involve algebraic reasoning. In particular, the questions that guided this research are: (1) Do students' written notations match the expression of their ideas in natural language ? (2) What type of notations do students invent ? (3) Do particular notations help students build a solution? Forty eight students who came from three school districts and from grades four through seven, provide a representative, diverse population for the study. The data includes videotapes of the students working together, follow-up interviews of individual students or groups or students, transcripts, detailed analyses of the videotapes and students' work. A case study analysis is used to show the development of particular algebraic ideas. For the problem tasks posed, students participated actively, discussed their ideas with each other, and invented a notation to express their ideas and to justify their solutions. The representations produced by the students were different and varied. Some students discussed and wrote rules for general cases. ***The notation students invented helped them keep track of their ideas and organize their data.*** In developing explanations to support their ideas, the notation was helpful in demonstrating they had found all possibilities.

Sjostrom (2000) studied the beliefs and practices of teachers regarding the high failure rate in Algebra I. The sample consisted of four algebra teachers in a high school with a diverse student population. The study was a qualitative case study and tools used were seen structure interviews and classroom observations. ***It was found that there were strong connections between the beliefs of the teachers regarding the nature of mathematics, their attributions for student failure in algebra, their self-efficacy, and the modifications they made in instructional practices.***

Warrick (2000) conducted an intervention program for parental assistance with mathematical homework and the relationship with increased student achievement. The sample consisted of children of thirty parents in the experimental group and thirty five students of parents in the control group. The experimental group scored significantly higher than the control group in all section of the ITBS

(Iowa Test of Basic Skills) and in addition completed more homework than the control group. ***These findings suggest that training parents to help their children with mathematics homework leads to ignored student achievement.***

Duncan (2000) studied the relationship between math preparation in high school and mathematics skills of college entering students. The sample consisted of college extras. The study found that most students in remedial mathematics were exposed to the mathematics content in high school but they never learn the material sufficiently enough to acquire math skills for college. ***The researcher concluded that increasing the mathematics requirements in high school does not ensure students that they will have sufficient mathematics skills necessary to readily enter college.***

Woggon (2000) studied students' perceptions of learning mathematics: A phenomenological study of learning moments in secondary mathematics classes. ***After a comprehensive examination of this literature, I concluded that the voices of students were noticeably absent from the research in mathematics education.*** Instead, most researchers in this field have assumed some theoretical orientation toward learning, like behaviourism, constructivism, or social constructivism, and have collected evidence of learning based on that orientation. In my opinion, this outsider's view has given the educational community a rather distorted sense of how mathematics is learned. Thus, in my study I have attempted to build a definition of learning from the perspective of those learners old enough to possess vast amounts of knowledge about how they learn. As a result, this qualitative study was designed in the phenomenological tradition. The core meanings that five hundred high school students, mostly of color, placed on the phenomenon of learning were reduced to a description of the fundamental structure of their best learning moments. Significantly, this structure was not equivalent to any of the three major learning theory orientations, yet was related to each. In the final analysis, it was concluded that students had perceived their best learning moments as a tension between two competing concerns, the first interpreted as their concern over precision and the second as their concern over purpose. The significance of this finding was analyzed

by contrasting this structure with each of the three major learning theories. Further, the impact of this structure on other fields of educational research was also discussed, including its potential influence on teacher education, the reform moment in mathematics education, research on authentic assessment, and the study of epistemological beliefs.

Siebert (2000) studied the coherent, dynamic accounts of prospective secondary mathematics teachers' knowledge of and beliefs about mathematics. This thesis presents accounts of the mathematical knowledge and beliefs of eight prospective secondary mathematics teachers (PSTs) as they progressed through a six-week unit on division of fractions that was designed to bring about change in their knowledge and beliefs about mathematics. These accounts capture the sense that the PSTs made of their experiences during the unit and investigate how their knowledge and beliefs interacted to both facilitate and prevent change. One of the pressing problems currently facing mathematics education reform efforts is that PSTs frequently leave college with critical gaps in their understanding of secondary school mathematics topics and with traditional beliefs about mathematics, teaching and learning. Efforts to better prepare PSTs have only been partially successful, in part because teacher educators do not have a clear understanding of PSTs knowledge of and beliefs about mathematics and how PSTs perceive of their experiences in classes designed to influence their knowledge and beliefs. This study used qualitative methods, including grounded theory, teaching experiment methodology, and case studies to investigate PSTs' knowledge of and beliefs about mathematics as they participated in the division of fractions unit. The PSTs' initial knowledge of division of fractions consisted mostly of procedural expertise, with only limited conceptual understanding. They tended to perceive of secondary school mathematics as an interrelated, consistent set of rules, procedures, facts and definitions. This interrelated rules, perspective towards mathematics persisted for a short period after the PSTs began the unit. However, through a series of mathematical explorations, the PSTs were also to develop new understandings for division of fractions. This new conceptual knowledge led PSTs to rethink how they would teach division of fractions and to reconsider how they perceived mathematics. They began to view mathematics

as a collection of rules and procedures that were supported by underlying concepts. ***Nevertheless, they continued to see rules and procedures as the major landmarks in the mathematical landscape, which in turn limited the mathematical understandings they were able to develop during the unit.***

Dominguez (2001) Studied about the college algebra students' understanding of the concept of variable. The sample was made up of thirteen students enrolled in a college algebra course. Think aloud procedure in class observation and analysis of the text book were used. ***The study found that students' level of confidence in approaching standard algebra problems was higher for familiar type of problem than for non-familiar type of.***

2.4.1 Summary

The foreign studies have used qualitative methods and focused on attitude towards mathematics, hurdles in learning of mathematics, students beliefs, and similar such areas.

Studies on achievement by Smith (1999) Woggon (2000), Ridlon (1999), Bellisio (1999), Dupree (1999), Rose (1991) found certain elements in the teaching-learning of mathematics. They were : student's attitude towards themselves, student's decisions, their language and representations, student's beliefs, notations used by children, students construction of mathematical knowledge.

From the focus of these studies, it was possible to gauge the importance given to student and mathematics relationship

Rose (1991) demonstrated the need for teachers to concentrate on fostering student's self-esteem and positive attitudes towards problem solving. Non-routine problems should become a regular part of school mathematics. Kalamaros (1991) insisted on teacher to be aware of the potential relationship between reading ability and mathematics performance. Also the impact of beliefs about mathematics ability on student performance. Smith (1999) elicited the reasoning of children as they do mathematics, and designed tasks to know their language, decision-making tools.

These studies bring one nearer to the understanding of student's thinking and learning

Woggon (2000) investigated into the learning of mathematics from the perspective of matured learners, apart from known theoretical orientations. This gave different dimension to mathematical learning leading to rethinking in mathematics education. This study was found similar in its findings to Dupree (1999), which felt need for restructuring the mathematics curricula, making students construct their own knowledge. Ridlon (1999) addressed to the decisions made by children during middle school affecting their attitude and ability to do mathematics for the rest of their lives. Problem centered learning changed their view about mathematics in a more positive light, enjoyed the class and felt they had learned more than usual. A study very near to student's nascent knowledge, language and representation, was done by Bellisio (1999). It was found that the notations students invented helped them keep track of their ideas and organize their data.

These studies indicate need for liberating the students from traditional, stereo-type teaching-learning situations

Kalamaros (1991), Tzen, Shwu-Rong (1987), Karen (1988), Greg (1998), Sichert (2000), Aviles (1989), tried to investigate into the attributes of low achievement in mathematics, effect of neglect of errors, attitude of teachers towards mathematics, knowledge and beliefs of mathematics teachers.

Kalmaros (1991) emphasized need for teachers to evaluate types of errors and show how to correct them or else errors were likely to be repeated. Tzen, Shwu-Rong (1987) found higher the achievement, the more attributions of success were due to having ability to effort, to interesting tasks and to effective teachers.

Hence, there was a felt need for continuous monitoring of student errors to enhance mathematics performance and ensure higher performance leading to positive attitude.

Karen (1988) found students had positive attitude towards mathematics projects. Aviles (1989) found that familial and academic environment were closely related to development of attitudes towards academic performance.

Hence curriculum planning and school environment, contributed towards attitude formation.

Greg (1998) found that students tend to improve their attitudes towards mathematics when taught by instructors who model appropriate strategies. Siebert (2000) found that prospective secondary teacher had only limited conceptual understanding.

Teacher's attitude, beliefs, conceptual understanding, influenced student's attitude towards mathematics.

Lee (1999) tried to identify factors for low achievement in mathematics by low-math achievers and high-math achievers. The study found low-math achievers were slow to solve number facts used less efficient strategies, less mature concept of place values.

Such studies tell about the cognitive processes involved in arithmetic competence, which should be addressed rather than mere drill.

Timmel (1999) found parent encouragement, self-esteem, monitoring and encouragement of a teacher.

Study by Sjostrom (2000) addresses the high failure rate in Algebra I. In relation to teachers' beliefs. The study recommended teachers must go beyond their student related alternation to design an effective instructional program, teacher educators need to teach content in connection with reformed pedagogy and challenging teachers' beliefs about mathematics, educational administrators must clearly define what students are expected to do and provide teachers with the necessary training provide a supportive environment which include manageable class sizes.

This study has tried to draw the attention of the people concerned towards high failure rate in Algebra I. Thus explaining the causes of high failure rate in Algebra I were not exclusively student related. A very similar study was that of Duncan (2000), who tried to find the need for increased number of students requiring college remedial mathematics and causes for innumeracy among high school students. The study found that students were not adequately learning the mathematics they have taken in high school. Also increasing the requirements in high school does not ensure sufficient mathematics skills necessary to cater college. ***This study brought to light the fact that though mathematics requirements (Contents) were increased, students entering college did not have sufficient mathematics skills. This should the facility of voluminous syllabi. Instead more efforts should be put to ensure acquisition of mathematical skills, concepts***.

Another unique study was of Warrick (2000) also examined the difference in academic achievement between one group from parents enrolled training program and a groups who received, no such assistance. The findings suggested that training parents to help their children with mathematics homework leads to improved student achievement. This study focused on an area hardly considered in relation to student achievement in mathematics. Homework being an essential ingredient in school program, this study suggested that other than changing teaching methods, providing remedial teaching and such similar efforts, now efforts could be made to train parents, to enhance student achievement in mathematics.

Studies by Warrick (2000), Sjostorm (2000), Dominguez (2001), Duncan (2000) have brought new dimensions, new areas in mathematics education research. Such studies would contribute constructively towards finding solutions to the epidemic of mathematical backwardness.

2.5 Implications for the study

After having reviewed studies from the surveys, DAI, journals, new view points, new research methodologies, new areas of research emerged. Similar findings of [Lulla (1966), Das and Barua (1968), S.I.E. Guj (1969), Gupta (1972),

Ashar (1972), Bhirud (1975), Thakore (1980), Jain (1979), Bhattacharaya (1982), Rastogi (1983), Bhardwaj (1987), Kapur and Rosario (1992)] lead to an urge to try out a similar study in Goa where no such study has been reported. Moreover, the analysis of the Fifth Survey of Research in Education shows absence of any such study in mathematics. Sharma (1978) pointed out blind use of rules. Bhirud (1975) found weakness in signs, coefficients indices in grade nine, Sashidharan (1992) commented on the faulty promotion policy and students not cognitively prepared. Studies by Rajyaguru (1991), Rosaly (1992), Thampurati (1994), Sumangala (1995), Wangu and Thomas (1995), found attitude towards mathematics as a deciding factor of mathematics achievement.

Studies on achievement by Smith (1999) Woggon (2000), Ridlon (1999), Bellisio (1999), Dupree (1999), Rose (1991) found certain elements in the teaching-learning of mathematics. They were : student's attitude towards themselves, student's decisions, their language and representations, student's beliefs, notations used by children, students construction of mathematical knowledge.

Rose (1991) demonstrated the need for teachers to concentrate on fostering student's self-esteem and positive attitudes towards problem solving.

The findings of the above mentioned studies, gave sufficient ground for the investigator to launch a study to diagnose mathematical weakness and to find remedial measures. The investigator was especially inclined to improve attitude of the students towards mathematics.

The foreign studies gave a glimpse of new research methods and new areas of research. Woggon (2000), Dupree (1999), Bellisio (1999), Kalamaros (1991), Ridlon (1999), these studies challenged the traditional teaching methods and attempted to look at teaching-learning from learner's point of view.

Ridlon (1999) addressed to the decisions made by children during middle school affecting their attitude and ability to do mathematics for the rest of their lives.

A study very near to student's nascent knowledge, language and representation, was done by Bellisio (1999).

This was a paradigm shift, for the investigator. Most of these studies adopted qualitative methods to investigate.

Kalmaros (1991) emphasized need for teachers to evaluate types of errors and show how to correct them or else errors were likely to be repeated. Tzen, Shwu-Rong (1987) found higher the achievement, the more attributions of success were due to having ability to effort, to interesting tasks and to effective teachers.

Need for evaluating students errors at the earliest, Kalamaros (1991), higher achievement related to positive attitude towards mathematics, Tzeng, Shwu-Rong (1987), constructivist view of learning, Smith (1999), cognitive processes involved in arithmetic competence, Lee (1999).

Studies such as these helped the investigator to understand the phenomena of mathematics learning. Hence, case study remedial programme became a part of the study, other than only identifying errors by diagnosis and standardization.

The investigator could lay hands on the studies by Warrick (2000), Sjostrom (2000), Dominguez (2001), Duncan (2000), towards the latter phase of the study. They could not influence the execution for planning of the study. They definitely helped to rethink about the suggestions and research gaps.