CHAPTER - II

REVIEW OF RELATED LITERATURE
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2.1 NEED FOR RELATED LITERATURE

Any worthwhile research study in any field of knowledge requires an adequate familiarity with the work which has already been done in the same area. A summary of writings of recognized authorities and of previous research provides evidence that the researcher is familiar with what is already known and what is still unknown and untested. Since effective research is based upon past knowledge, this step helps to eliminate the duplication of what has been done, and provides useful hypothesis and helpful suggestions for further investigation.

Citing studies that show substantial argument and those that seems to present conflict conclusion help to sharpen and define understanding of existing knowledge in the problem area, provides a background for research project, and makes the investigator aware of the status of the issue. The studies that are plainly relevant, competently executed and clearly reported are included.

2.1.1 STUDIES ON COGNITIVE ABILITIES

The cognitive study of abilities has tried to identify mental structures, process, representations and strategies that underline test performance (Pelligrino, 1988). The psychometric perspective inferred the mental operations involved in test solutions from test content and
factor analysis, a strategy that does not permit direct hypothesis testing (Carrol, 1989, Stemberg, 1977). If an ability construct can be explained in terms of key mental components, then individual and group differences can also be linked to those particular cognitive factors.

2.1.1(a) Introduction to Spatial Visualization

Spatial visualisation is often thought to have two components. One requiring the capacity to rotate or otherwise transformed two-or-three-dimensional objects using only visual strategies, and another requiring capacity to discern a shape from a confusing background. The former we will call spatial visualisation ability and the later is often called field independence. Both show consistent sex difference in favour of males, although the results with field independents are less consistent than those with spatial visualizing ability.

A critical review of research literature of the 1960s prepared and delivered by Eleanor MacCoby and Jacklin in 1974 highlighted that girls tend to be superior to boys in verbal abilities whereas boys tend to be superior to girls in spatial and mathematics aptitudes.

Results from a National survey conducted for the Education Commission of the State on 1953, thirteen years old and 1788 high school seniors provides a different picture from some of the earlier studies conducted in the area of sex differences in mathematical abilities. The average mathematics problem-solving score of the 13 years old girls in this survey was nearly equal to that of the 13 year old
boys, but, the girls’ average in computation and spatial visualization was higher than that of boys.

Suggestions of comparatively poorer spatial ability in girls, and comparatively better verbal ability, have led to consideration of brain differences. The left hemisphere of the brain controls verbal abilities, whilst the right hemisphere controls spatial abilities. Are the two hemispheres differently developed in girls and boys? At the present time research does not confirm that such a difference exists, and therefore cannot provide an alternative to the hypothesis that the differences in attainment are a product of environmental and social influences which perhaps determine the development of the various mental faculties within the brain. Other genetically based theories have also been proposed to explain the observable differences between girls and boys in terms of mathematical attainment. None are considered to provide convincing evidence that it is genetic factors which give the differences. (Anthony Orton, 1987).

Spatial ability, as we have seen is not required in all of mathematics, only in certain aspects, and many mathematicians have not felt themselves to be at all capable in geometry. However, if we accept that spatial ability is comparatively weaker in girls than in boys, this is a major handicap to a study of some parts of mathematics. The greatest sex difference in mathematical performance found by Wood appeared in the results to a question which... ‘was an almost pure measure of ability to visualize in three dimensions’.
Dr. Arthur Jensen (1981), in his 'Straight talk about mental tests' observes that, "Women and men are essentially equal when it comes to general intelligence or 'g' factor, but they differ in certain other abilities. However, the most well-established difference is in spatial visualization. Visualisation ability - the ability to mentally visualize complex objects and to mentally manipulate relationships among objects in three-dimensional space. It is an important ability for geometry, organic chemistry, architecture, structure engineering, and the like. Spatial visualization is also a component of mathematical ability, in which spatial representation of quantitative relationships play a part in problem-solving proficiency. In the best tests of spatial visualization ability, only about one-fourth of females surpass the average male".

The sex difference in spatial ability is evident in childhood, but increases markedly after puberty. There is some evidence that it is related to male hormones and also some evidence that other genetic factors play a part in the sex difference. No single expert in this field who believes that cultural and environmental causes - such as the cultural difference in sex-role socialization - is anywhere near adequate to explain all the evidences related to the sex difference in spatial and mathematical ability. Because of the connection between spatial ability and mathematical ability, there is a notable sex difference in the latter as well, and it cannot be explained by differences in amount of exposures to mathematics or differences in motivation to succeed in mathematics.
2.1.1 (b) Studies on Spatial Visualization and Gender Differences

Smith (1964) carried out extensive studies into spatial ability which ultimately led him to conclude the spatial ability was a key component of mathematical ability. He also considered that the relationship between spatial ability and the cognitive trait which has become known as field-independence was a strong one.

Several investigations and reviews regarding sex differences in mathematics achievement have been conducted which report that in class VI and beyond, boys are superior to girls in arithmetic reasoning, spatial abilities and problem solving (Aiken 1970, Armstrong, 1980; Fennema and Carpenter, 1981; Marshal 1984) and girls are somewhat superior to boys in verbal ability, arithmetic fundamentals and rote learning (eg. computations). But sex differences in abilities are less pronounced in earlier classes and there is a general differentiation of abilities with age and experience.

Hutt (1972) takes the evidence from selected items as support to her view that, 'men think differently from women. She argues that the advanced maturation of females does allow a fair comparison to be made'. The main differences raised were as follows. First, 'scores obtained from applying tests designed to measure overall intelligence or ability consistently produced different distribution for males and females'. Secondly, 'males were said to excel in spatial ability, whilst females excelled in verbal ability'. Thirdly, 'females were clearly superior
in both manual dexterity and in rote learning ability, whereas facts of
divergent thinking tended to produce high scores for males’.

Krutetskii (1976) writing about school pupils who were
mathematically able, reported that some favoured spatial or geometrical
thinking whilst others did not.

Waber (1976, 1977) proposed that timing of maturation, by
influencing the extent of brain lateralization for spatial skills, was
responsible for the sex difference. She reasoned that later maturers are
more likely to so show a greater degree of laterization for spatial-visual
functions.

Witelson (1976) reported that the same brain structure may have
different cognitive functions in boys and girls at the same age level. He
further reported that, in case of boys, by the age of six; the right
hemisphere dominates the left hemisphere in processing non-linguistic
spatial information. With girls, however, not until adolescence does the
right hemisphere become dominant in processing spatial information.
Hemispheric specialization or lateralization is developed earlier, or more
strongly in girls than boys. Dominance of the right hemisphere by the
left is associated with poorer spatial ability, which is controlled by the
right hemisphere in girls. Boys, on the other hand, develop greater right
hemisphere specialization or dominance.

Wood (1977) observes, ‘Girls’ weakness at spatial visualization,
is, by now, well documented and is generally known that genetic causes
armstrong (1980) reported that class xii boys were superior to
girls in problem solving and girls had lost their earlier advantage in
spatial visualization.

benbow and stanley (1980) had declared that superior male
mathematical ability was related to greater male ability in spatial tasks.
they did accept the clear and massive influence of socialization as a
determinant of differences in performance in mathematics but did not
accept that such social factors accounted for all the differences. of
course, spatial ability is itself not necessarily vital to the whole range of
mathematical activity.

mcglone, (1980), suggests that the brains of males are more
laterlized that those of females, this results is not found consistently
related to spatial performance.

social factors have been proposed as explanations for sex
differences in spatial ability but have not often been investigated
(peeterson, 1980).

luchins (1981) suggested that the poorer spatial ability of
females who study mathematics leads them to choose algebra rather
than geometry or topology.
Fennama and Tartre (1985), in reporting a longitudinal study confirmed that, 'there was a difference between boys and girls in respect of spatial visualization skills, but it was small. They agreed that, 'low spatial visualization skill may be more debilitating to girls' mathematical problem solving ability than boys'.

Berinderjeet Kaur (1986) looked at achievement within her own national boundaries of Singapore by examining the performance of girls and boys, matched in ability, in one particular syllabus taken at 16 plus and comparing their mathematical results with their results in some other subjects. Her results are consistent with those in other societies in that they demonstrate males outperforming females in general, and in mathematics, and in particular in qualification and spatial relationship. In that study it appears that spatial visualization skills are important to the learning of mathematics. Among the Singapore pupils, it was found that girls were lacking in such skills and the issue does warrant attention. Would teaching girls and boys separately, using sex-biased examples and methods of instruction, match the performance of the two sexes on parallel sex-based problem which contains a spatial element?

Any differences in spatial and mechanical ability between boys and girls are because of differences in environment in which the two sexes are reared. (Nuffield checkingup Books).

Ferrini Mundy (1987) conducted an experimental study in which the effect of spatial training on calculus achievement, spatial
visualization in problem solving on solids and revolution was investigated. Students enrolled in a calculus course individually completed six spatial training modules over an eight weeks period. No significant differences were found between males and females before the experiment. After the experiment, girls performed better than boys which indicates that those groups given exposure did better than their counterparts.

Gender differences favouring males are well established. The largest gender difference can be found in the test of spatial relations, but test of visualization factor. The differences are small (Voyer and Bryden, 1995). Gender differences in spatial abilities added to psychological and social factors responsible for different career paths, Pezaris and Benbow, 1995).

2.1.2 Gender Differences in Different Areas of Mathematics

Wood (1977) drawing from the examination script of boys and girls educated in the same schools, discovered that the superiority of boys was most marked in items of two types, one of which was concerned with 'ratio'. The common core difficulty was a 'comparison factor'. Fractions were found to be more difficult for girls than for boys.

Christopher and Borden (1978), selected 70 children of grade one and administered 'Word problems in Arithmetic and did not find any significant difference among girls and boys performances.
Roach (1979), selected 418 sample of Jamaican students of grade six pupils and administered "Reids Arithmetic Test". He found that the "performance of girls was better than that of boys".

In a study, Swafford (1980) reported that females achieved as well as, and, in some instances, better than males in the standardized first year algebra test. Smith Wallker (1988) also supported Swafford’s findings. They reported females performed better than males in the ninth and eleventh class papers.

Differences between the sexes are often found in specific areas of mathematics. For example, men were found superior to women in Geometry (Hashaway 1981; Stones et. al. 1982). Women were found superior to men in fractions in Hashaway’s (1981) study. Men, on the other hand, tended to surpass women in ratio, proportion, and in percentage in Hashaway’s (1981) study and in measurement, relations and probability and statistics in Stone, Beckman and Stephen’s (1981) study.

An interesting feature of the measured differences in performance is that only in certain mathematical topics, that, “boys score very much higher than girls”. The APU Secondary survey (1982b) stated, ‘In all these surveys, the mean scores of boys have been higher than those of girls in every sub-category, with only one exception (modern algebra). The greatest differences were recorded in the topics mensuration, rate and ratio, descriptive geometry and unit measures’.
Rastogi, S (1983) found that 1) there were no significant sex differences in either attitude towards Mathematics or achievement in mathematics 2) The course of self help in basic arithmetic skills was equally effective with either sex.

In contrast, Ethington and Wolfe (1984) reported that women scored somewhat lower than men in a combined test of mathematics even after controlling for the effects of parental education, spatial and perceptual abilities, high school grade, attitude towards mathematics and exposure towards mathematics course. They concluded that there is complex interaction among sex, selected other variables and mathematics achievement.

Berinderjeet Kaur (1986) conducted a study on a sample out of a population of 42,627 Singapore candidates (21,037 boys & 21,590 girls) who took GCE 'O' level mathematics examination, a random sample of 176 (88 boys and 88 girls) was used for the study. From the study, she observed that there were significant marking for sex/ability interaction. She also concluded that boys did significantly better than girls on the following topics - mensuration, statistics, arithmetic, geometry and probability. While girls outperformed boys in algebra and graphs. Boys also surpassed the girls on spatial ability.

Other studies conducted in this area reflect very promising findings. Data from the Second International Mathematics Study were used by Hanna (1986) to examine sex differences in mathematics
achievement of Canadian class VIII students. Five areas were surveyed: arithmetic, algebra, probability and statistics, geometry and measurement. No specific differences were reported in the performance of boys and girls on the first three subsets. In geometry and measurement, the boys' mean was somewhat higher than that of the girls. These differences, though not large, were significant at 0.01 level.

Gila Hanna, Erika Kundiger and Christie Larouche investigated sex differences in mathematics achievement among students in the twelfth grade in a number of North American, European and East Asian countries. The investigation used the data of the Second International Mathematics study (SIMS) conducted by the International Association for the Evaluation of Educational Achievement (IEA). The data derived from the SIMS test administered in 15 different countries to over 40,000 grade 12 students under comparable conditions. The test items, 136 in total, were in seven main content categories, sets, Relations and Functions, Number Systems, Algebra, Geometry, Analysis, Probability and Statistics and Finite Mathematics. In Geometry, Analysis, Probability and Finite Mathematics boys over-performed girls. In the other topics sets, Relations and functions also boys did better than girls. Data on mathematics achievement between males and females show that males pull ahead of females in mathematics ability while they begin to learn Algebra. The explanation for this have ramped from genetics to social conditioning.
Moore and Smith (1987) compared the mathematics achievement of young men and women, aged between 15 and 22 years. They reported that males generally outperformed their female counterparts in arithmetic reasoning and mathematics knowledge test.

Battista (1990) did not find any sex differences in logical reasoning or the use of geometry problem solving performance.

Sastri, S.M. has reported that 1) The retentive capacity of the girls was more than that of the boys in the following order, namely, decimals, arithmetic, numerals and geometry. 2) In arithmetic, both boys and girls did not show any interest during the period of feedback. 3) The girls possessed better understanding factors than boys in long-term retention. 4) In memory ability there was a small but consistent sex difference, the girls being higher than the boys over the entire range in all the three standards (7 - 10½ years old). 5) After feedback, the girls maintained their superiority over the boys.

Nagavalli. T (1996), reported that the performance of X standard girls was better than that of boys in Arithmetic, Algebra and geometry.

2.1.3 Studies on Age Factor and Gender Differences in Mathematical Ability

Between the ages of nine and thirteen, most studies indicate that, the sexes perform similarly, though differences in favour of boys have
been demonstrated’ by Hilton and Berglve (1971), Kenting and Stanley (1972) and Stevenson (1971).

Shipman’s (1971) work on a large sample of under privileged children found girls to be superior on enumerational tasks between the ages of three and four years.

Many studies have shown that by age 13, boys are significantly superior to girls both in their mathematical performance and their attitude towards mathematics. (Backman 1972, Multis 1975, Benbow & Stanley 1980) and that the male advantage is especially pronounced among high scoring exceptionally gifted students, with boys outperforming girls (Benbow & Stanley 1983).

In early school years, large studies of disadvantaged children, including the Stanford Research Institute (1972) study show, ‘girls to be ahead of boys on tests of quantitative ability’. Other studies with more representative samples show ‘no differences in the early years’.

Maccoby and Jacklin (1974) published their findings in American journals during a ten years period proceeding 74. They found that, ‘the sexes do not differ consistently in tests of composite abilities. Girls appeared to have a slight advantage in tests up to the age of 7 years’. Maccoby and Jacklin speculate that, ‘this could be seen as evidence in support of the different maturation rates of boys and girls. They concluded that, ‘this could be seen as evidence in support of the different maturation rates of boys and girls. They concluded that, ‘sex
differences were well established with three cognitive constructs, mathematical performance, verbal ability and spatial visualizing ability'. These differences appeared fairly consistent by early adolescence.

Christopher and Borden (1978), selected 70 children of grade one and administered 'word problems in arithmetic' and did not find any significant difference among the girls' and boys' performance'.

Flangan (1978), administered an 'Introductory Mathematics Test' to ninth grade pupils. His samples were quite large in number. 4 lakh pupils took this test. He found that 'there is no significant difference with performance of males and females'. Flangan (1978), analysed that 'PROJECT TALENT' sample of twelfth grade pupils. He found that, 'the performance of males were better than females'.

Reis & Burton (1978), selected 434 pupils from grade four and six administered 'IOWA Test' (Mathematics concepts). They administered 'Newyork PEP' (Mathematics II) to grade nine students. Also they administered PSAT (math subset) to grade eleven students. Among all these three level of students, they did not find, 'any significant differences in the performance of boys and girls'.

Schatz (1978) chose 240 pupils each from grades 3, 4, 5 and 9 and administered 'Modern mathematics supplement' (IOWA test). He did not find significant difference in the performance of boys and girls in the grades three to five while in the grade 9, difference was found favouring the females. He found females performing better than the males'.
Boswell (1979) administered 'McGraw Hill test of basic skills' to 562 students of grade three to six. He also did not find any significant difference between the performance of boys and girls.

Roach (1979), selected 418 Jamaican sample of grade six pupils and administered 'Reido Arithmetic Test'. He found that 'the performance of girls were better than that of boys'.

Benbow and Stanley (1980), carried out research involving intellectually gifted pupils (SAT-M), administered to grade seven and eight for 210 pupils. Their results suggested, 'sex differences in achievement in and attitude towards mathematics results from superior mathematical ability.

Sherman (1980) chose 210 pupils of grade eight and administered tests in 'Mathematical concepts' and 'Romberg-Wearne problem solving' and found that 'there was no significant difference in the performance of boys and girls'. While his study with grade eleven students, revealed, 'the male dominance over the females performance'. To the grade eleven students, he administered, 'Basic Mathematical Concepts - ETS test' and 'Mental Arithmetic Problems'. Both his studies were follow up of a longitudinal data.

In Britain, 'little difference has been reported at the primary level', though the 'Assessment Performance Unit (APU)', primary survey (1982a) is commenting on sex difference at age 11, recorded that,
'what differences that were appear to fore shadow the main areas of mathematics, where the differences were larger some five years later'.

There is still powerful evidence that males achieve at higher levels in mathematics than do females, particularly in tasks of high cognitive complexity such as true problem solving. Although it has been believed that such differences do not appear until early adolescence.

Ketkar (1982), developed unit tests in mathematics for class VIII for Marathi-medium students and found that, "urban boys and girls scored better than their rural counter parts."

Mainka, G.K (1983) reported that there did not exist sex differences in the acquisition of mathematical concepts at primary level.

Rao, T.G (1983) has reported that 1) In grades V and X, girls scored higher than boys. 2) There existed no sex difference in the learning goals of the programmed learning groups separated on the basis of sex. 3) The girls of the private schools, irrespective of their stage of instruction, scored higher than the boys by the programmed learning method of instruction in mathematics, though these differences were not found to be significant.

Leder (1985) also pointed to 'few consistent sex related differences at the primary level'. In many countries, the post-primary pattern is the same, more boys than girls succeed in public examinations taken around the age of 16, many more boys than girls
choose mathematics as one of their specialist subjects, and comparatively few females have, in the past, taken up employment directly related to mathematics or dependent on qualifications in mathematics.

Evangeline Tresson Milonas (1986) conducted research concerning the possibilities of applying SMP 7-13, an English method of teaching Mathematics, in Greek primary schools. The main objective of the research was to establish if and under what conditions such an individualized system could be applied.

The observations were as follows:

1. Girls at this age, 7+, do not seem to be inferior to boys as far as their competence in Mathematics is concerned.
2. The girls of certain social classes (for instance - working class and rural) hesitate more than the boys when asked to produce an answer about which they are not absolutely positive.
3. It appears that for children of working class families, mathematics is seen as a more appropriate subject for boys.
4. On the contrary, the upper middle class girls seem to progress at Mathematics more than their male peers, and moreover they appear bolder and more positive about their knowledge of things.

In a first grade study that used a specially developed test of problem solving, 'boys performed significantly higher than did girls' observed Fennama, Peterson and Carpenter (1987).
Nagavalli, T. (1996) reported that the performance of X standard girls was better than that of boys in the three cognitive objectives viz. knowledge, understanding and application of mathematical ability.

Banerjee, Surendranath (1997) found that the primary school leaving pupils attained expected standard of competency in the use of numbers. Computational ability and concrete problem solving ability while they did not acquire competency up to deserving standard in calculative manipulation of sums and geometric ideas.

2.1.4 **Studies on Gender Differences in Mathematical Ability due to Socio-Cultural Factors**

Fennema and Sherman (1977) said that females take fewer courses than males because of socio cultural factors and thus show less achievement.

Helson (1980) opines that an inspection of biographies of outstanding mathematicians clearly shows that they have traits of independence and persistence and that they chose to do those mathematical activities that are mentally stimulating.

Mary Belenky, et. al. (1980) in their studies of women's conceptions of knowledge, and the humanistic and contextualized dimensions of mathematics that have so far been neglected in the mathematics curriculum.
Dorothy Burork’s case studies of math-avoidant women (1981, 1985) together with the information Katya and Mary provided at the beginning and at the end of the mini-course, revealed that the image of mathematics as a cold, cut-and-dried, impersonal discipline is often at the bottom of many women’s dislike of the discipline, and, consequently, of their decision to abandon their study as soon as possible.

Among the possible causes of this disturbing phenomenon most researchers have identified social pressures and stereotypes that tend to orient women toward less technological and quantitative (and less lucrative) careers (Isaacson, 1981) and toward somewhat less successful learning styles such as the tendency to be less autonomous and to look to the teacher for reassurance identified by Elizabeth Fennema’s research (Fennema & Peters, 1981).

Carol Gillingon (1982) has analysed interesting parallels between gender differences and has identified female ways of thinking.

Gustin (1982) reported that opportunity to work independently during early school years was extremely important to those who want to become independent learners.

Stephen Brown highlights similar parallels between gender differences in moral thinking and in approaches to mathematics.
Reasons for differences in attainment have been investigated from a variety of different standpoints including biological, psychological and sociological. The best-documented conclusions have emerged in relation to the domain of societal attitudes and expectations. There is a strong indication that, in a variety of ways, girls have been consistently discriminated against in terms of mathematical education. This is clearly a serious issue, particularly since qualified mathematicians are permanently in short supply and it was considered important to warrant a separate appendix in the Cockcroft report (Shuard, 1982a). Sociological factors are not disputed, but the problem is whether there are other factors at work in addition to discrimination, and it is here that research evidence is particularly inconsistent.

Russel (1983), actually has drawn attention to the fact that 'pressure might work equally unfairly against both the sexes. Girls are not encouraged to opt for mathematical studies, whereas boys are, even when their ability and interest with the subject have been at best, barely inadequate, encouraged to the maximum'.

Boys often opt for mathematics, because it is expected of them and not because they enjoy the subject. Society always appears to have conveyed the message that mathematics is a male subject and that certain other subjects are female subjects. Peer group pressures therefore add to the difficulties faced by girls when choosing subjects in a mixed school. Russel also drew attention to the ways boys and girls regard themselves in relation to mathematical ability. Girls tend to
underestimate their potential whereas boys tend to overestimate. Boys display confidence about their ability in mathematics, which is sometimes not justifiable whilst girls, perhaps with better results, display unjustifiable anxiety.

Grieb and Easley (1984) report that teachers allow some boys to exert their independence overtly by refusing to learn specific algorithms. They argue strongly that independence in learning is essential to achieve a conceptual framework in mathematics.

Many more women than men see mathematics as neither relevant to their interests and experiences not useful to them in their future lives and careers (Brush, 1985, Chipma & Nilson 1985, Eccles 1985).

According to Dweck (1986), performance goals are used in education instead of learning goals. The problem with using performance goals instead of learning goals in the learning environment is that it sets up a negative attributional process in some children. When competitive structures such as performance goals are used, children compare their ability with others, and effort is viewed negatively. Dweck said that females are more likely to suffer under performance goals. This is apparently because males attribute success to ability and failure to external causes such as luck or effort. Females do worse than males with performance goals. On task performances, females prefer tasks on which they are assured of success; whereas the females prefer difficult tasks.
McCombs (1986) suggested that men's belief about oneself, such as self-esteem, influence how that person is willing to interact with any information, thus, those beliefs influence learning.

Fennema and Peterson (1987) report that there are differences in how teachers interact with and treat girls and boys. Boys interact more with teachers than do girls. Girls have many more days in which they do not interact at all with the teacher than do boys. Teachers initiate more contacts with boys than girls. Boys receive more discipline contacts as well as more praise. Teachers respond more frequently to requests for help from boys than from girls and tend to criticize boys more than girls for the academic quality of their work.

The fact that, usually starting in junior high school, female students worldwide take fewer mathematics courses and achieve lower results in mathematics than their male school mates is a well-known and well-documented reality (NRC, 1989; Fennema & Carpenter, 1981; Hann Kumdiger and Laroache, 1988).

Paul Earnest (1989) argues against the tradition of training students to approach mathematical problems in total abstraction from the social context in which they originated, a procedure that allows social decision-makers to consider and adjudicate social issues without feeling the human consequences of their decisions. He has brought further evidence to the contention that the mathematics that we teach
today, although apparently culture and value free, may in reality be sexist.

Suzzanne Damanin (1990) has pointed out the heritage of many centuries in which essentially only men worked in mathematics in the language today used in mathematics education, showing for example an abundant references to aggressiveness — a typical male trait — in expressions such as, 'mastery of a topic, mathematical power, or hierarchies of objectives. She also notes that the emphasis on formal and abstract activities that characterizes much of current mathematics instruction may not be conducive to women's preferred way of thinking.

The influences of society and from the environment, which might affect the mathematical development of girls have varied. There have always been differences in the kinds of toys given to girls and boys and, indeed, the kinds of games and activities encouraged. There have always been differences in parrental expectations and desires, which may even, have led to differences in the pressures exerted within the home. The usefulness and value of mathematics has always generally been considered to be in other school subjects also regarded as boy's subjects and in careers, which have been viewed by society as male occupations.

In the social arena, the material that was found on this subject used statistics comparing gender differences in pay, enrollment in
undergraduate and graduate math programs as well as in people in mathematical-related employment (Vetter, 1992).

He observed that there is gender duality in what is expected of American children. This socialization starts at a young age. Young boys know how many shovels full of dirt can fit into the bed of the Tonka dump truck. They can estimate the parabolic path of a ball inorder to have the glove in the place to catch it. These are experiences that are not the 'norm' for a girl. They are however, lessons in mathematics and physics.

He was very much surprised to find some low expectations in the home with the only difference being that the parents would be pleased if their child (of either sex) was passing mathematics. There were important gender differences in the home, however. Parents had lower expectations for their daughters than they had for their sons in terms of mathematical achievement. It is no wonder that men perceive themselves better in mathematics than women. This is a myth learned at a young age.

2.1.5 Studies on Gender Differences in Using Short cuts

For differential success in the public examination in the U.K is in different entry pattern. Girls tend to be allocated to easier routes in Mathematics than their ability warrants, because, they are seen as hardworking rather than bright remarked, Walden and Walkerdiere (1985).
Betz and Hackett (1983, 1986) showed that females feel less capable in mathematics than do males, regardless of their ability. Their studies showed that females feel capable in mathematics only when the problems are in stereotypically female areas. The females do not seem to generalize this ability to similar, more formal mathematics problems. By not taking the leap beyond these limited types of problems, females do not choose mathematically oriented professions, which pay well.

Marshall (1983) studied the kinds of mistakes made by boys and girls in mathematics tests. The errors made by girls were more likely due to misuse of spatial information, use of irrelevant rules. Choice of incorrect operations, negative transfer and keyword association. Boys, on the other hand made mere errors of preservation and formula into reference, while both sexes made language-related errors, but of different kinds.

Vyas, C.S (1983) had found that, 'there was no significant difference between the means of achievement in mathematics of boys and girls taking the SPLP, and also there was no significant difference between the means of achievement in mathematics of boys and girls who did not take the SPLP.

Marshall (1984) further conducted a study on arithmetic computations and concluded that girls were more likely to perform computations successfully than boys. In contrast, boys solve story problems more correctly than girls. Senk and Usiskin (1983) found no
differences in the abilities of males and females in learning to write geometry proofs. Gender differences in mathematical and spatial skills in third, fourth, fifth and ninth class Black, Hispanic and white ethnic groups revealed a significant interaction between sex and ethnicity. White adolescent boys scored higher than white adolescent girls but not significantly. In contrast, Hispanic adolescent girls were significantly superior to Hispanic adolescent boys in both skills. A similar difference in favour of girls was found in Black adolescents, but it was Not Significant.

Fennema and Tartre (1985), in a longitudinal study, explored the relationships between mathematical problem-solving performance, spatial visualization, verbal skills and sex-related differences in mathematics performance. They reported that girls tended to use pictures more during problem-solving than boys did, but it did not enable them to get as many correct solutions. Low spatial visualization skills may be more debilitating to girls' mathematical problem-solving than boys. There are differences between responsiveness of males and females to the types of goals that are set. Dweck said that females are more likely to suffer under performance goals, whereas males do better under competitive modes of performance goals. This is because males attribute success to ability and failure to external causes such as luck or effort. On task preference, more females prefer tasks on which they are assured of success, whereas the males prefer difficult tasks.

In contrast, Rubinstein (1985) examined computational estimation and related mathematical skills among class VIII students.
Bhaskara Rao and Pushpalatha, (1994), "didn't find any difference in the achievement of boys and girls".

Bhaskara Rao and Sridevi (1994), concluded that, "the achievement of intermediate students was high".

Ruthaiah (1994) also found that, "Pupils of residential system was superior in achievement than their counterparts".

Suraksha Pal and Jaiprakash Singh(1994), inferred that, "favourable attitude towards education, and subjects, implies better academic achievement".

Data on mathematics achievement between males and females show that males pull ahead of females in mathematics ability. The explanation for this have ranged from genetics to social conditioning (McDonal, 1989).

2.1.8 Studies on Learning/Cognitive Preferences Styles and Gender Differences

Padhi, J.S (1993) found that there were no gender differences in cognitive performance styles.

Oza, Dipti J (1995) reported that generally girls used better learning strategies than boys.
Rajagopalan, Malathi (1996) reported that the cumulative coefficient of 0.29 as gender attributed to gender influences rather than on any natural differences.

Saroop, Jyot; Nanda, Paramjit and Karg; Tejpree Kaur (1999) reported that 1) There was no significant differences between the memory ability of the boys and girls at the age groups 6.5, 7.5 and 8.5 years. 2) A moderate level of significant difference has been observed at age group 5.5 years among urban children. 3) Highly significant locale difference in memory ability at various age groups in boys and girls have been obtained.

2.1.9 Studies on Problem Solving Ability and Gender Differences

Lester (1980) in his review of literature on problem solving indicated that three affective factors/willingness, perseverance and self confidence) are the most important influences on problem solving performance.

Reyes (1984) has also suggested that the student’s willingness to work on a variety of mathematical tasks and their persistence in dealing with these tasks might take a difference in the degree to which a class is task oriented and easy to motivate. The presence of highly praised affective outcomes and carefully organized classroom in which the problem solving teaching practices has important common elements. This suggests that developing positive affective responses to
mathematical problem solving may involve classroom practices other than those specifically oriented toward providing a warm, caring classroom environment.

Beliefs and attitudes play an important role in the emotion generated during the problem-solving process (Mandler, 1984).

Lester, Garafalo (1987) and D.L. Kroll (1987) state that knowledge about problems can affect self-confidence and an individual's beliefs about self, mathematics and problem solving play a dominant, often overpowering, role in his or her problem-solving behaviour. Persistence is not necessarily a virtue in problem solving.

Some of these beliefs about the learning of mathematics have been identified by Schoenfeld (1987) and are considered to be important determinants of students' mathematical behaviour. Student's beliefs about mathematics and the learning of mathematics can have serious deterrent effects on problem solving.

2.2 STUDIES ON GENDER DIFFERENCES IN THE AFFECTIVE DOMAIN

Studies on gender differences in mathematics have not been limited to cognitive variables; affective and psychomotor differences have also been observed.

Affective variables have been studied in connection with mathematics education in several ways. It is a goal of many
mathematics educators that their students have positive attitudes towards mathematics some educators are convinced that positive attitude will improve the ability of students to learn mathematics. Other educators view positive attitudes as an important educational outcome, regardless of the impact of attitudes on student learning. The best way to foster positive attitudes in students is to increase the level of understanding of mathematics.

It is relatively clear that divisions about how many and which mathematics courses to take in middle school, high school and college can be influenced by affective characteristics of the students that have developed over a period of many years. The number of mathematics courses taken in high school affects the types of majors open to students in post-secondary education; this, in turn, affects career choice.

Basavaya, D (1995) found that at the IX standard level, Andhra Pradesh boys had slightly better positive perception of mathematics in comparison to girls. This was not true in the case of Kerala girls.

2.2.1 Studies on Affective Variables

Simon (1982) distinguishes among several aspects of affect. He uses affect as a generic term and describes its main forms as ‘emotion’, 'mood' and 'valuation'. The emotion of aspect is associated with the affect that can interrupt the attentional mechanisms of the human nervous system and more direct attention to a present danger or
requirement. Surprise, fear and anger are particular examples of this aspect of affect.

Eccles (1983) and Meyer (1985) utilized path-analysis techniques to show how affective variables influenced educational outcomes. Eccles explored the relationship between affect and the choice of mathematics courses in secondary school, whereas Meyer used LISREL to explore the relationship between causal attributional patterns, confidence and mathematics achievement.

Research by Becker (1984) with graduate students in mathematics and Helson (1967) with creative mathematicians showed the females lacked confidence in their mathematical abilities. The males in these studies were markedly more confident in their mathematical abilities than the females.

Affect has been used by psychologists in a variety of ways (Benner, 1985; Clark & Fiske, 1982; Corsini, 1984; Mandler, 1984). According to Encyclopedia of Psychology, affect refers to 'a wide range of concepts and phenomena including feelings, emotions, moods, motivation and certain drives and instincts' (Cosini, 1984).

Kloosterman (1984) has proposed a model in which affect influences learning through the mediating value of participation in cognitive activities.
Reyes (1984) said confidence in one’s own ability to learn mathematics appears consistently as a strong predictor of mathematics course election.

Fennema & Peterson (1985) & McCombs (1986) say that when considering gender differences, three interrelated affective variables are of importance a) confidence in one’s ability to do mathematics, b) perceived usefulness of mathematics and c) causal attribution in mathematics.

Fennama and Peterson (1985), found that, ‘teachers believe strongly that certain affect variables those dealing with motivation or self esteem are of vitally important reason, why children fail or succeed in mathematics’.

Fennama, Sherman and Meyer (1985), have found that correlational studies have confirmed that ‘the relationship between affective variables and achievement’ and other studies have shown that ‘certain variables predict achievement’.

Leder (1985), observed that, ‘sex differences possibly due to biological constraints are dwarfed by the far greater pressure imposed by social and cultural stereo-type about cognitive skills and occupations.

Meyer & Fennama (1988) found that ‘there was also gender differences in three important affect variables. Males indicate more confidence in their ability to learn mathematics, report higher perceived
usefulness, and attribute success and failure in mathematics, in a way, that has been hypothetisized to have a more positive influence on achievement.

Certain groups of students have been identified that are not achieving their full potential in mathematics. Female students, minority students and students from families with low social economic status have not participated in mathematics and mathematics-related activities to the degree that their abilities predict. Affective variables have been found to be related to the representation of these groups in mathematics classroom and careers requiring knowledge of mathematics (Hart, L.E 1989).

The National Council of Teachers of Mathematics (1989) had said one of the most important goals reflected in their mathematics curriculum standards in 'becoming confident in one's ability mathematically'.

Confidence has been reported by many researchers (Fennama, 1981; Steen, 1987; and others) to be one of the most important variables related to mathematics learning.

2.2.2 Studies on Aptitude and Gender Differences

Michael, (1960), suggested that 'ability' would be preferred to 'aptitude' in most situations, but that many people in the testing field
use the term ‘ability’ when prediction of future success is the primary purpose of the test.

Aiken (1974) reported that boys scored significantly higher than girls in the test of mathematical and scientific aptitudes and the discrepancies between the sexes increased with age.

In contrast, Fennama and Sherman (1977) concluded that females a group do not have less aptitude for mathematics than males. Unfortunately, there was a methodological flaw in Fennama and Sherman (1977) investigation, which makes interpretations of the results unclear. The investigators undoubtedly realize that even if sex differences in mathematical achieved are reduced when mathematical experiences and attitude towards mathematics are equated for boys and girls, it does not prove that there are no gender differences in aptitude towards mathematics. Analysis of covariance used in this study does not control gender differences in mathematics aptitude and leaves much variance in sex. Partial correlation should be used for removing gender variables.

Urban boys were also found superior to female counterparts in mathematical ability (Pandey, 1980).

Snow, (1980) Aptitude as a construct refers to psychological characteristics of individuals that pre dispose and then predict differences in later learning under specified instructional conditions.
Callan (1985) conducted a study in the area of Computer Aptitude, Literacy and Interest Profile (CALIP) on a sample of male and female students. In this study, women obtained equal, and in some cases, better scores than their male counterparts.

### 2.2.3 Studies on Attitude and Gender Differences

It is generally seen that less amount has been paid to the students' attitude by the classroom teachers or researchers in comparison to the considerable amount of attention given to cognitive achievement. Mathematics, specially can be quoted as an example in which very few attempts at measuring attitude towards its study have been made. Mathematics is generally regarded as a difficult subject for study. It is not so popular even at college level, where less number of students offer it for their studies.

Many studies to date have shown that by age 13, boys are significantly superior to girls in both their mathematical performance and their attitudes towards mathematics. (Backman, 1972, MacCoby and Jacklin, 1974; Mullis 1975; Aiken, 1976; Benbow and Stanley, 1980) and that the male advantage is especially pronounced among high-scoring exceptionally gifted students, with boys out numbering girls 13 to 1 (Benbow and Stanley, 1983).

Earlier studies include those by Biggs (1962) and Husen (1967). The APU (1982a) found that the relationship between attitude and performance in mathematics at age 11 was 'surprisingly weak'.
Yasui (1967) has reported in his study of an analysis of algebraic achievement and mathematical attitude between the modern and the traditional mathematics programme in the senior high school (a longitudinal study) that the measures of student attitude towards mathematics provided by the 'Mathematical Inventory' showed no significant difference between groups.

In terms of the totality of educational research, comparatively little work has been carried out in the domain of preferences and attitudes in learning mathematics. Interesting results were obtained by Kempa and McGough (1977) in a study of attitudes to mathematics amongst sixth-form students. Differences in curricula did not appear to have resulted in differences in attitude. Curriculum innovators had often hoped that the modern syllabuses, introduced from early 1960s onwards, would result in greater interest in mathematics.

Benbow and Stanley (1980) summarizing data on a large sample (N = 9927) of intellectually gifted junior high school students, concluded that gender differences in mathematical attitude result from superior male mathematical ability, which may be related to greater male ability in spatial tasks.

Fennema (1981) has found parental and teacher attitudes toward the student as a learner of mathematics are influential.

Singh, R.D and Verma, S.C., (1981) in their study on Mathematics as a function of Intelligence, Sex and Age found that males
do not have more favourable attitude than females. That is, attitude towards mathematics is independent of sex.

Rajendran, S and Narayanasamy, M. (1982) have found that 'there seems to be a slight difference in attitude towards mathematics between 5\textsuperscript{th} standard girls and boys'. On the other hand, there is evidence that more 8\textsuperscript{th} standard girls have a more positive attitude towards mathematics than the 8\textsuperscript{th} standard boys.

Attitude towards mathematics tends to be less positive and less variable in girls (Schofield, 1982). It was the opinion of the investigator that separate regression equations should be developed for boys and girls for predicting achievement in mathematics from attitude towards mathematics.

Hacket and Betz (1984) reported that mathematics performance and self-efficiency were positively and significantly correlated with attitude towards mathematics and masculine sex-role orientation.

Kolhe (1985) compared boys and girls and urban and rural populations on attitude towards mathematics. He indicated, 'significant differences between attitudes of urban and rural students towards mathematics irrespective of sex.

Alvi (1986) of Cincinnati University has shown in his study on effect of individualized instruction in achievement and attitude in general mathematics in the ninth grade, that there was no significant
difference between the attitude scores of the experimental group and the control group.

McDonald (1989) says that emotional reactions attest to the possibility that even relatively cool attitudes and beliefs can have extremely deleterious effects on learning performance. Although the beliefs or attitudes may represent cooler emotions, by the time they are influential in an individual students' information processing, they become hot. In the case of differential mathematics performance, females hold poor self-concepts with respect to their ability to survive failure and to perform ambiguous tasks, whereas males of similar ability do better on difficult-to-master tasks in mathematics. Once an emotion, attitude or belief is held that predisposes an individual to feel less than competent in the learning environment, the cognitive system is handicapped. Emotions, attitudes and beliefs take up processing capacity and interfere with the energy available to put toward the task.

Cynthia (1991) reported that gender had a significant effect on attitude towards mathematics.

Wein Burg, (1995) found more positive attitudes among boys. His analysis found positive correlation between attitude and achievement higher correlation for girls.
2.2.4 Studies on Gender Differences in Interest in Mathematics

Hardy (1940) attributed the development of his own interest in mathematics, at least in part to the discovery that he was very successful in competition with other pupils.

Adolescents' interest in mathematics ranges from obsessive avoidance to obsessive pursuit. Most peoples' interest in mathematics deteriorates between the ages of 8 and 15 (Cangelosi, 1948, Dossey et. al.)

Hudson (1966) drew attention to the possibility that a liking for mathematics stemmed from preferred styles of study. Mathematics does not involve the learner in revealing emotions or options to others and hardly involves, of absolute necessity, any communication with others.

The fact that mathematics provides 'a beautiful haven from the fears and anxieties of life' (Caldwell, 1972) is attractive to some.

Lalithamma (1975) has also reported that boys were higher on interest in mathematics than girls. She also reported that boys were higher on intelligence than girls. It may be one of the reasons for greater male variability on interest in mathematics. Comparison of boys and girls on affective variables in mathematics without controlling extraneous variables and minimizing error variables have no meaning at all.
APU (1982b), mathematics was believed to be important by a majority of 15 year old pupils and there was correlation between ratings of usefulness and interest.

Russell (1983) found many sixth form boys studying mathematics did not like the subject. They opted mathematics because they considered it a useful subject. Girls, on the whole did not perceive mathematics to be all that useful and there was evidence that it was largely those girls who really did enjoy mathematics who continued with the subject into the sixth form. Mathematics was considered to be a high status subject, particularly by boys, but this does not of itself imply liking. The attitude of many girls to mathematics appeared to deteriorate steadily through the years of secondary schooling, alongside the growth of self conscious about errors and difficulties. At the same line, private emotional reaction to the beauty or elegance of mathematical ideas and results is not ruled out. On the other hand the fact that 'Mathematics is just a matter of facts being hammered into you...it's not a subject you can humanize' (Russell, 1983) is a deterrent to others.

Gender differences in interest in mathematics have been studied by Razik and Zakaria (1995). Razik and Zakaria (1995) reported significant differences between boys and girls in the development of interest in different areas of mathematics.
2.2.5 Studies on Gender Differences in Anxiety Towards Mathematics

Research on mathematics anxiety done by mathematics educators has not, with some important expectations used careful definitions of the construct. It has sometimes been viewed as a negative feeling toward or dislike of mathematics. Other researches have conceptualized mathematics anxiety as a fear of mathematics. The view of mathematics anxiety as an attitude indicates a cooler, less intense emotional reaction to mathematics than a view of mathematics anxiety as a strong gut-level response to specific mathematics experiences.

Gender differences in cognitive variables may be due to anxiety towards mathematics. Mathematics has been considered as a chance factor subject by many boys and girls. Chances of right and wrong always create anxiety among students. Those students who are not risk takers are always under the grip of anxiety and this anxiety affects the level of achievement in mathematics.

Female students experience significantly more nervousness on math and science tests. Further investigation is necessary to becoming if achieving female students experience math tests anxiety, provide evidence of positive and negative effects of anxiety on their achievement. Higher levels of anxiety may mean female students are less likely to continue in math and take advanced or optional classes.
Mandler (1959) reports that correlation between test anxiety and effective problem solving strategies is negative for individuals.

In terms of Spielberger's state-trait conception of anxiety (Spielberger, O'Neil & Hansen, 1972), the emotional state could, through repetition, become a trait, with the result that the students would always be anxious when confronted with a problem-solving task.

Buxton (1981) argues that this type of long-term negative reaction to mathematics is quite common, and he refers to it as the panic response. All of the working memory seems to be engaged in evaluating that emotional state.

Cockcroft (1982) found that 'enormous numbers of people end up with feelings of anxiety, helplessness, fear and even guilt about mathematics' and 'for too many it remains a subject to be endured, not enjoyed and to be dropped as soon as the necessary examination results have been achieved' (Skemp, 1971). However, as the cockcroft report (1982) and other studies like Buxton (1981) indicate the widespread prevalence of 'maths anxiety' among the general population shows that this aim has been largely unrealized in practice.

Anxiety is one of the most studied emotions. Mathematics anxiety has been examined mainly by educators and is viewed as a form of state anxiety that is aroused in situations perceived as involving the use of mathematics (Byrd, 1982).
Mandler (1984) suggested that the behaviour patterns of students with high anxiety differed from those of students with low anxiety. Reassurances given to a high anxious student may counteract negative self-task by the student. The same reassurance given to a student with low anxiety has the opposite effect. This suggests that the classroom may not be appropriate place to deal with mathematics anxiety creating classrooms where anxiety is less like to occur is certainly desirably.

Paul Cobb, Erna Yackel and Terrywood (1985) reported that, 'children came to believe that doing mathematics is essentially a problem-solving activity, typical negative emotions such as anxiety, embarrassment and shame, which accompany the obligation of producing publicly evaluated solutions to large number of tasks in a quick, error-free manner.

A study by Gentry and Underhill (1987), in which, they and physical instruments of muscle tension as well as paper and pencil measures of anxiety toward mathematics. There was a little correlation between the two measures, suggesting that traditional measures of anxiety may be quite different from the emotional responses that influence students in the classroom.

Gender differences in anxiety towards mathematics have been studied intensively by Hembree (1990). He used meta-analysis to synthesize the findings of 151 studies - mainly articles in journals, ERIC studies, documents and doctoral dissertations. He reported that at each
grade level (K-12 and post secondary) females reported greater mathematics anxiety than males. At both the junior and senior high school levels, high anxiety affected mathematics performance less for females than for males. High anxious females were on average also more likely to continue with mathematics than high anxious females.

Verma (1991) also reported no significant difference between males and females in a test of mathematics anxiety.

Springer (1995) reported significant positive correlation between sex role stereotyping and mathematics anxiety. He further reported no significant relationship between sex role identification and mathematics anxiety.

Without a better understanding of etiology of anxiety in academic tasks, the role of societal and attitudinal factors remain unclear. The recent attempt to revisit the dimensions of math anxiety, conclude that event cross culturally, affective factors are distinct from cognitive factors.

2.2.6 Studies on Gender Differences in Classroom Interaction

Systematic classroom observation approach has revealed that teachers often interact differently with their female and male students, with males attracting more and qualitatively different interactions.
Holt (1969) has provided anecdotal evidence of the strategies pupils run to cope with the question and answer situation in class, and has also referred to cultures where such a situation viz. one in which individuals might be laid open to ridicule – would be completely unacceptable. Clearly, pupils who feel that they are being embarrassed in this way will develop a negative attitude to mathematics.

Teacher-child dynamic interactions were quantified using an approach, based on that described by Brophy and Good (1970). Length of time spent on various interactions was also monitored. The methodology used by Rowe (1974) in her ‘wait-time’ studies shaped the categories measured in this observation schedule. Teacher-student dynamic interactions were categorized using the approach of Brophy and Good (1970) and discussed in Leder (1987a).

Fennema and Sherman (1978) say, ‘Teachers are the most important educational influence on students’ learning of mathematics. They influence students in many ways, a very significant one is sex role socialization. They believe that ‘part of the teachers’ influence is as the learners’ development of sex role standards. These sex role standards include definitions of acceptable achievement in the various subject areas. It is believed that this influence by teachers is exerted through differential treatment of the sexes as well as expectations of sex-related differences in achievement.
Observations in high school algebra and geometry classes were summarised by Stallings (1979) as follows 'though few of the differences are significant, the trend is rather clear. Men are spoken to more often than women. Men ask more questions and teachers ask men more questions. Women volunteer answers as often as do men but the men are called upon to respond more frequently than are men. Men receive a little more individual and special interactions. Acknowledgement, praise, encouragement and corrective feedback are given slightly more frequently to men than to women.

Russell (1983) states that a good relationship with the teacher was more important for girls than it was for boys. A particular problem was that, certain topics in mathematics were considered irrelevant by pupils. The teacher perhaps needs to make efforts to explain why certain topics are included, but there may be other topics, which defy justification.

Research focusing on length of interaction and particularly on wait time has rarely examined the impact of gender on teacher-student interactions in mathematics classroom. Gore and Roumagons (1983) had reported that, 'grade four boys were given more wait time than girls in mathematics lessons'. General work on wait time has indicated that the quality and scope of student's answers, and their overall achievement, tend to improve when teachers increase their wait time. Thus if boys indeed have more wait and length of interaction times than
girls, this could be reflected in the quality of work produced, on average, by the groups.

Grieb and Easley (1984) report that teachers allow some boys to exert their independence overtly by refusing to learn specific algorithms.

There are also differences in how teachers interact with and treat girls and boys. Boys interact more with teachers than do girls. Girls have more days in which they do not interact at all with the teacher than do boys. Teachers initiate more contacts with boys than with girls. Boys receive more discipline contacts as well as more praise. Teachers respond more frequently to requests for help from boys than from girls and tend to criticize boys more than girls for the academic quality of their work. (Fennema & Peterson, 1987).

Teacher-student interactions were examined in a sample of grades 3, 6, 7 and 10 mathematics classes. Teacher influence was operationally defined in terms of frequency of interactions and time spent on waiting for and interacting with students. The overall impression conveyed by the date suggested that boys and girls are treated differently in mathematics lessons. The differences seem to precede gender differences in performance in mathematics. A significant difference in the mathematical performance of boys and girls was found only at the grade 10 level. The link between teacher treatment and student achievement is suggestive, indirect and probably further reinforced by the gender-linked expectations and beliefs of the wider society. No direct causal relationship can be deduced from the results
presented. Schools function within a cultural context, reflect it and continue to reinforce the notion that competing in mathematics is more important for boys than for girls (Leder 1987a; 1987b; 1988). Contemporary treatment of boys and girls in mathematics classes still appears to place the latter at some risk.

2.2.7 Studies on Attributional Styles and Gender Differences

The observed sex differences in casual attributions about success and failure are probably linked to those in confidence. Frieze and Colleagues summarise the literature into three basic models; general externality, self-derogation and low expectancy; all three models predict that women are unlikely to attribute the success to ability.

Deaux, (1979) reported that people are more likely to attribute successful performance to ability or skill when the success individual is male; in addition, the tasks are judged more difficult when they are successfully accomplished by males and less difficult than accomplished by females.

Weiner (1979) conducted an analysis of the possible causes of success and failure and classified them according to whether the causes are internal or external to the individual, stable or unstable and controllable or uncontrollable. Within this scheme, ability is considered to be an uncontrollable, stable, internal cause. This is the differentiated conception of ability – ability as capacity.
failure in that females are more likely to see success as caused by effort and less likely to seek success as caused by ability.

With regard to the conception ability; 'If students attribute their failures in problem solving to their lack of ability, they are likely to be unwilling to persist in problem solving tasks very long (McCeod, 1985).

Dweck (1986) states that beliefs and attitudes take the form of attributions in the cognitive process. Through attributions of behaviour, the self-concept is implicated in or protected from damaging emotional reactions. The motivational variables operating in the learning environment and the way in which they affect attributions of students in an interesting example of cultural influence.

Meyer & Fennema (1988); Fennema & Peterson (1985); Reyes (1984) found that males are more likely than females to attribute their failure in mathematics to lack of effort and females are more likely to attribute their failures to lack of ability. The resulting differences in participation in mathematically related careers appear to reflect these gender related differences in attributions.

Women tend to attribute success to luck or effort, men attributes success to ability Fennama (1990).

2.2.8 Studies on Confidence and Gender Differences

Gender differences in Confidence to learning has been reported by many researchers. (Helsm, 1967; Fennema, 1981, 1987; Becker, 1984;
Reyes, 1984; Steen, 1987) to be one of the most important variables related to mathematical learning.

Shavelson, Hubner and Stanton (1976) had proposed a theoretical model that shared the relation of confidence to learning, and there were data available that indicated that the theory was valid.

Frieze, Fisher, Hansua, Mettugh and Valle (1978) and Dornbusch (1974) had indicated that females tend to underestimate their own intellectual activities (including mathematics) more than the boys did.

Gilligan (1982) and Fennema (1981) found that females are often more open than males to expressing their feelings and doubts. American males are typically socialized to be 'strong' and not show any doubts or signs of 'weakness'. The fact that all the males in this study were able to express their doubts could be an indicator of their confidence.

Reyes (1984) said, 'confidence in one's ability to learn mathematics appears consistently as a strong predictor of mathematics course election'. Yet, research by Becker (1984) with graduate students in mathematics and Helson (1967) with creative mathematicians showed that females in these studies were markedly more confident in their mathematical abilities than the females.

Taylor (1988) reported that in his study, the female mathematicians are different from those in other research studies such as Becker's and Helson's. They are as confident mathematically and
equally comfortable in social situation as the men. In addition, all the women and men in his study embrace equitable values, which support the development of all persons regardless of gender and ethnicity.

The National Council of Teachers of Mathematics (1989) has said one of the most important goals reflected in their mathematics curriculum standards is ‘becoming confident in one’s ability mathematically’.

2.3 STUDIES ON GENDER BIAS / GENDER DIFFERENCE

Benbow and Stanley (1980) suggested that the difference is due to the fact that the mathematical reasoning of boys is better developed than that of girls, which leads to boys taking more mathematics courses than girls.

Betz and Hackett (1983, 1986) showed that females feel less capable in mathematics than do males, regardless of ability. Their studies showed that females feel capable in mathematics only when the problems are in stereotypically female areas. The females do not seem to generalize this ability to similar, more formal mathematics problem. By not taking the leap beyond these limited types of problems, females do not choose mathematically oriented professions, which pay well.

Chitkara, M (1985) found that 1) All the three strategies, namely a) lecture discussion, b) lecture drill c) auto instruction and d) 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. 3) Girls of average ability were significantly higher in mathematics than boys of average ability.

In the case of differential mathematics performance, females hold poor self-concepts with respect to their ability to survive failure and to perform ambiguous tasks and in mathematics. Once an emotion, attitude, or belief is held that predisposes an individual to feel less than competent in the learning environment, the cognitive system is handicapped (McDonald, 1987).

Behera, Amarendra Prasad (1993) had found that girls did not differ significantly in all the variables of verbal creativity i.e., fluency, flexibility and creativity except the measures of originality from the boys.

Upmanyu, Sushma; Upmanyu, V.V. and Bharadwaj, S (1994) had found that 1) The two genders differed significantly in sex-role identity. 2) Males with androgynous and masculine sex role identity did not differ significantly in perceived loneliness, the additional presence of feminine characteristics in androgynous sex-role identity failed in providing special benefits in terms of vulnerability to loneliness. 3) Males with androgynous and masculine sex-role orientation, however, were less lonely than feminine or undifferentiated characteristics. 4) For females,
there was no significant difference in loneliness among different types of sex-role orientation. 5) Among less depressed adolescents, there was no significant difference between males and females on loneliness, but among highly depressed adolescents, males scored significantly higher on loneliness.

Mukherjee, Chandra (1997) has found that 1) Boys appeared to be higher achievers than girls in all the aspects of mathematics i.e., knowledge and skills, understanding, applications, arithmetic, algebra, geometry and total score in all the three classes, viz., class VI, VIII & X. 2) In particular, class VI & VIII boys achieved significantly higher scores as compared to girls in all the aspects of the test. 3) The difference between boys and girls was slightly less in higher classes i.e., class X.

Kishore, Lalit (1998) recorded the following views as expressed by the subjects in the group discussion. 1) Gender stereotyping in science participation and employment continues. In 1997, more have been lesser number of girls enrolled for University level Physics courses. Boys are outperforming girls in mathematics and technology. 2) Gender stereotyping over ages has produced masculine mind-sets for numerary tasks and feminine mind-sets for literary tasks. 3) Some studies prove that girls taught physics by male teachers performed far below than those taught by female teachers, thereby suggesting a need for shift towards single sex school. 4) Things required for better learning of science, technology and mathematics are: women-friendly learning environment, science learning ethos, a variety of teaching strategies
and monitoring and support to building better self-concept among women. 5) Both gender and science have a social construction.

Agarwal, Sweta and Agarwal, Suman (1999) had found that males had higher scores in creativity and intelligence as compared to females.

Gyanani, T.C (1999) found that 1) The global self-concepts of males and females did not differ significantly but there were gender differences on various dimensions of self-concept. 2) Boys were high in physical, intellectual and activity dimensions of the self-concept, while the girls perceived themselves high in moral, ethical, social and emotional aspects.

Tyagi, Manorama (1999) suspected that girls were more altruistic than boys.

2.4 RECENT TRENDS

NAEP data show that “the black-white achievement gap has narrowed, although significant differences continue in each content area tests, the improvement by blacks have been in lower proficiency level in mathematics and science, “Linn (1992), Gender differences although, this trend has been more gradual at the level of college admission test”.

International surveys appear to show that, “the gender gap in mathematics has narrowed, even reversed." The pattern of performance in the UK now shows, “girls performing better than boys in English,
Mathematics, Science in the Standard Assessment Tasks (SAT), at ages 7 and 14. At GCSE (age 16), “girl’s performance is improving compared with boys”; in 1992, "girls gained significantly more good grades (A-C) in GCSE, Overall, than boys, "However, the 7-16 patterns is reversed at 18+ and the same appears to be the case in the USA.

2.5 SUMMARY

This chapter highlighted the need for related literature and also presented few studies, which were taken up in topics related to the present study. The review of the studies presented here, facilitated the investigator to design and execute the present study. The next chapter will describe the 'Research Design' in detail.