CHAPTER II

Review of related literature

“The literature in any field forms the foundation upon which all future work will be built”

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2.1 Introduction:

In the field of research, the research worker has to acquire up-to-date information about what has been thought and done in the particular area from which the present problem has been taken up. Hence a thorough survey of related literature was conducted. This kind of survey forms the basis of all kinds of researches.

The survey of related studies implies locating, studying, and evaluating reports of relevant researches, study of published articles, going through related portions of Encyclopedias, and research abstracts, study of pertinent pages out of comprehensive books on the subject and going through related manuscripts, if any. The researcher has to build upon the accumulated and recorded knowledge of the past. Survey of related studies provides the investigator with new ideas, theories, explanations, hypotheses or methods of research valuable in formulating and studying the problem. It enables him to know the means of getting to the frontier in the field of his research. It helps to formulate hypotheses, which is the basis for the entire research plan.
The present study deals with learning of mathematical concepts, problem solving skills and spatial ability of IX class students. The investigator proposes to present the review of related literature in three sections i.e. Section 1: Literature related to learning mathematical concepts. Section 2: Studies related to problem solving skill. Section 3: Studies related to spatial ability.

Again each section is subdivided into two categories-the studies conducted at Abroad and the studies in India.

Section – I: Literature related to learning mathematical concepts

This section includes the studies and related literature.

2.2 Previous studies conducted at abroad on mathematical concepts

The fundamental purpose of teaching mathematics is to help the student in developing good understanding and skills related to concepts, principles and operations and to develop abilities to face these problem solving situations.

Related literature:

COLBURN (1900) introduced, the first lessons in Arithmetic, on the Plan of Pestalozzi, with some improvements, which were designed to furnish the child with practical examples, which required arithmetical operations, and to provide exercises for drill upon the communications, which the child discovers, are needed to solve the examples proposed. With few exceptions the
practical examples were taken from situations in the life of children or from situations, which children easily understand.

JAMES A. MCCLELLAN (1900), Principal of the Ontario School of Pedagogy in Toronto, together with Dewey (1900), had, furthermore, produced a volume entitled “The Psychology of Number and Its Application to Methods of Teaching Arithmetic” in which it was mentioned “When the child is asked how much 4 times 8 feet, or 9 times 32 cents, there is no intrinsic reason for performing the operation; psychologically it is senseless, because there is no motive, no demand for its performance. The pupil should be so trained that all addends, sums, minuends, products, multiplicands, dividends, quotients, could be instantly interpreted in their nature and function as connected with the process of measurement. For example, a farmer has 8 baskets of potatoes to sell, and the market price is 55 cents a bushel; how much can he get for them?”

EDWARD LEE THORNDIKE (1921) Produced a text for student teachers entitled The New Methods in Arithmetic in Which Dewey’s influence is seen. Thorndike began his text: The older methods taught arithmetic for arithmetic’s sake, regardless of the needs for life. The newer methods emphasized the processes which life will require and the problems which life will offer.

A list of 500 of ‘the best problems in elementary algebra that are available at the present time’ was compiled by Powell (1929) who saw demands ‘on the part of the general educator as well as the mathematician’ for
genuine problems which will show the application of mathematical theories…’ and demands on the part of the pupil for problems that are real to him and that will arouse his interest.

Powell’s selection of problems was: Performing better on the ‘interesting problems’, she concluded: There is little evidence in these data that children prefer their Arithmetic to concern itself with their plays, games and social activities. Interest does not initiate substantially improved arithmetical thinking.

National council of Teachers of mathematics Commission, on Post War Plans (1945) presented a report - ‘Suggestions for improving Mathematical instruction from the beginning of the elementary school through the last year of Junior College”. Consideration was given to the ‘Social aims’ of arithmetic and it was suggested that:

‘Natural’ as well as planned classroom and extra classroom uses of number are especially serviceable. Children appreciate the value of arithmetic when it helps them to meet needs of vital importance to them.

**ALLYN AND BACON INC. BOSTON, (1964), “Banks, learning and teaching Arithmetic”, 2nd Edition** reported on a study that pupils prefer fantasy problems to problems describing real life situations. Even ridiculous situations were not found to be a distraction. Pupils performed as well on the unreal problems as they did on the real problems.
CARINGTON AND CRUTCH FIELD (1965) used self-instructional booklets that highlight the use of repeated questions in mathematical exercises. In the general problem-solving programme, they reported that students were asked to plan their procedures, search for uncommon or new ideas and try to transform the problem given into a known situation. They found significant gains in favour of experimented students.

CARPENTER, COBURN, RAYS AND WILSON (1975) in Results and Implications of the NAEP mathematics assessment: Elementary School’ observed that learning to solve word problems is notoriously difficult. Yet the related mathematical concepts, a large percentage can analyze a simple word problem correctly. If they are not completely familiar with the concepts, or if the problem is complex, then errors in the analysis of the problem (selection of the wrong operation and so on) tend to occur.

Related studies:

LYNWOOD (1935) in his study: “A survey of Research in the teaching of Secondary Algebra’ stated that in solving verbal problems, students have been found to have greatest difficulty in determining what is given and in translating the statement into algebraic symbolism.

2.3 Research studies in India on mathematical concepts:

GOKHALE (1943) did Factor Analysis of Mathematical Ability, to determine the number and nature of mental factors involved in mathematical
ability. A battery of tests was constructed which include arithmetic operations, number series, error detection, judgment, problems and computations. These tests were administered to two groups of students. The first group consisted of 320 student-teachers from two training colleges at Belgaum and Dharwar. The second group consisted of 210 students of classes VI and VII from 4 high schools in Belgaum. Tests were common to both the groups. Findings reveal that the mathematical ability consisted of following. Reasoning factor, Number factor and Arithmetic factor.

**DAS, R.C. and BARUA, A.P. (1968)** studied the effect of remedial teaching in Arithmetic, on Grade IV pupils, SIE, Assam. Present post test experimental control group design was followed. In each group there were 30 grade IV pupils. For the purpose of diagnosis of individual differences F.J. Schonell’s ‘Diagnostic Arithmetic Tests were adopted’. The major finding of the study was that remedial teaching had definitely improved significantly the achievements in arithmetic.

**IYER,K.K. (1977)** studied some factors related to underachievement in mathematics of secondary school students, The study was conducted on a representative sample of 862 subjects selected from a representative educational level-std-IX-of the secondary schools of the Trivandrum district of Kerala. The tool was two aptitudinal criteria, a verbal group test of intelligence, a non verbal group test of intelligence and a standardized test of mathematics were administered to the subjects. The findings were, there was significantly a greater number of over achievers among the high intelligence group than
among the low intelligence group. Out of the 11 non personality variables 5 variables, Sex, age, caste, parental profession and parental education were associated with all the three achievement levels.

KOUL.L., (1978) studied the personality needs of high and low achievers in mathematics. The study was designed to make a comparison between low and high achievers in mathematics. The initial number of 1,030 students was selected from six randomly chosen boys higher secondary schools of Ajmer. The major findings of the study were i) The high achievers in mathematics differed significantly form low achievers on eight of Murray's needs. ii) The low achievers in mathematics were more exhibitory, succorant, heterosexual and aggressive.

BHARITIYA, A. (1979) studied the effectiveness of mathematics in relation to certain students characteristics. The cluster and stratified sampling was used for selecting the sample. The sample comprised 196 students (100 boys and 96 girls) of IX Class. In the analysis the pretest scores were adjusted to the post test scores. Intelligence was measured by the General Mental Ability Test developed by S.Jalota. Creativity through the verbal test of creative thinking ability by Baquer Mehdi, Neuroticism and extraversion by Eysenk’s M.P.I. adopted in Hindi by Jalota and Kapoor, and levels of aspiration by the Aspiration test of Shah and Bhargava. 1. Intelligence of subjects was found to be significantly related to their mathematical performance. 2. Creativity was significantly related to mathematical
achievement. 3. The boys and girls were equally benefited by mathematical learning experience.

GADGIL., A.V., (1979) Studied the causes of large failures in mathematics at the S.S.C. Examination (Std.X) of March 1977. The sample is 27,990 pupils for algebra and 19,869 for geometry out of the total sample, 2,56,940. The tool used was a questionnaire meant for schools. The sources of data were the marks sheets of S.S.C. Examination, and a sample of randomly selected answer scripts. The findings were, results in algebra and geometry were comparable and it could not be concluded that more failures were due to more failures in algebra or in geometry. Reasons for failure in mathematics were inadequate coverage of the syllabus, inadequate attention paid to some difficult topics, inadequate motivation for study and inadequate guidance provided to pupils for study.

WELLS (1981) in his study on “The processes involved in the activities of computer programming and mathematical problem solving”, found that there is a significant correlation between mathematical problem solving success and computer programming problem solving success.

MAINKA (1982) attempted to determine the ability of children to acquire mathematical concepts and to evaluate understanding and the acquisition of mathematical concepts of pupils. He found that the majority of pupils who were promoted to the next grade did not show acquisition of concepts.
KULAKARNI, MOHANLAL AND NAIDU(1982) undertook “All India Survey of Mathematics Achievement”. This study was undertaken at three levels of education i.e., primary middle and high school in all the states. Adequate importance was given to the higher cognitive objectives like application, logical thinking and integration of knowledge arising out of different branches of mathematics. The results showed that. On the whole, public schools did better than Government schools. The reason for the superiority of the public school performance has to be sought in other factors like socio-economic status of the parents. With regard to the nature of occupation it was found that students whose parents were engaged in professional and technical occupation scored higher on cognitive objectives like application, logical thinking and integration of knowledge than those whose parents were engaged in farming or unskilled labour.

RAO.T.G. (1983) did a comparative study of programmed learning and conventional learning methods in the instruction of mathematics – A Psychological approach. A sample of 300 students from grade-V and 296 students from grade X was taken. Equal number of students were assigned to the programmed learning group and conventional learning group in both the grades. The tools employed for data collection were the Hyderabad State Bureau of Education Group Test of Intelligence (1980), an interview schedule to know the attitude of students, and achievement tests in mathematics for students of grade V and Grade X. 1. The mean performance scores of the programmed learning group and conventional group on the achievement test
were less than the normative means of the test. 2. The mean performance scores of all the programmed learning groups were higher than those of the corresponding conventional learning groups. 3. The performance of urban subjects was superior to the performance of rural subjects under the programmed learning method irrespective of grade.

**Vyas, C.S. (1983)** had the development of symbol picture logic programme to study its effect on Mathematical achievement. Four schools were selected at random from 16 schools of Bayad Taluka. The equivalent group technique was adopted. There were 160 students in the experimental group and 160 in the control group. The other tool that was used for collecting data was the group test of intelligence by K.G. Desai. The $2 \times 2 \times 2$ factorial design was adopted for studying the SPLP in relation to achievement, parents education and sex. 1. The students with high intelligence benefited more by the SPLP by better achievement in mathematics than those who possessed low intelligence. 2. The students possessing high reasoning ability benefited more by the SPLP by better achievement in mathematics than those who possessed low reasoning ability. 3. There was no interaction among the programme, intelligence and syllogistic reasoning ability. This showed that the achievement in mathematics was independent of these variables.

**Yadav, P.S., (1984)** studied the effect of Mastery Learning Strategy on pupils' achievement in mathematics, their self-concept and attitude towards mathematics. The mathematics attitude scale which had a split-half reliability of 0.85 and had content validity, the mathematics achievement test which had a
split-half reliability of 0.73 and had content validity, the Swatva Bodh Parikshan-a test of self-concept developed by Sherry were the tools used. 1. Before the experimental treatment, the experimental group (mastery group) of pupils and the control group (conventional group) of pupils evinced no significant differences in respect of their achievement in mathematics, self-concept and attitude towards mathematics. 2. After the experimental treatment, the experimental group of pupils exhibited a significantly higher achievement in mathematics than the control group of pupils and higher gain scores of achievement in mathematics. 3. Different percentile achievement scores of the experimental group of pupils were found to be significantly higher than those of the control group of pupils at post-test stage.

**PATEL, N.R. (1984)** conducted an investigation into the mathematical ability of pupils of classes IX and X in the context of some cognitive and affective variables. A sample of 1250 students of Class IX and 1035 students of Class X were taken. The mathematical ability test was constructed by following the usual method of test construction, Space visualization test, Syllogistic reasoning test in mathematics (STRM), Mathematical Attitude Scale (MATS), Mathematical Anxiety Scale (MANS). 1. There were no significant sex differences with regard to mathematical ability of pupils of classes IX and X. 2. The pupils possessing a favourable attitude towards mathematics were found better in mathematical ability than those with a less favourable attitude. 3. The pupils possessing high anxiety were inferior in mathematical ability to pupils having low anxiety.
RAO, L.N. (1985) studied the factors influencing the effective use of audio visual equipment and materials in class room teaching. The study was conducted on a sample of eight schools. Questionnaire on the availability of audio visual equipment and a questionnaire on the availability of audio visual materials were used. 1. There was no positive association between the effective or ineffective use of audio-visual equipment in class room teaching and the type of management. 2. There was no significant relationship between the effective use of audio-visual equipment in class room teaching and the locality of the schools. 3. There was no relationship between the effective use of audio-visual equipment in class room teaching and the strength of the schools.

BHALWANKAR, A.G., Ph.D. (1986) conducted a study on the “Effects of Expository and Guided Discovery Methods of Teaching Mathematics”, on the achievements of students of different levels of intelligence. The basic design of the experiment was 2 X 3 factorial design. One factor was method at two levels expository and guided discovery method. 1. Guided discovery and expository methods were equally effective on knowledge and comprehension objectives with respect to both immediate post-test as well as retention test. 2. The expository method was more effective than the guided discovery method on the criterion of scores on application objectives with respect to students of high intelligence. 3. The guided discovery method was more effective than the expository method on the criterion of percentage of retention scores on the application objective in the
case of students of low intelligence. 4. The guided discovery method was more effective than the expository method on the criterion of percentage of retention scores with respect to total achievement of the students of middle intelligence.

**PATEL (1986)** investigated into the mathematical ability of class IX and X. the investigator chose to provide a standard and valid tool to measure mathematical ability of pupils and also to establish norms of a mathematical ability test. He found that the people possessing high reasoning ability were to be better in mathematical ability than those with low reasoning ability.

**KOTHARI, R.G., (1987)** did an investigation into efficiency of different instructional media in the teaching of mathematics to the pupils of class IX in relation to certain variables. The experiment was carried out in two schools. Four groups of class IX pupils having 30 pupils in each group were selected for implementing the instructional media while the other four groups were treated as control groups. The pre-test and post-test control group design was adopted for the purpose of studying the efficiency of different media. The Junior Index Motivation (JIM Scale) and test of reasoning ability were used for collecting necessary information about the variables under study. The major findings were 1. Visual projection, activities and experiment were equally effective for unit – I, while visual projection was superior to the activities and experiment approach for Unit-II. 2. The approach of media, activities and experiment was superior to programmed learning material for Unit-I but they were equally effective for Unit-II. 3. Visual projection was superior to
programmed learning material for Unit-I, while they were equally effective for Unit – II.

**CHITKARA.M. (1988)** studied the effectiveness of different strategies of teaching on achievement in mathematics in relation to intelligence, sex and personality. A sample of 300 students was randomly selected from grade IX students of four schools of Chandigarh. Tools were the mathematics achievement test, the Jalota group test of mental ability (1972) and, The Eysenck personality inventory (1964). The major findings of the study are the following. All the three strategies namely, (a) Lecture-discussion, b) Inductive–drill and, (c) Auto-instruction group discussion, were found to be equally effective in terms of achievement in mathematics disregarding levels of intelligence, sex, and personality type. 2. Boys and girls of superior ability did not show any significant difference between their mean scores on achievement in mathematics. The strategy of lecture discussion was found to be equally effective with the above. Extraverts of high ability, average ability and below average ability scored equally well when taught through strategies.

**RAO,A.V., RAGHVENDRA, (1989)** did an investigation into the relative effectiveness of guided discovery and expository approaches of teaching mathematics. The population selected for testing the above hypotheses was Class IX pupils of Vizag. From this population, three samples, namely, boys, girls, and rural pupils, were selected. Intelligence test was given to them. 1. There was no significant difference in achievement in mathematics when taught by the guided discovery and expository approaches. 2. There was no
significant difference in problem solving when taught by the guided discovery and expository approaches, except in the case of girls where a significant difference was found.

**GREWAL S.S. and KAUR (1990)** studied achievement motivation and anxiety as related to academic success in mathematics. The study was conducted on a random sample of 200 students (males and females) of IX class. Aberdeen’s Academic Motivation test, Sinha’s Anxiety Scale, Achievement scores in mathematics based on annual examination of VIII class were used. The major findings of the study 1. The measure of anxiety correlated significantly negatively with achievement scores. 2. The variation between overachievers and underachievers exists because of anxiety scores has been accepted as is evidenced form high t-values. 3. High level of anxiety tends to show poor academic performance in mathematics while a group with low level of anxiety tends to achieve higher.

**GURUSAMY, S.(1991)** did a diagnostic study of the errors committed by students of standard IX in solving problems in Geometry. Case study Method was followed. To collect data, a questionnaire developed by the investigator was set to 20 expert Geometry teachers of standard IX. 1. It was found that the student mean achievement scores increased and the errors were considerably reduced in the post-test. 2. The level of performance of the students in the post test was found to be high after the implication of the remedial programme.
PURUSHOTHAMAN, (1995) studied maths study attitude of the underachievers. The sample consisted of students of Std. IX selected form 3 Tamilnadu State Board Schools-1 rural & 2 Urban. There were 30 underachievers from each IQ category high, average and low. Culture fair intelligence test scale, form B designed by R.B.Cattel and AKS Cattel, 1961 Edition, and the Maths Study attitude scale constructed and standardized by sundararajan and srinivasan in 1990 were the tool used. 1. There is no significant difference between the maths study attitude of underachieving boys and girls. 2. There is significant difference between the maths study attitude of underachieving urban and rural pupils.3. There is significant difference between the maths study attitudes of high and low IQ underachievers.

GIRIJA DEVI THAMPURATTY, N.R. (1996) studied socio-economic status of creative high achievers and creative low achievers in mathematics. The study was conducted on a large sample of 771 pupils of Std. IX in the secondary schools of Kerala selected by stratified sampling technique giving due representation to factors like sex, locale, instructional efficiency and type of management of the schools. Tools were Creativity measured by a comprehensive test of creativity for secondary school pupils (1987) developed and standardized by Sumangala, the Socio economic status variables (parental income, parental occupation and parental education) were measured by the scale of school position (1992) developed by Sumangala, Achievement in mathematics was measured by the test of achievement in mathematics (1992) developed and standardized by Sumangala. 1. There is significant difference in
the mean scores of parental income of creative high achievers and creative low achievers. 2. There is significant difference in the mean scores of parental occupation level of creative high achievers and creative low achievers. 3. There is significant difference in the mean scores of parental education level of creative high achievers and creative low achievers.

**SUMANGALA, V. (1997)** studied “the effect of attitude towards mathematics and sex on achievement in mathematics. The sample for the study consists of 442 (212 Boys and 230 Girls) secondary school pupils drawn from 12 schools by stratified sampling technique. Achievement Test in Mathematics for standard IX was framed and used (Sumangala and Jayasree). The test has been assigned to measure the six components of cognitive domain classified by Bloom and his associates, Scale of attitude towards mathematics of a Likert type 30 item scale was designed to measure seven constructs of attitude towards mathematics. Findings of the study. 1. The variables attitude towards mathematics and sex have significant effect on achievement in mathematics. 2. The interactive effect of the variables attitude towards mathematics and sex on achievement in mathematics was significant.

**SUMANGALA V. and MALINI, P.M. (1998)** studied mastery learning strategy and achievement in mathematics at secondary school level. This being an experimental study, the sample was selected by the method of purposive sampling. The sample consisted of 74 experimental subjects and 65 control group subjects drawn from two secondary schools of like instructional efficiency and belonging to the rural locale. Lesson plans for mastery learning
strategy, Lesson plans for conventional learning, Unit achievement test in mathematics, Formative tests in mathematics, school examination marks in mathematics were studied. 1. The two groups differ at all the percentile points. 2. All the percentile points of the experimental group are greater than the percentile points of the control group. 3. 90 percent of the pupil of the experimental group secured more than 67 whereas in the control group the point above with there are 90 percent of scores.

PADMAJA, K. (2002) studied Mathematical Ability in relation to mathematical achievement of VIII class pupils in Warangal district. The pupils were found to possess average mathematical ability. There is high positive significant relationship (0.63) between the mathematical ability and mathematical achievement of the pupils.

NOORGAHAN. N GANIHAR and WAJIHA, A.H, (2009): investigated factors affecting academic achievement on IX standard students in mathematics the major findings were as follows.

1. students studying in both aided and unaided schools were high on achievement in mathematics, mathematical creativity and test anxiety when compare to government schools.

2. Students of unaided schools were high on mathematical creativity when compared to students of aided schools.

3. Boys were high on mathematical creativity than girls.
MAHENDER REDDY.SARSANI and RAVI MADDINI (2010) : studied achievement in mathematics of secondary school students in selected variables, the findings were as follows.

1. Girls performed better than boys in mathematics scholastic achievement test.

2. Type of school as influence on the performance on mathematics scholastic achievement test.

3. There is influence of locality on the performance in mathematics scholastic achievement test.

Section II : Studies related to problem solving skills

2.4. Research studies conducted at abroad on problem solving skill

TREACY (1944) observed that pupils who are well acquainted with the special vocabulary of mathematics do better in solving verbal problems than the pupils to whom these words convey little meaning or an inappropriate meaning. He concluded that help that enriches pupil’s understanding of their reading may have a beneficial effect on their performance in problem solving.

JOHNSON (1944) in his study ‘The Effect of Instruction in Mathematical Vocabulary upon Problem Solving in Arithmetic’ concluded that vocabulary instructional material should be used regularly and systematically as an integral part of the classroom procedure.
TAVERS (1967) developed an instrument for testing for problem preferences and found no significant difference in success between preferred and non-preferred problems. Scott and Llighthall (1967) tested the hypothesis that disadvantaged children would perform relatively better on problem whose content dealt with lower needs such as food and shelter than problems whose content dealt with higher needs such as mastery and education. Need content of the problems was not related to degree of disadvantage. The principal component analysis of the data suggested that factors associated with difficulty and the mathematical content of the items, rather than the need content, accounted for differences in performances.

COLLIER AND LERCH (1969), AND KINSELLA (1970) observed that problem solving is a major force in the modern growth of mathematics and continues to be an integral part of mathematics instruction in schools. Students should be encouraged to think, to solve problems, in a programme, which aims at developing a related system of mathematical ideas and an ability to perform at higher levels of problem solving.

LIPSON (1972) involved three senior mathematics majors in a seminar on the problem solving style advocated by Polya and concluded that better problem solvers were trained. Similar studies by Smith (1967) and Post (1967) on the problem solving process however did not result in significant results.

LESH R. WANDAN, M. HAMILTON, (1982) found that seemingly realistic word problems appearing in most mathematics text books often differ
significantly from their real world counterparts with reference to degree of
difficulty, processes needed in solution and error types most frequently
committed.

Furthermore, if important problem-solving experiences are identified
based on observations of everyday situations in which mathematics is used,
then it becomes obvious that many of the most important problem types are not
represented in most instructional development.

**RAI, S. (1982)** studied problem solving in science of creative and non
creative students. The sample for the study consisted of 200 students from two
secondary schools of Patna. The tool was the creativity test of Medi. The two
groups creative and non creative students were tested on problem solving tasks.
The main findings of the study were that the creative and non creative groups
differed significantly in their problem solving ability.

### 2.5 Indian studies related to problem solving skills:

**KELL (1965)** found that ability to solve textbook problems improved
when students are given experience in writing and solving problems.
**WILLS (1967)** reported a strong positive gain in problem solving ability at the
eleventh grade level as a result of providing experience of learning by
discovery. On the post-test covering general mathematical topics the
experimental group doubled their pre-test performance while the control group
made only slight gains. **Schoenfeld (1979)** and **Lester (1980)** found that
problem solving heuristics could be taught successfully.
Although evidence was inconclusive Wilson (1967) reported that students had improved in their ability to solve mathematics problems when they were made aware of both general and task specific problem solving maxims and when they had opportunity to use the maxims. However, Stilwell (1967) who adapted the Flanders interaction analysis scheme to study problem solving activity in Geometry class rooms found that less than 3 percent class rooms spend time on problem solving. Out of the time spent on problem solving only 7 percent of the time was devoted for discussing student’s solutions.

HULL (1979) in a study on “developing competency with problem solving ability in mathematics” found that pupils achieved an average gain of nine tenths of a normal years growth in their measured ability with verbal problem solving.

KESKAR,P.U. (1980) developed a test on problem solving ability for Gujarati children of Grades III to VII. Split-half method, test–retest method, kuder method, and Hoyt’s method were followed. The final form of the test was administered to 1010 students of both sexes from urban and rural background. The first preliminary form consisting of 93 items was administered to sixty students of both the sexes. Results of the studies were I) The reliability indices of the test were 0.97,0.30,0.72 and 0.96 by the split half method, test –retest method, kuder Richardson formula and Hoyt’s method respectively All the reliability coefficients were statistically significant at 0.001 level  iii) The coefficients of correlation between the scores on the test and the
examination marks of the students were found to vary between 0.25 and 0.95 for grades III to VII. iv) The coefficient of correlation between the scores on the test and intelligence test were found to be 0.82. v) Factor analysis of the data showed that all the variables had a good deal of general intelligence factor, G.

The major educational implication of the study is that remedial teaching, even for a small period compared to the total duration of working days in the year, can effect significant improvement in achievement in arithmetic.

**FELTOVICH AND GLASER (1980)** conducted a study entitled, “High school students in organization of mathematics word (verbal) problems in relation to success in problem solving”. They found that more successful problem solvers were able to recognize underlying mathematical relationships among the problems and immediately organize the problems based on structural criteria.

Less successful problem solvers did not see these underlying structural characteristics and instead, organized the problems based on such “surface structure” criteria as question form, context and common units of measurements.

**CHARLES FUNKHouser (1981)** examining the problem solving conceptualization of in-service teachers revealed that 40 percent of responses were categorized as conceptually vague, 27 percent as terminologically vague, 12 percent as strategies, 9 percent as skills based and 12 percent based on others.
TRIPATHI, AWADHESH AND TIWARI, B.D., (1993) studied the effect of dependence proneness and demonstration on verbal problem – solving in Grades VIII and IX children. Experimental Method was used. One hundred and twenty boys studying in Grades VIII and IX their age varying between 12 – 15 years, served as subjects. The findings revealed 1. A significant difference between the performance in problem solving by high and low dependence-prone persons. Low dependence prones are more efficient in such tasks than high dependence prones. 2. The main effect of demonstration on performance has been found statistically significant. 3. The present investigation indicated that dependence proneness was an important component of the entering behaviour of subjects, and that the effect of demonstration on performance in problem- solving showed a trend that LDA subjects gained slightly more than HDP subjects though it did not show statistical significance.

SWARNALEKHA (1997) : studied joyful active learning in promotion of problem solving ability among primary level students the major findings were.

1. It is found that remarkable improvements in the area of problem solving area of mathematics learning were attained by paying attention to the language comprehension skills and non scholastic areas.

2. It was found important to frame different activities to develop different skills like comprehension, judgment, analysis, synthesis, critical
thinking, problem understanding, finding analogy, checking equivalence in similar situations.

**JAYESH (1999)** undertook a study entitled “A study of VII std students achievement in mathematics and their ability to solve mathematical problems related to daily life situations”. The findings of the study were there was a relationship between the achievement of VII std students in mathematics and their ability to solve mathematics problems related to daily life at a moderately high level. There is a significant difference between the students with high and low mathematics achievement score in their ability to solve mathematical problems related to daily life. The local of the school does not influence the ability of students to solve mathematical problems related to daily life situations.

**LAKSHMIKANTH, N., (1999)** studied Psycho Social Correlates of social Problem-solving skills among preadolescents. Experimental Method was followed. The sample was drawn from five English Medium Co-educational schools in Bangalore city. To collect the data information schedule, Preadolescent Adjustment Scale, State- Trait Anxiety Inventory, What I am Like Scale. Aggression Questionnaire, Test Battery on Moral Development, Social Problem-solving Skills Questionnaire and a Tool of group Social Problem – Solving Assessment were used. A significant positive correlation was found between all the sub-tests of moral development and the components of SPSS. Aggression and anxiety were found to have a negative correlation with the components of SPSS. 2. Girls showed greater appreciation of their
behavioral conduct and greater responsibility on moral development scale, whereas boys were more anxious and they could foresee the negative consequences of situations. 3. The younger group showed better school adjustment and were more appreciative of their social acceptance, physical, appearance and behavioural conduct on self- concept as compared to the older group. 4. A significant score difference was found among the only child and last born on interpersonal sensitivity and problem analysis and action. 5. Interaction effects of birth order and SPSS level were not found to be significant on any of the variables.

BISWAJIT BEHERA (2009) : studied problem solving skills in mathematics learning, the major findings were.

1. The mean difference between high ability and low ability groups, between boys and girls with in each ability group is quite large.

2. Students with high mathematical ability are far superior in mathematical problem solving skill to their counter parts in the lower ability irrespective of their gender.

Section – III : Studies related to spatial ability :

2.6 Studies related to spatial ability:

JAIN,D.K (1979) studied significant correlates of high school failure in mathematics and English with special reference to Jammu Division, the sample formed was with two groups of students identified as successful and failures in
both the subjects. Thus, 200 passing and 150 failing in English and 150 passing and 175 failing in mathematics were selected. The tools were numerical ability test, abstract reasoning test, spatial ability test and English ability test. Factors that played a vital role in mathematics were intelligence, abstract reasoning, numerical ability, spatial ability, mathematical background, knowledge of mathematical concepts and the status of mathematics in the family.

KATIYAR.P (1980) had the study of cognitive functions in relation to achievement in mathematics at high school stage, the sample was 1000 girls and boys of class X, of whom 300 boys were studying general mathematics and 300 advanced mathematics and 200 girls were studying general mathematics and 200 advanced mathematics. The tools were five tests on cognitive functions, namely, abstract reasoning, numerical reasoning, numerical ability, space relation and substitution of symbols, of which two were prepared by the investigator and three adapted from DAT. The major findings are the study revealed no significant difference in the average scores of boys and girls studying advanced mathematics on the achievement test. Girls with advanced mathematics course scored better on the tests of cognitive functions.

PILLAI.K.S. (1981) studied sex differences in certain personality and aptitudinal dimensions related to science achievement. The sample consisted of 888 pupils of standard IX drawn though the proportionate stratified sampling technique. The Kerala university science interest inventory, the Kerala science aptitude test and Ravens Progressive matrices were the tools, the major findings were significant sex differences were found in science aptitude,
science information, number series, verbal comprehension and interpretation, spatial ability. When the role of intelligence, place of residence, age and socioeconomic status was controlled one by one.

SINGH.R. (1981) did construction and standardization of a mechanical aptitude test for X class students of Haryana, the sample were 1,020 students selected from government and private schools of 11 districts of Haryana. The main objectives of the study were to construct and standardize a mechanical aptitude test battery for class X students and to establish reliability, validity and norms for the different tests in the battery. The components of mechanical aptitude were general intelligence, spatial ability, perceptual ability, mechanical adaptability, mechanical comprehension, mechanical information and manual dexterity.

SUMANGALA (1995) studied the relationship between mathematical aptitude and achievement in mathematics the total sample was 750 students of class IX in Kerala and found all the components of mathematical aptitude, i.e numerical ability, numerical reasoning, ability to use symbols, spatial ability and abstract reasoning abilities are significantly correlated to achievement in mathematics.

From the presentation of review of related literature in the above three sections it is observed that no attempt has been made to take up a study on combination of the three areas i.e learning of mathematical concepts, problem solving skills and spatial ability.
2.7 Observations:

LYNWOOD (1935) studied on the teaching of secondary algebra and found that meaningful problems enhanced the interest of the children. Gokhale (1943) studied the factor analysis of mathematical ability and findings reveal that the mathematical ability consisted of reasoning factor, number factor and arithmetic factor. Carington and Crutch Field (1965) studied the self instructional booklets that highlights the use of repeated questions in mathematical exercises. They found significant gains in favour of experimented students.

DAS, R.C. AND BARUA, A.P. (1968) studied the effect of remedial teaching in Arithmetic on grade IV pupils and found that remedial teaching had improved significantly the achievement in arithmetic. Iyer, K.K. (1977) studied some factors related to under achievement in mathematics of secondary school students and found that there was significantly a greater number of over achievers among the high intelligence group than among the low intelligence group.

KOUL.L(1978) found the personality needs of high and low achievers in mathematics and found that the high achievers in mathematics differed significantly from low achievers. Bharitiya, A. (1979) studied the effectiveness of mathematics in relation to certain student characteristics and found that the boys and girls were equally benefited by mathematical learning experience.
GADGIL. A.V. (1979) studied the causes of large failures in mathematics at the S.S.C. examination and found that reasons for failure in mathematics were inadequate coverage of the syllabus, inadequate attention paid to some difficult topics, inadequate motivation for study and inadequate guidance provided to pupils for study. Kulakarni, Mohanlala and Naidu (1982) undertook an “All India Survey of Mathematics Achievement” and found that public schools did better than Govt schools. The reason for the superiority of the public school performance has to be sought in other factors like socioeconomic status of the parents.

RAO, T.G. (1983) did a comparative study of programmed learning and conventional learning methods in the instruction of mathematics and found that the performance of urban subjects was superior to the performance of rural subjects under the programmed learning method irrespective of grade. Chitkara. M. (1988) studied the effectiveness of different strategies of teaching on achievement in mathematics in relation to intelligence, sex and personality and found that boys and girls of superior ability did not show any significant difference between their mean scores on achievement in mathematics.

2.8 Research gap:

A study on secondary school students mathematical problem solving ability was done by Lynwood in 1935 in algebra, studies on mathematical achievement were done by Iyer in 1977 by Koul, in 1978 and Vyas.C.S in 1983 and an All India survey on the achievement of mathematics was done by

An Indian study on factor analysis of mathematical ability was done by Gokhale in 1943 and Mathematical ability with special reference to cognitive and affective variables was done by PATEL. N.R. in 1984. Studies on instructional media were done by Rao.L.N.in 1985and Kothari, R.G. in 1987. Studies on teaching methodologies or strategies were done by Yadav P.S in 1984 and by Tripathi, Awadhesh and Tiwari in 1993 and Sumangala.V, Mallini, P.M, in 1998. Attitudes towards mathematics were studied by Purshothaman in 1995 and Sumangala.V.in 1997. Studies on achievement motivation and anxiety as related to academic success in mathematics was done by Grewal,S.S, Kaur in 1990 and studies on factor affecting academic achievement was done by Noorgahan, N Ganihar and Wajiha,A .H, (2009) and achievement in mathematics in selected variables was done by Mahender Reddy sarsani, Ravi Maddini(2010).

The effectiveness of mathematics in relation to certain students characteristics was done by Bhartiya.A, in 1979 and another study was done by Manika in 1982 on the ability of children to acquire mathematical concepts.
Lakshminath, N. in 1999 studied psycho social correlates of social problem solving skills. Travers developed in 1967 an instrument to test problem preferences. Study on problem solving abilities and competences was done by Hull in 1979 and Feltovitch and Glaser in 1980 and Wells in 1981 and Charles Funkhouser in 1981; with in-service teachers. by RAI,S, in 1982; and on problem solving in science by Jayesh in 1999 with special reference to daily life situations. Spatial ability test or spatial relations test was used by Jain, D.K. in 1979; Katiyar, P in 1980; Pillai, K.S in 1981; Singh, R. in 1981 and Sumangala in 1995. It appears that there is no study on the student’s ability of learning mathematical concepts in relation to spatial ability and problem solving skill. Hence this research is unique in its own way and thus the researcher has taken up this study to fill up the gaps in the field of learning mathematical concepts in relation to problem solving skill and spatial ability.

**TIME LINE CHARTS**

**Reviews abroad on mathematical concepts**

Colburn (1900) \[\Rightarrow\] James A. McClellan (1900) \[\Rightarrow\] Edward Lee Thorndike (1921)

Carpenter, Coburn, Rays and Wilson (1975) \[\Leftarrow\] Carlington and Crutch Field (1965) \[\Leftarrow\] Allyn and Bacon Inc. Boston, (1964)
Reviews Indian studies on mathematical concepts

GOKHALE (1943) → DAS, R.C. and BARUA, A.P. in (1968) → IYER, K.K. (1977)


MAHENDER REDDY SARASARI (2010)
Reviews abroad on problem solving skill

TREACY (1944) ➔ JOHNSON (1944) ➔ TAVERS (1967)


RAI.S. (1982)

Reviews Indian studies on problem solving skill

KELL (1965) ➔ WILSON (1967) ➔ HULL (1979)


Studies related to spatial ability


2.9. Conclusion :

All the studies presented by the researcher gave a detailed account of the previous research done on mathematical concepts, spatial ability and problem solving skill. The fourth coming chapter describes the plan and procedure adopted in the present study.