Chapter II: Review of Related Research

Section I: Review of Research related to Science Achievement

Section II: Review of Research related to Science Attitude

Section III: Review of Research related to Problem Solving Ability.

Statement of Hypotheses
CHAPTER II

REVIEW OF RELATED RESEARCH

The present study is designed with a view to analyse the attitude towards science, science achievement and problem solving ability among the secondary school students in Aizawl. The investigation is further directed to examine the relationship of select personal and socio-educational variables such as sex, parental education, parental occupation, socio-economic status and type of school on the science achievement, science attitude and problem solving ability of the students. A survey of the studies conducted in the related areas is undertaken in this chapter. The review of related research has been presented under the following three sections:

Section I : Review of Research related to Science Achievement.
Section II : Review of Research related to Science Attitude.
Section III : Review of Research related to Problem Solving Ability.
In recent years, many reports have been published on researches related to student academic achievement. Science achievement has been studied analysing its relation to variables like sex, socio-economic status, parental interest, indifference of parents, qualities of teachers, student motivation, participation in science programmes and media exposure. The studies vary in methods, techniques, and mode of analysis. Several studies have been conducted in India to analyse the science achievement among the college and school students. The research related to science achievement both in India and abroad has been reviewed in this section. In general terms, achievement refers the the scholastic or academic achievement of the student in the subject at the end of the educational programme. It is to this concept that the term is addressed in the research and is referred to students achievement in science subjects. It has been indicated that a number of variables such as sex, socio-economic environment, the organizational climate of the school, motivation of the students influence achievement in different degrees. A synoptic view of the researches will enable the researcher to explore greater depths in this important area of study.
Researchers have examined the characteristics of students that seem to be related to successful achievement, positive attitudes toward science and problem solving ability. One of the most frequently hypothesized relationships is between student sex and achievement. Studies in sex difference clearly show that boys do about as well as girls at all levels - in elementary school science (Smith and Litman, 1979)\(^1\) at the middle school (DeLuca 1979; Alaimo 1979; McDuffie 1979)\(^2,3,4\) at the high school (Stephenson, 1979; Cohen, 1979;)\(^5,6\) and among college students.


5. Stephenson, R.L: Relationships between the intellectual level of the learner and student achievement in high school chemistry. *Dissertation abstract International*, 1979, 39(11), 6677A.

(Andrews, 1979; Walker, 1979)\(^7,8\) Another consistent finding is that students of higher ability or aptitude achieve more than their peers of more limited ability (Burrows and Okey, 1979; Nussbaum, 1979; Howe and Early, 1979; Brown and Butts, 1970)\(^9,10,11,12\) Students' previous science experience appears to have little correlation with their science achievement. Werline (1979)\(^13\) reported that older children had more knowledge about


their environment than did younger students. McDuffie (1979)\textsuperscript{14} found that eighth-graders did better than seventh-graders on a science-criterion achievement measure.

Beyond the control of the science teacher but significantly related to the success of the student in the classroom are environmental variables such as socio-economic level, parental interest in schooling success, and ethnic origin of the student. It has been shown in NAEP studies (1978)\textsuperscript{15} that student ethnic origin is closely associated with achievement. La\textsuperscript{16} found equally strong relationships between ethnic original, parental background, and urban or rural home location. In a study of scientific literacy among Georgia students, McNeill and Butts (1981)\textsuperscript{17} however, found no evidence of a relationship between urban-rural home location and scientific literacy.

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  \item \textsuperscript{14} McDuffie, T.E. Op.Cit. 1979.
  \item \textsuperscript{16} La\textsuperscript{16}, D.E. The Influence of Knowledge on Young People's Perceptions about Wildlife (Final report to the National Wildlife Federation). June, 1978.
  \item \textsuperscript{17} McNeill, C., & Butts, Scientific Literacy in Georgia Schools. Paper presented at the annual meeting of the National Association for Research in Science Teaching, Grossinger's Newyork, 1981.
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In academic abilities, girls tend to excel boys. However, administration of standardized achievement tests reveals sex differences in separate school subjects that corresponds closely to those based on intelligence and aptitude test. (Terman, 1954, and Traxler, 1954) observed that on batteries as the standford achievement test, given to thousands of elementary school children in several different surveys, boys score significantly higher in science, social studies, and arithmetic reasoning; girls in spelling, language usage, and (less consistently) arithmetic computation. Sex differences have also been reported on science tests administered at the high school students by Jordan (1937) and on college students by Learned and Wood (1938).  


Edgerton and Britt (1944) and Edgerton and Britt (1947) established equally striking differences in the annual science talent search tests. Although two to three times as many boys as girls apply for this competition each year, and the girls would, thus be expected to be a more highly selected sample, significant differences are regularly obtained in favour of the boys.

In general, girls surpass boys in school subjects depending largely upon verbal abilities, memory, and perceptual speed and accuracy. Boys excel in subjects that call into play numerical reasoning and spatial aptitudes, as well as in certain "information" subjects such as history, geography, and science. This is in agreement with the common superiority of boys on tests of general information included in intelligence scales, and probably results from the less restricted and more heterogeneous environment to which boys are exposed, as well as from their wider range of reading interests. Terman (1925) in his survey of the reading habits of gifted children, found that girls read

imaginative and emotional fiction as well as stories of school and home life far more often than boys, while the latter showed a predominant interest in books on science, history, biography, travel, and informational fiction and adventure tales. It is also noteworthy that sex differences in science and mathematics increase markedly with age. Moreover, studies at the preschool and primary levels revealed no sex difference in functions related to quantitative and scientific thinking, such as the development of number concepts or the solution of problems involving causal relations.

With regard to school progress, girls were found consistently more successful than boys and less frequently accelerated, and promoted in larger numbers than boys (Lincoln, 1927).25 Similarly, in school grades girls excel throughout, even in those subjects that favour boys on achievement tests. Thus, a comparison of grades in arithmetic, history, or any other subjects in which boys obtain higher achievement test scores shows a sex difference in favour of girls. The advantage enjoyed by girls in school grades was projected particularly by Lentz (1929)26 in his study of 202 boys and 188 girls in

grades 2 to 6 on the Stanford Achievement Test. The girls were found to excel in school grades, when compared to boys receiving the same achievement test scores. Thus the grades showed a far greater female superiority than seemed to be warranted by performance on objective achievement tests.

In high school, girls generally obtain better grades than boys, even though the latter are a more select group and make a better showing on achievement tests. There is likewise evidence that at the college level girls adjust better than boys to the academic environment. Summerskill (1955) while analyzing the records of 1818 students entering the co-educational college during a single year showed that women accounted for a relatively small proportion of superior students. Gordon's study (1953) of the air force technical school also observed similar results as women obtaining better grades than men with the same aptitude index.

One reason for the greater scholastic success of girls may be found in their superior linguistic aptitudes, which probably form an important part in school learning. Current methods of instruction, as well as methods of testing, are predo-


minantly verbal. Another possible factor, especially in the early school grades, is the neatness and general superiority of girls' handwriting, which may affect grades on written work. In investigations on both elementary and high school groups, Lincoln (1927)²⁹ and Zazzo (1948)³⁰ noticed that girls excelled markedly in the quality of their handwriting.

It is likely that personality difference between boys and girls also influence the assignment of grades. Girls are generally more docile, quieter, not so subject to out-of-school distractions, and less resistant to school discipline than boys. These personality differences may affect grades both through the amount of material actually learned and, more directly the impression they created on the teacher.

The effect of sex stereotypes on the judgements of both teachers and classmates is illustrated by the findings of Hartshorne, May and Maller (1929)³¹ In this investigation


Sex differences in ability and achievement were analysed in a number of studies and these studies have brought about marked change in views towards the education of girls. The nature of the research undertaken in the field closely followed societal views and concerns and most of the studies concerning sex differences have been conducted in the fields of education and psychology. The research carried out in the United States into sex differences and ability and achievement has been surveyed by Tyler (1956), Anastasi (1958), and Maccoby (1966). They reported that in the United States boys generally show stronger numerical and spatial abilities and perform better on tests of mathematical reasoning than girls, but girls usually do better in verbal and linguistic studies. However, Tyler, (1969) emphasized that the dif-


ferences between the sexes in these areas are, in general, not large when compared with differences within each sex group. Nevertheless, there remains the major question for investigation of why marked differences between the sexes are observed in the patterns of education and career paths which are followed by the two groups.

It was Herbert Spencer in 1873 in his "psychology of the sexes" who agreed that the intellectual attributes of women developed differently in the course of evolution. Women were thus deficient in the powers of abstract reasoning and in the most abstract of the emotions, i.e. the sentiment of justice. The prevalent views in Germany according to Sherman (1978)\textsuperscript{36} were even less favourable to women. Thorndike in 1906 rejected the view that the differences between the sexes could be inherent, since such differences were too small to be of practical significance. Hollingworth, a student and colleague of Thorndike at Teachers College, Columbia University, contended that the small differences observed were due to social influences and not to biological causes, and that the true intellectual potential of women would only be revealed when women received a similar education and had the right to choose equivalent careers. Such views supported the claims of the feminist movement and generated

interest in research that sought evidence for the equality of the sexes. Ellis (1894)\textsuperscript{37} argued that there was social significance in the hypotheses of greater male variability for the development of civilization. However, Pearson, in (1897)\textsuperscript{38} challenged Ellis on both empirical and conceptual grounds, and concluded that the male variability hypothesis remained unproven. However, the reason for a low perceived proportion of women among the famous and the eminent even today remains unclear. Research into sex differences in 1920 and 1930, was primarily concerned with the study of differences in attitude and emotional needs. Masculinity and femininity were also examined in an attempt to differentiate more accurately the characteristics of persons within the same sex group. Studies were mainly related to psychoanalytic theories which hypothesized that emotional differences arose from biological rather than sociological sources. However, during the 1950s the emphasis in research shifted once again to the study of sex roles in order to account for differences in personality development. Sex differences as an identifiable

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field of psychological and sociological enquiry was established after comprehensive review of the studies by Maccoby in 1966. The subsequent emergence of the women's liberation movement led to new strands of research which sought to understand the implications of measured sex differences for developmental psychology. Recent research has brought to examine issues without using the male group as the reference group for the study of both differences and similarities. Peterson et al (1982) summarised new approaches in the investigation of the processes operating within sex groups associated with biological, psychological, social, and cognitive development. The basic issue in the examination of sex differences in achievement is concerned with the cognitive factors that led boys and girls to study different subjects during the years of secondary schooling and thus prepared themselves for different types of occupations and different careers. The rapid growth of the women's liberation movement and the increasing recognition of equal pay for women and men have led to some change in the pattern of subjects studied at school and in the courses taken at tertiary level, and also a change in career paths for women. As a consequence it is of relevance to examine not only sex differences in

achievement across countries but also across time to determine whether relationships are observable in different parts of the world, and at different points in time. It is unfortunate that the published findings of research have to date been dominated by work carried out in the United States. Tyler (1956)\textsuperscript{40} in a review of research in the United States reported that in all studies girls achieved consistently higher grades than did boys, were less frequently retarded, and were more frequently accelerated through the years of schooling than boys. When batteries of achievement tests were used to assess achievement rather than using school grades for this purpose, girls continued to exceed boys in performance in language studies, and boys tended to perform better in mathematics and science. However, the differences between the sexes were small and frequently inconsistent within the same subject area; for example, boys performed better on problem solving in mathematics, while girls frequently performed better on computation. Tyler contended that the magnitude of the sex differences reported afforded no justification for the setting up of different schools to provide different teaching for boys and girls.

Keeves (1973)\textsuperscript{41} reported from the International Association for the Evaluation of Educational Achievement (IEA) studies of mathematics and science that while the general pattern of results was one of superior performance by male students in both these subjects, there was considerable variation between countries in the extent to which boys exceeded girls in performance. Furthermore, while the differences between the sexes in achievement in science increased markedly from primary to secondary schooling a similar relationship was observed in mathematics from the lower secondary to the upper-secondary-school levels, adjustment must be made before effective comparison is carried out. It is evident from the data recorded that the differences across countries are too great for simple explanations. For example, in terms of sampling variations, to be advanced as to why such sex differences should have been observed, the differences recorded could well be related, in part, to differences in the time given to the study of the subjects of mathematics and science, and thus to differences in opportunity to learn or to the patterns of provision in single sex schools and co-educational schools which would appear to reflect different expectations for the roles of men and women in society.

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An index of enrolment of single sex and co-educational schools has been found to correlate (0.75) with differences between the sexes in achievement in mathematics at the lower secondary school level across twelve countries. It is observed that as a consequence of effects operating at the secondary school level, girls are less well-prepared to enter occupations and careers that require prior knowledges of mathematics and science.

Walker (1976) found that on reading comprehension tests, boys showed lower performance than girls in a majority of countries, but the differences between the sexes were, in general slight. In the cognitive literature tests, at both the 14 years old and the pre-university level and in all countries the boys did less well, and they also showed less interest in literature. Again, in the study of the teaching of French as a foreign language it was noted that fewer boys had chosen to study French, and showed inferior achievement in some countries.

Statistical significant differences between the sexes in the learning of French were recorded in the English speaking countries. When other factors were taken into consideration, it was only for the pre-university students in the English-speaking countries that the sex of the students was important. In the civic education achievement test, the boys at the 14 year-old level generally recorded higher scores than the girls and in all countries taking part in the study the boys showed greater superiority at the pre-university level. These differences in both achievement and participation between the sexes were found in the several different subjects examined at the secondary school level and that the patterns of differences are related to the sex-role expectations of the societies in which these young people are undergoing their secondary school.

Moss (1982)\(^{43}\) reported sex differences in achievement in mathematics in Australia among the secondary school girls during 1964 to 1978. The finding from this study, which involved the use of the same tests on the two occasions and across seven autonomous state educational system within Australia, indicated that at a lower secondary level a slightly higher level of performance by girls on sub-tests involving

elementary arithmetic and algebra, and a higher level of performance by boys in sub-tests involving advanced arithmetic and geometry. There was little evidence of change in the patterns of sex differences associated with the learning of mathematic over 14-year interval, but recognizable and consistent differences in the results were recorded over this time period for the different state system. When sex was the only variable taken into account at the pre-university level, a superior average level of performance of boys on both occasions and also an increase in the difference in performance between 1964 and 1978 was observed. On the surface, this change in average level of performance appears contrary to expectations. Over the 14-year period there were marked increases in the retention of girls at school and in their participation in mathematics courses at this level. In terms of the yield associated with the learning of mathematics at the achievement of girls did not equal that of boys, greater gains were made by girls over the period from 1964 to 1978. Furthermore, after adjustment was made statistically for time given to the study of mathematics, the sex differences in achievement showed a tendency to reverse, with girls showing a superior level of performance in a majority of system on the later occasion. The recorded evidence appears to suggest the existence of sex difference in educational achievement at the upper-secondary school level. It is, of course, pos-
sible that the sex differences recorded above have their origins not on societal and cultural factors but in differences in abilities between the sexes.

Significant differences between the sexes in performance on intelligence tests have been noticed in a number of studies. Some tests have given boys a slight advantage and other tests would appear to have favoured girls. When such studies have shown a consistent result favouring one sex rather than the other, the tests have been revised to remove what is considered to be a sex bias by the deletion of items from a test that shows substantial sex differences. Tyler (1956)\textsuperscript{44} has noted that in an extensive and well-executed study carried out by the Scottish Council for Research in Education 1937, using the Stanford-Binet intelligence test with children aged approximately 11 years, there was a difference of less than one point in IQ in favour of boys. However, when the study was repeated in 1947 using the Terman-Merill revision of the Stanford-Binet test with a large carefully drawn, and equivalent sample, a difference of four points of IQ was recorded. This difference in IQ although statistically significant does not appear to be of marked practical significance to derive any valid conclusions. Nevertheless, the problem remains as to whether the differences recorded between the

\textsuperscript{44} Tyler, L.E., \textit{Op.Cit.} 1956.
two occasions were a consequence of the sampling or due to changes in the characteristics of male and female student populations on the two occasions or differences resulting from the revision of the test that was employed.

In the context of the achievement differences discussed above it was more relevant to consider whether the sexes differ with respect to specific abilities rather than whether they differ in general intelligence. Female students would appear to perform better on tests of verbal ability than do male students, although the results supporting this conclusion show some inconsistency. There is great consistency in the results for all areas of verbal function, but generally the differences are relatively small. Maccoby and Jacklin (1974)\(^\text{45}\) give little credence to the long-held view that girls gain the advantage in verbal skills during the early years, before the age of three years. They suggest that, if girls have an early advantage boys catch up by about age of three, and both sexes perform similarly until about 10 or 11 years of age. Males generally score higher than females on tests of quantitative ability, when this is assessed in terms of quantitative reasoning or problem-solving rather than in terms of computational skills. Again there

are inconsistencies in the results obtained up to the age of about 12 or 13 years, when the quantitative problem-solving ability of boys appears to develop at a faster rate. Petersen et al (1982)\textsuperscript{46} found significant sex differences associated with the superior performance of boys recorded with respect to spatial abilities. Sherman (1978)\textsuperscript{47} however, emphasized that the size of the differences reported is smaller than has been suggested in some of the writing on the subject. Moreover, the age at which differentiation between the sexes becomes clear is during the years of early adolescence Maccoby and Jacklin, (1974)\textsuperscript{48}.

It seems possible that the apparent superiority of females on verbal ability tests and of males on spatial and quantitative ability tests could account for the differences reported above with respect to achievement test performance. In the main, sex differences in achievement test scores in mathematics are substantially reduced or eliminated when spatial ability has been partialed out. However, it is not possible to conclude from this that the sex differences in

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spatial ability cause the differences in mathematics achievement which have been observed, although the results obtained are consistent with this hypothesis. Fennem and Sherman (1977)49 have shown that it is possible to eliminate sex differences, by controlling the time spent in learning mathematics or attitude towards mathematics. The effect of differences in ability on achievement test scores would be more soundly based if the origins of the differences in ability could be identified and the possibility thus examined that the differences in both ability and achievement have related origins. It is evident that at the secondary school level substantial differences in achievement do emerge in some situations. However, differences in verbal, quantitative, and spatial abilities which might be seen to be causes of these achievement differences are hard to establish particularly since sex differences in these abilities do not become clear until adolescent, and would not appear, in general, to be large, to a certain extent.

Sex differences in abilities and achievement may be due to the effect of a number of factors as (1) biological factors which include genetic, maturational, hormonal,

and brain lateralization influence, (2) socialization factors including effects which are transmitted by parents, teachers, or the peer group and are related to sex roles in society, and (3) effective factors including expectancy of success, attitudes, and values. The biological basis of sex-related differences in cognitive performance have been discussed by Sherman (1978) and Wittig and Petersen (1979) Perhaps, the most basic difference between the sexes is the chromosomal difference, and the evidence of a relationship between parent-child scores on spatial ability tests has led to the suggestion of possible sex-linked genetic factor. However, the hypothesis that spatial visualization is sex limited has not been supported by later findings. Ljung (1965) demonstrated using group data that there was general agreement between the physical growth pattern and the mental growth pattern at adolescence, since differences in abilities begin to emerge at adolescence, when hormonal differences between the sexes are increased.


and possibility of a relationship between hormones and the development of cognitive abilities cannot be ignored. However, very few effects have been demonstrated although some relations have been shown between androgen levels and cognitive performance. Studies of sex differences in brain organisation have been carried out in recent years. While there are sex-related differences in bilaterality, in so far as females use the left hemisphere for spatial function more than males do, such differences have not as yet been related to sex differences in cognition or more importantly in space perception. There is substantial evidence to support the theory that sex-role, socialization both directly and indirectly influences sex-related cognitive differences. Moreover, the effects of sex-role socialization differences emerge at the beginning of secondary schooling and continue throughout the years of adolescence. A study by Keeves (1973) has shown that parental attitudes and home practices, student-teacher interpersonal relationships, and peer group attitudes and practices had small but recognizable effects on achievement in mathematics and science at the lower secondary school level in Australian high schools.

Wittig and Petersen (1979) reviewed the studies on the effect of sex-role as a mediator of intellectual functioning,

together with relationships between sex-role socialization and achievement in mathematics and it is observed that further work is required to clarify the relationships on the effects of sex-role on cognitive functioning. Nevertheless, it is evident that differences in the patterns of socialization of male and female students, both across countries and across time, as well as between students within a particular country at a particular time, are likely to be the most powerful factors influencing the development of sex differences in abilities and achievement. Meece and Parson (1982)\(^5\) have argued with respect to the development of sex differences in achievement in mathematics that socializers are likely to contribute in three important ways: (a) male and female socializers create differences through their power as role models; (b) socializers convey through a variety of direct and indirect means different expectations and goals for boys and girls; (c) socializers promote the development of different activities for male and female school children. The studies reviewed by Meece and Parsons (1982), particularly in the studies by Parson et al. (1982)\(^6\) strongly endorse the hypothesis.


that socializers treat girls and boys differently in a variety of ways that would seem to be related to course selection. Some of the studies reviewed assessed directly the causal relationships between these socialization experiences and both achievement and academic choice. Such factors as parental perception and expectation were related to the children's plans to continue to take mathematics courses. However, the direction of causality has been difficult to determine. In addition, factors associated with the behaviour of the students in classrooms which their teachers foster may also contribute to the development of sex differences in performance. It seems likely that the effect of socializers would be most marked on the attitude and values held by students which act as mediating influences between the socializers and ability and achievement outcomes. Many effective factors have been studied in relation to the learning of mathematics and science. In particular, girls have been found to be more likely to be less confident about their ability to solve mathematical problems, and to be less likely to believe that mathematics would be personally useful to them.

It is often hypothesized as a partial explanation of the apparently poorer achievement of girls in mathematics and science that there is a motive to avoid success that is stronger in girls than in boys. There is a growing body
of evidence that girls are higher on measures of fear of success than boys and that this attitude acts more strongly against undertaking quantitative studies which is perceived to be a male preserve, than towards verbal and language studies. If this was a significant factor for both ability and achievement, there is some hope that it would be a malleable factor and gains could be effected in the performance of girls through programmes to change attitude.

The scholastic performance of students does not solely depend upon their intellectual ability, but is also governed by motivational and background factors. Number of studies have clearly established a definite relationship between socio-economic status and academic achievement. Bennur and Abraham, (1973)\textsuperscript{57} have reported that pupils from higher socio-economic status excelled in scholastic performance. Singh (1965)\textsuperscript{58} found scholastic performance to be positively correlated


with father's education. Studies conducted by Curry, (1962)\(^{59}\) Anand, (1973)\(^{60}\) revealed that the low socio-economic status (SES) children performed less successfully than the middle-SES children in many kinds of academic and experimental situations. Pointing to the importance of SES, Lalithama (1975)\(^{61}\) observed that the achievement of high school children in mathematics was positively correlated to socio-economic status of the children. Other studies by Chopra (1966)\(^{62}\),


Verma, (1971)\textsuperscript{63}; Reddi, (1973)\textsuperscript{64}; Abraham, (1974)\textsuperscript{65}; Prakashchandra (1975)\textsuperscript{66}; Saini, (1977)\textsuperscript{67} and, Ganapathy and Singh, (1981)\textsuperscript{68} also revealed a positive and significant relationship between academic achievement and socio-economic status of pupils. Again, a study conducted by Contractor (1984)\textsuperscript{69} on Some Background Factors Underlying Scholastic Performance, the finding revealed that the mean score of high achievers is greater than low achievers on SES scale. These findings

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\item \textsuperscript{63} Verma, D., "Student Failure; Few Observation," The progress of Education, XLVI, 3, 1971, pp 82-85.
\item \textsuperscript{64} Reddy, V.I.N. "A Study of Certain Factors Associated with Academic Achievement in the First Year Degree examination, Ph.D., Edu. MS University, 1973.
\item \textsuperscript{65} Abraham, M., "Some factors relating to under achievement in English of secondary school pupils," Ph.D. Education, Kerala University, 1974.
\item \textsuperscript{66} Prakashchandra 'A Study of the Problems of High School Students in the Varanasi Educational Region of U.P. and Their Relative Effect on Achievement,' Ph.D. Education. Gorakhpur University, 1975.
\item \textsuperscript{67} Saini, B.K., "Academic achievement as a function of economic status and educational standard of parents," Psychological Studies, 22, 2, 1977, pp 24-27.
\item \textsuperscript{68} Ganapathy, M., & Raghuram Singh, M., "The impact of socio-economic conditions on achievement," Experiment in Education, 9(8), 1981, pp 144-177.
\end{itemize}
support the view that the students who have high socio-economic status are likely to get better schooling. Generally parental attitude towards education is positive in high SES groups. Higher socio-economic class also encourages more parental interactions with children which in turn, help children to acquire better verbal fluency and this in turn, helps better educational performance. Students, coming from low SES group have many family responsibilities over and above academic ones which may not permit them enough time to devote to their studies. The motivation and level of aspiration of students are likely to be lower among the families of lower social class. However, there are certain parallel studies by Rao (1965) Srivastava (1967) Bernstein (1968) Jha, (1970) Sudama (1973) and Ahluwalia and Shyam (1975).


Sharma and Bhargava (1980)\textsuperscript{76} which revealed very little to negligible impact of SES on academic achievement. Miller (1970)\textsuperscript{77} concluded that factors associated with achievement of the children are generally less associated with social class. Besides, the finding of Bansal (1977)\textsuperscript{78} revealed that SES was not insignificantly related to achievement in any subject or group of subjects.

The educational background and financial position of parents and other members of the family have a direct influence on the aspirations of children. A lot of studies revealed that the style of life to which a child is exposed makes difference with regard to his scholastic achievement.


\textsuperscript{78} Bansal, J.P., "A study of need differences among urban high school boys and girls at different levels of general intelligence and socio-economic status," \textit{Ph.D. Education}, Kurukshetra University, 1977.
The higher is his socio-economic background the superior will be his academic performance. A couple of studies on reading readiness by Jewell (1941)\textsuperscript{79} in Springfield, Illinois and Fram (1946)\textsuperscript{80} in Iowa indicate that children from lower class or under privileged homes tend to be less ready for reading in the first grade than more fortunate ones. Corroborative evidence is provided by Warner, Havighurst and Loeli (1944)\textsuperscript{81} in comparison made between sub-groups of higher and lower socio-economic status based on a survey of pupils with I-Q 110 or above. In the upper social groups 93\% graduated from high school and 57\% attended college. In the lower, 72\% graduated from high school and 15\% attended college. This clearly illustrates that high status children are taught to respond favourably to the situations represented by academic challenges and that they are most strongly motivated for


\textsuperscript{80} Fram, Inzetta. "Reading readiness as conditioned by home background" Unpublished M.A. thesis, Iowa State University of Iowa, 1946.

\textsuperscript{81} Warner, Havighurst R.J. and Loeli M.B. Who shall be educated, New York, Harper and Bros., 1944.
academic advancement. In another study comparison of the high school records of the two schools, one predominately lower class and the other predominantly upper middle class showed that no student from the upper class made F during the same period while 44% of the lower class made 'F's. Many more from the lower group failed and were retained in the lower grades. This indicates that there is a way of life with the lower socio-economic classes that does not encourage academic attainment.

Carefully controlled studies of Hollingshead and others (1949) show that students grades are correlated positively with social-class position. Warner and associates (1949) conducted a survey in "Jonesville" in the U.S.A. and established relationship between class position and continuance in, or dropping out of school. All the young people in the classes above the "common man level" were in school; over nine out of ten in the lower middle class; but only one out of ten in the lower-lower class. Thus the class to which a child belongs plays an important role in his educational interests and aspirations.


Abrahamson (1951)\textsuperscript{84} found that students with parents of high status received better grade and held more school offices. The six schools gave a total of eighteen prizes; fourteen went to children of upper middle origin and four to those of lower class origin. Davis (1951)\textsuperscript{85} has demonstrated that children of parents who work with their hands are likely to run into trouble in school works. Campbell (1952)\textsuperscript{86} observed that certain aspect of the home background greatly affected secondary school achievement. Sewel, Haller and Strans (1957)\textsuperscript{87} studied educational and occupational aspirations of more than four thousand Wiscons in high school seniors in all parts of the United States. The study established the general

\begin{itemize}
\item \textsuperscript{86} Campbell, W.J., "The influence of home environment on the Educationist Progress of selected secondary school children." \textit{British Journal of Educational Psychology}, Vol,122, 1952, pp 89-100.
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hypothesis that "levels of educational and vocational aspirations of youth of both sexes are associated with the social status of their families, when the effects of intelligence are controlled." Klausmier (1958)\textsuperscript{88} compared certain physical, behavioural and environmental characteristics of high and low achieving students and observed that two environmental factors were different for the two groups. One was parental occupation and the other was sex ratio in the class. Coster (1959)\textsuperscript{89} studied students from the three income groups and concluded that "high income pupils were more likely than middle income pupils to participate in school and out-of-school activities, holds office in an organisation, get high marks in school, be named to the school honour roll, attend sunday school and church regularly, successfully complete courses in school, and continue education". Youmans (1959)\textsuperscript{90} examined the hypothesis that certain factors in school, home and community


\textsuperscript{89} Coster, John K., "Some characteristics of high school pupils from three income groups" Journal of Educational Psychology, (April, 1959) p-62.

ty influenced the formal educational attainments of rural youth. Data were obtained by interviewing four hundred eighty mothers and 439 youths aged six and seventeen. By means of a socio-economics status scale, the 480 families were divided into three social status groups of approximately equal numbers. He found that one half of the youth in the lowest social status group were attending school; seven tenth of those in the middle status groups currently going to schools; and over eight tenth of the youths of the highest status groups were attending high school. The research revealed that the mother's educational values were influencial in their children's educational attainments, especially in the low status group. Singh (1965) also found scholastic performance to be positively correlated with father's education. Mother's education is also found to play significant role on the academic achievement of her children. Generally, mother is more close to her children. Mothers' having higher educational attainment are more inclined to pay a careful attention towards the education of their children. This may arouse interest and educational aspirations in the children and as a result better scholastic performance can

be gained. Seigel and Duff (1960)\textsuperscript{92} obtained a negative relationship between effective utilization of academic ability on the one hand and a degree of participation in physical, social and heterosexual activities on the other. A groupwise breakdown of the results indicated that within the ability group, over-achievers tended to conform more to social requirements and to participate more actively in religious activities than did the under-achievers. In the male group the highest correlation was obtained between over achievement by low ability students and their participation in political and intellectual activities. Hunt (1961)\textsuperscript{93} tried to explore fourteen characteristics including age, parental education, number of elder brothers and sisters, number of younger brothers and sisters, age and occupational level of parent or guardian etc. But none of these factors showed a significant difference between over and under-achievers. In Frankel's study, (1961)\textsuperscript{94} six factors were found to reveal


differences for the two groups. These are family and home background, socio-economic status, reaction to school, out of the school and leisure time activities and vocational and college planning.

Jyotsna (1962)\textsuperscript{95} studied the relationship between home environment and failure in examination and concluded that the parents of failed students had low income and low standard of education. She further observed that these parents rarely visited schools and in general showed indifference towards their wards' failure in the examination. Lindgren and Guedes (1963)\textsuperscript{96} in a Unesco sponsored investigation of elementary and secondary school children in Sao Paulo, Brazil, showed that social status (as indicated by the educational level of parents) and academic achievement were positively and significantly correlated. However in this study, the social status at the secondary stage did not correlate with academic achievement as highly as it did in the elementary sample. One of the important variables when considering children's academic achievement is that of attendance. Few would disagree with the

\textsuperscript{95} Jyotsna, T.B., "The study of family background of students who are backward in studies at Union High School, Broach." Masters thesis, M.S. University Baroda, 1960.

\textsuperscript{96} Lindgren Henry Clay, & Guedes, Hilda de Amilda. Social Status, intelligence and educational achievement. Sao Paulo, Regional Centre for Educational Research, 1962.
hypothesis that high achievers are more highly motivated towards school than low achievers.

Wylie, (1963) studied "Children's estimate of their school work ability, as function of face, sex, and socio-economic level." For this study 823 Junior high school students were asked to make three kinds of estimates of their ability to do school work. Each child was asked to estimate (i) Whether he was in the top or bottom half of his class. (ii) whether he was capable of college work and (iii) whether he desired to go to college. These data were correlated with the previously administered mental ability tests. One of the important conclusions was that children of lower socio-economic levels made more modest estimates of their abilities than children of higher socio-economic levels.

In a stratified society as that in India, a researcher is apt to start with a hypothesis that SES contributes to academic performance. In one of the studies Mathur (1963) has examined the relationship between SES factor


and academic achievement keeping the effect of intelligence constant. He has found that nearly ninety six percent of students who discontinue education attribute the reason to poor economic condition of the family. On the basis of parent's education, occupation, and family income, students belonging to higher qualitative group show significantly higher achievement. Burckman (1966)\textsuperscript{99} also found significant and positive relationship between achievement and both social class membership and social stream assignment. The middle class is characterised more strongly by activist and future oriented values that are conceived in terms of individual differences in ability. Achievement themes centre more around immediate material rewards in the lower social stratum. (Hoffman, Mitos and Protz, 1958)\textsuperscript{100}


\textsuperscript{100} Hoffman, M.L., Mitos, S.B., and Protz, R.E. "Achievement Striving social class and Test Anxiety" \textit{Journal of abnormal and social psychology}. 1958, pp. 56, 401-403.
Desai (1970)\textsuperscript{101} studied achievement of the pupils and socio-economic status. The findings reveal that pupils of high and middle socio-economic status score higher in achievement (5.96, 5.91) than the low, (5.82). With regard to educational level of the parents the children of the graduate parents score higher on achievement (10.03) than the children of the parents who had secondary (7.14) and Primary (5.13) education. The children of illiterate parents score the lowest (3.13) achievement score. The difference between these groups is found significant at .01 level. About the occupational level pupils coming from business family and 'A' grade service group score higher (7.20, 9.15) than the pupils whose fathers are farmers and unskilled workers (6.66, 5.72). The difference between these groups was found to be significant at .05 and .01 level.

The pupils of middle income group score higher in achievement (4.94) than the low and the high income group (3.71, 2.00) though the difference is not significant.

Pathak (1973)\textsuperscript{102} studied the achievement according to school status. The findings reveal that the highest mean

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Achievement score (3.41) has been obtained by the pupils of schools with high SES, and the lowest mean Achievement score has been obtained by the pupils of low SES status.

Parikh, (1975)\(^{103}\) studied the relationship of achievement and SES in Bombay children. The findings reveal that the parents having high educational level (4.89) and high income level (3.22) whose children have more Achievement score than the children of the parents having low educational (4.22) and low income level. Phutela (1975)\(^{104}\) studied the relationship between SES and Achievement. The findings reveal that Achievement has been found positively but not significantly related to the total score on the socio-economic status scale.

In a study by Gokulnathan and Mehta (1972)\(^{105}\) boys of fathers belonging to professional occupation showed the highest Achievement followed by those from semi-professional occupations and then by those from skilled, the semi-skilled and the unemployed showing the least.

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Rao (1975) studied socio-economic status, as one of the variable affecting achievement. The findings reveal that there is significant difference in the achievement levels between the subjects whose parents were illiterate (3.19) and subjects whose parents had high school education (5.24), College education (6.67) and educated at University level (5.91). The results indicate that the better the education of parents, the better is achievement level. The development of achievement in the children and young people is partly due to the educational level of the head of the family, under whose care, guidance and discipline they are brought up. Choksi (1973) found that the high SES pupils have higher achievement than the middle and low SES pupils. The difference is significant at .05 level between high and low SES on their achievement score.

In another study Bokil (1956) attempted to ascertain comparative examination efficiency of boys and girls of


different age groups at the S.S.C. Examination held from October, 1952 through March, 1956 by the Maharashtra State Board of Secondary Education. Some of the major findings were (1) the percentage of girls gaining a certificate was higher than that of the boys in each of the eight examinations considered; (2) the percentages of successful girls of 19 and 20 years were higher than those for the boys. Further, the percentages were nearly equal for boys and girls of age 17 and 18 years while the boys of 16 showed better performance than the girls of the same age; (3) for March examination, the percentages of the successful girls were higher than those of the boys of the age 16, 19 and 20 years while the reverse seemed to be the case for the remaining two age groups.

The analytical study conducted by Raja (1981)\textsuperscript{109} of the results of the High School Leaving Certificate Examination in Mizoram reveal that variables like type of school and sex did not contribute significantly towards determining the level of achievement of the candidates in the Board examination in Mizoram while the variable like location of the school was found to have a marked effect on the achievement of the candidate in the Board Examination. The urban private high schools were superior to rural private high schools.

Lalduhsanga (1983) studied the personality factors of low, normal and high achievers in secondary school science. Science Achievement Test (SAT) was constructed to evaluate the achievement of pupils on secondary school science as there was no standardized test available in the union territory of Mizoram. The test was standardized on a sample of 500 students selected from various schools of Aizawl town. The study revealed that out of the total 500 high school students 81 were low achievers, 324 normal achievers and 95 high achievers, segregated on the basis of the test scores. The major findings were:

(i) The high achievers tend to be more outgoing, intelligent, emotionally stable, phlegmatic, assertive, conscientious, tough minded and self sufficient than the low achievers.

(ii) The high achievers tend to be more outgoing, intelligent, emotionally stable phlegmatic and group dependent than the normal achievers.

(iii) The normal achievers tend to be more outgoing, intelligent, emotionally stable, assertive, conscientious, toughminded, self sufficient and tensed than the low achievers.

Science achievement among the secondary students in Aizawl in relation to intelligence and socio-economic status was analysed by Sudhir and Muralidharan Pillai (1987)\textsuperscript{111} The sample consisted of 311 students (146 boys and 165 girls) selected at random from eight high schools of Aizawl town. The study recognised significant difference in the science achievement of students with low and high intelligence. Comparison of science achievement scores of students belonging to low and high socio-economic status revealed that the groups differed significantly, the high SES group having a higher mean score than the low SES group. In yet another study, Sudhir and Darchhingpuii (1987)\textsuperscript{112} examined the achievement in science and attitudes toward science of college students. The study recognised sex and birth order as significant correlates of achievement in science.

The review reveals that the researches are inconclusive in their results relating to factors affecting the achievement in science. Also, it has been noticed that very few studies have been conducted to investigate the interaction effects of variables influencing the achievement. It is further observed that though there are a number of researches reporting the achievement of students in general, those which focussed on the achievement in science specially among the schedule caste/schedule tribes are very few.


Section 11: Review of Research Related to Attitude towards Science

Attitude towards science is a potential area for research. Recent reviews of research on science attitudes reflect the increasing interest in this area. Aiken and Aiken (1969)\textsuperscript{113} reviewed 54 studies in the United States, Gardner (1975)\textsuperscript{114} referred to more than 200 British, Australian and United States Studies, while Ormerod and Duckworth (1975)\textsuperscript{115} included nearly 500 studies all attributed to science attitudes. Sufficient studies now exist to enable researchers to conduct quantitative syntheses of research results. These integrative studies, called meta-analysis, have been done for science attitude. Haladyna and Shaughnessy (1982)\textsuperscript{116} also provide additional understanding of the accomplishments and problems in this area.

Considerable attention has been directed towards the identification of variables which may be related to attitudes towards science. The studies have focussed on two classes

\begin{itemize}
  \item Aiken, L.R., Aiken, D.R., Recent research on attitudes concerning science. \textit{Science education}, 1982. 53: 295-305.
\end{itemize}
of variables: those under the direct influence of the schooling process such as, teaching behaviour, and those located outside the influence of the institution of schooling, such as, gender of the students. The former are called endogenous or internal variables while the latter are classified as exogenous or external variables. Knowledge of the role of both classes of variables helps people to understand the nature of science attitudes, but it is the endogenous variables that offer most potential for improving attitudes through new curricula, better teaching methods and practical science experience.

Inspite of the apparent logical connection between science attitudes and science achievement, the research results suggest a very modest positive relationship. The median correlation between achievement and science attitude in the IEA studies was only +0.20, Comber and Keeves (1973)\textsuperscript{117}. Similarly, a meta-analysis of 49 studies conducted by Haladyna and Shaughnessy (1982)\textsuperscript{118} found a median correlation of +0.15 between scores on various achievement and attitude measure. The strength


\textsuperscript{118}. Haladyna T., and Shaughnessy J., Attitudes toward science: A quantitative synthesis. Science Education, 1982
of this relationship tends to increase somewhat in the higher grades (probably due to selection factors) but seldom goes above +0.40. In some studies a negative relationship between achievement and attitude has been found. Further work is needed to understand these surprising results. A consistent relationship has been noted between gender and attitude toward science. Males take more science courses and show more interest, especially in the physical sciences. In fact, sex is the most consistent variable related to science attitudes even though the variance accounted for seldom exceeds 10 percent. There has been a surge of interest in this area as investigators seek to understand the social forces and cognitive factors that may account for these differences (Gardner 1975).119

Several researchers have pointed out that interest in science develops early in life (between the age of 8 and 13) and call for increased attention to the science experiences during the latent pre-adolescent age of 8 to 13. Children usually express positive attitudes toward science during this period but this favourable attitude diminishes with time. It has been found that seventy per cent of the 9 year old children in the United States have positive attitudes towards their science experiences in school but this number drops to

half among the 13 to 17 years old. Something occurs to turn children away from science. Perhaps it is the inherent difficulty of science, the way in which it is taught, the curriculum, or merely part of a maturing process which detracts children of these factors which creates this situation.

It has been further noticed that the choice of science courses and careers appear to have been related to certain personality traits which in turn, foster positive science attitudes. Gardner (1975) observed that the students who offer science course are serious, achievement oriented, realistic, independent and conventional. Making science appealing for other personality types still presents a formidable challenge to science educators. Interest in doing laboratory work is likely to be positively correlated with attitudes towards biology or towards other science careers. People who find satisfaction with one characteristic of the scientific enterprise are likely to find it with another. While it is possible that part of this relationship is due to similarities in items and item-formats, it seems reasonable to conclude that attitudes toward science comprise both general and specific attributes.

Home backgrounds form another group of endogenous variables which has been correlated with student attitudes. Geographic location, parents' education, father's occupation, and science materials available at home are included as potential 120. Ibid.
research variables related to science attitudes. Geographic location—urban, suburban, or rural background was found related with formation of attitudes towards science. In general, suburban students sport more positive attitudes than do their urban or rural counterparts. Comber and Keeves (1973) socio-economic status and science opportunities in the home are correlated moderately with science interest and science career choice. The results are in the expected direction with upper and middle class families providing more science opportunities and encouragement and their children responding accordingly, Gardner (1975). Although many variables have been found to be related to attitudes, the generally 'weak' effect of these variables and their interaction, as yet, does not provide a clear picture of their individual and collective influence. Parental Education, home opportunities, choice of College are some of the variables studied, but the direct and independent influence of the home and other background factors are difficult to assess as they interact with each other.

Socio-economic background of the students were related with their attitudes toward school and teachers and their academic achievement in a number of studies.

Neale and Proshak (1967)\textsuperscript{123} and Glick (1970)\textsuperscript{124} reported that children in schools located in the upper socio-economic status areas held more positive attitudes toward teachers and schools than children in the schools located in the lower socio-economic areas. Yee (1966, 1968)\textsuperscript{125,126} suggested that since lower class pupils often have fewer potent sources of adult warmth and support at home, they are influenced more by the teachers in school than students of middle-class background. Teachers' less positive attitudes toward students in lower class schools tend to make pupils' attitudes toward teachers become less favourable. In a study on the influence of family income on

\begin{enumerate}
\item Neale, D.C., and Proshak, J.M., School related attitudes of culturally disadvantaged elementary school children. \textit{Journal of Educational Psychology}, 58, 1967, 238-244.
\item Glick, O., Sixth graders' attitudes toward school and interpersonal conditions in the classroom. \textit{Journal of Experimental Education}, 38, 1970, 17-22.
\item Yee, A.H., Factors involved in determining the relationship between teachers' and pupils' attitudes. Austin, Texas: University of Texas. 1966.
\end{enumerate}
attitudes, Coster (1958) observed no significant differences between three income groups in students' attitudes toward school, school subjects including science and the value of education.

Significant sex differences in attitudes towards school and toward teachers have been reported in favour of girls. Leeds and Cook (1947) found that female high school students held more favourable attitude towards teachers than the male students. Gregersen and Travers (1968) observed that boys rejected their teachers more than girls did and there is an increase in rejection of teachers on the part of girls with increasing age while there is no such increase in rejection by boys. Jackson (1968) summarized the results of a study in which teachers were asked to classify boys and girls into 'satisfied' and 'dissatisfied' groups. The teachers were able to classify satisfied girls and dissatisfied boys with greater accuracy than they were able to classify dissatisfied girls and satisfied boys.


Results of studies on the relationship between students' age and their attitudes agree that school-related attitudes tend to become less favourable with increase in age or school experience (Demos, 1960; Dunn, 1968). After surveying 8,156 high school boys and girls, Coleman (1959) concluded that adolescents were negatively oriented to scholastic matters irrespective of the wider differences in parental background, type of school and type of community.

Learner's own characteristics and background factors such as sex, age, socio-economic status, school achievement and personality characteristics are some of the influence which impinge upon students' school related attitudes towards science. The relationship between students' attitudes toward science and such background characteristics as sex, age, socio-economic status and personality has been examined in a number of studies. Social class differences have been assumed to operate in educational attitudes because socio-economic status symbolizes a variety of values, attitudes and motivation Lavin (1965).


Astin reports the findings of a study done by Slee (1975)\textsuperscript{135} in the Seventy Fourth Year Book of N.S.S.E. which reveals that boys' high school subjects preference are based on subject content. On the contrary girls' attitudes appears to be strongly influenced by their perceived future feminine roles. The findings quoted in the above studies give one room to believe that many of the sex differences in achievement are basically evolved from the differences in attitudes, interest and other personality traits. This trend has been further strengthened in a study of the organisation of attitude by Diggory (1958)\textsuperscript{136} which presented evidence of differential factor pattern of attitude. Barrilleux (1961)\textsuperscript{137} also discovered that it was certain combinations of certain interest and aptitude scores which made a disproportionately large number of outstanding science students. He, in fact, ranked the individual interest on Kuder-Richardson Profile and tabulated a number of science students at each interest rank with a corresponding aptitude level mean as a criterion for outstanding preference in science.


The proportion of high achieving students were exceptionally large (88%) among those in the above average group in IQ classification. Recent research findings have revealed the existence of sex difference in attitude towards science. In a number of investigations it was reliably found that boys and girls differed significantly in their attitude, interest pattern and values. Most of the studies in this area were conducted on high school and college students. Following is a brief survey of the studies conducted in this area. Lewis (1969)\textsuperscript{138} studied the attitude towards science of the 5th grade boys and girls through Projective Techniques. The study revealed insignificant attitudinal difference among boys and girls. It was further noticed that student from upper socio-economic status have more positive attitude towards science than those from middle and lower socio-economic status. Neale, Noel and Tismer (1970)\textsuperscript{139} explored the attitude of students towards school subjects in a group of 6 graders. Correlations were obtained between ratings of subject on the Semantic Differential scores and corresponding sub-test scores SRA Achievement series.

\textsuperscript{138} Lewis, R.Aikan, Jr.and Dorothy R.Aikan "Recent research on attitudes concerning science." \textit{Science Education}, Vol.53, 4, October 1969

Significant positive correlation (at.01) level were observed for boys in Science, Social studies and Arithmetic. But in the case of girls the achievement and attitude scores were only significantly correlated for reading.

Edwards and Wilson (1958)\(^{140}\) conducted a study among boys and girls having similar interest in science. The finding indicated sex differences in the basic patterns of interest and attitude towards science. Boys were found to be motivated by intrinsic interest in understanding and solving problems, whereas girls worked to please their teacher and had more favourable attitudes.

Mayer (1961)\(^{141}\) studied sex difference on science interest and science attitude among the 11 to 15 year old students of England. Among those students who did not like science, female students were much more than male students in number while 16% of those who disliked science were boys the rest 84% of girls expressed their negative attitude towards science.


A swing away trend from science was noticed in Britain since 1960's by the Dainton Committee for scientific policy. Duckworth and Entwistle (1974) detected sex difference in two main aspects in science. Even the potential scientists reported physics and chemistry difficult even though they were quite interesting.


Jackson, (1968) and Aiken (1970) have reviewed studies indicating that if certain attitudes are held, and re-inforced consistently in the same direction, they lead to a particular self concept on the part of the pupil which influences his expectation of future achievement. The re-inforcing condition


is the type of regard he begets for his achievement from his teacher, parents and peers.

Studies in this area have generally followed the form of ascertaining students' school-related attitudes and relating such attitudinal measures to subsequent academic achievement. The rationale for these studies appears to be that since attitudes lend themselves to modification, positive findings will provide the basis for devising treatments in order to bring about change in academic achievement. Such a change will not only improve future attitudinal dispositions of students toward school and school learning but will also contribute to personal and social adjustment. Holtzman and Brown, (1968)\textsuperscript{146}, Khan and Roberts (1971)\textsuperscript{147}

Attitudinal studies in science have been carried out by researchers to examine the influence of those variables under the potential control of the schools. The studies attempted to discover the means by which attitudes toward science could be enhanced. Some significant relationships have been discovered, but much remains to be done in this


area in order to establish the relationship of these exogenous variables on student attitude towards science. Low, but positive relationships have been obtained between teaching behaviour, the science curriculum, and student attitudes. Studies on the students exposed to film, laboratory experiment, etc, have often shown positive results. Exposure to film, laboratory experiment, etc, enhances the science attitudes of the experimental group when compared to control groups. Unfortunately the methodological weaknesses, and unreliable outcome measures of many of the studies, make it hazardous to generalize the results. From the studies Ormerod and Duckworth (1975)\textsuperscript{148} and Welch, (1979)\textsuperscript{149} it is clear to conclude that curriculum effects may account for 5 to 10 percent of student variance in science attitude (and achievement). The teacher is thought to play an important role in the development of student attitudes. Although much more work seems to have been done on student achievement than on student attitude, teacher attributes such as enthusiasm, respect for students, and personality traits have been shown to influence student attitudes in science as well as in other subjects. However, the strength and direction of these rela-

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tionships is quite varied. Some have found very little correlation, while others have found moderate to strong relationships. It is difficult to sort out the meaning of the discrepant studies and considerably more work is needed in this area.

Recent researchers have investigated the influence of student peers and the results appear to provide some explanation of attitude development towards science. The social learning environment, peer pressure and nature of student interactions seem to be related to the attitudes towards science and their interest in science classes. The exact nature of these relationships is still not clear but the classroom experiences of the student and his interaction with the classmates, and more importantly with the teacher, are powerful influences on the attitude formation of the students.

The role of the teacher in shaping the classroom climate and its influence on fostering positive attitudes have also to be analysed. Differences in classroom climate such as variation in subjects, teachers belonging to different sex, age, experience, qualification etc. have also to be studied as to infer how these factors influence the development of student attitude towards science. This remains a potential area of research for exploration especially with respect to the formation of student attitude towards science.
A study was conducted by Darchhingpuii (1982) on attitudes towards science among college students in Mizoram. Students were grouped into two on the basis of the courses taken i.e. arts students and science students of the colleges of Mizoram. The major findings of the study among arts students were as follows:

1. Science attitude scores of male and female students showed a higher degree of favourable attitude towards science than female students (.01 level)

2. Analysis of science attitudes taking sex and locale, however, revealed that sex difference was evident only among the urban group, the score being in favour of the boys (p < .001). Locale difference was noticed among the female college students (p < .05). The score was in favour of rural female students.

3. Comparison of science attitude of college students taking sex and age revealed the existence of sex difference in the high age group (p < .001), girls, having lesser favourable attitude towards science.

4. Parental education was not found related to the science attitude of the students. Male and female students showed significant difference in the attitude scores only in the case of low parental education group (.01 level). Boys scored higher than girls.

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5. Science interest was found positively related to science attitude. But when the sex was controlled, only female students with high and low interest in science differentiated in their SA (p < .001). Sex difference was found among the low interest group as male and female students showed statistically significant difference in attitude (.001 level).

6. Science attitude scores of college students by birth-order revealed that first-born and middle-born showed statistically significant difference among the male (p < .05) and the first-born and last-born in the case of females (p < .05). Statistically significant sex difference in science attitude was found only among the middle-born.

Science attitudes of the science students showed the following trends:

1. Sex difference was evident in the science attitude of the science students. The male students having higher mean score than the female science students, showed statistically significant difference (p < .001) in their attitude towards science. Male students showing higher degree of favourable attitude.
2. Locale difference was noticed in the science attitude of science students only among the male students (p < .05). However, the sex difference in science attitude was very prominent in both the locale groups (p < .001).

3. Female science students, grouped by age showed statistically significant difference in science attitude (p < .001). Sex difference in science attitude scores was present only in high age group.

4. Parental education was not found to have influence on the attitude of science students towards science. However, male and female students showed statistically significant difference in science attitude in low parental education and high parental education groups, the significant level being .05 and .001 respectively.

5. Birth-order was found related with science attitude of the science students only in the cases of middle and last-born (p < .01) and first and last-born (p < .001) female groups showing statistically significant difference. Sex differences in science attitude were noticed only in the first-born and middle-born group (p < .001).
6. When grouped on the basis of science interest, knowledge about scientists and participation in science club etc., the female students showed significant difference in their science attitude.
Section III : Review of research on problem solving ability.

Problem-solving is a process of overcoming difficulties that appear to interfere with the attainment of a goal. It is a procedure of making adjustments inspite of interferences. It is largely a process of satisfying wants. Wants are sometimes called 'motives' and the satisfaction of motives is called the goal. The satisfaction of wants may be hindered or interfered with by the difficulties of various types. The inter-relationship of the three factors—the motive, the goal, and the hindrance constitutes the pattern of organic adjustment to environment. Both lower animals and human animals live or die depending on their effectiveness in environmental adjustment. If wants are strong, perhaps even necessary for life, and if hindrances are great, then states of tension are created that act as internal drives to activity. When equilibrium has been disturbed a problem exists, and this provides a need for thinking and reasoning to overcome the problem.

Problem-solving is obviously not confined to arithmetical or quantitative situations but may arise whenever the individual is faced by a difficulty or a task which he understands but to which he has no immediate answer in behaviour. Problem-solving implies a question to which the individual needs an answer, and the answer is not easily
or readily available. There is a need that is left unsatisfied or a goal that is not attained, and the individual has to employ all his physical and mental resources, knowledge, skills and attitudes to make an integrated approach to the situation.

Reasoning is the word used to describe the mental recognition of cause-and-effect relationships. It may be the prediction of an event from an observed cause, or the inference of a cause from an observed event. Accuracy is the criterion of good reasoning. Problem-solving is the framework or pattern within which creative thinking and reasoning take place. It is an attempt to seek freedom from tension created by obstruction in the way of want-satisfactions. The satisfaction of wants and the attainment of goals is often hindered and human beings have always struggled to remove such hindrances. The entire history of mankind and the magnificent edifice of science and culture which man has gradually built in the course of centuries are a testimony to the great ability and efforts of our ancestors in solving the problems of life. In a sense, successful and efficient living means successful and effective problem-solving.

One of the goals of education is the learning of facts. Students are passed or failed on the basis of the number of facts they have learned and are able to give
back on examinations. This requires the students to develop a degree of proficiency in the use of facts. For example, a teacher of English may require his students to learn certain facts about grammar and also to use these facts in writing themes and reports. A chemistry teacher teaches his students the facts of chemical reaction and may also require that his students solve certain chemistry-related problems which require application of knowledge of chemistry. Facts learned in isolation from their application in real life situation are likely to be mere verbalizations that can be written on an examination but not used in solving problems. Useful knowledge should be learned in the application of knowledge to solve problems. In solving problems arising from hindrances, a cardinal principle is that what is learned is determined by what is done in the process of learning. Facts learned through the process of problem solving are retained as dynamic knowledge ready for application.

Although there have been many approaches to the study of problem-solving, the current view is that it depends on a host of cognitive functions including learning, memory, and intelligence. It appears that as the cognitive abilities decline, so does problem-solving ability. Although verbal intelligence may not be closely related to problem-
solving ability, (Stork, Looft, and Hooper, 1972)\textsuperscript{151} adults with high IQs usually maintain the ability until late years in life (Arenberg, 1974)\textsuperscript{152} Adults with low IQs, however, tend to show decline in problem-solving early in life.

One particular type of problem that adults find increasingly difficult is that involving abstraction, Arenberg (1968)\textsuperscript{153} reported that when the same problem was presented in both abstract and concrete formats, older adults performed much more successfully with the concrete format. Walford, (1958)\textsuperscript{154} and Cijfer, (1966)\textsuperscript{155} however, argue that education is an important factor and better educated adults are more capable of thinking in abstract terms even in old age, than their less educated counterparts. Walford (1958) found that


\textsuperscript{155} Cijfer, E., An experiment on some differences in logical thinking between Dutch medical people, under and over the age of thirty-five. \textit{Acta Psychological}, 1966, 25, 159-171.
older adults make more enquiries about a problem, but they have more difficulty using this information when it is needed later. Jerome (1962)\(^{156}\) added that many older adults tend to ask the same questions over and over again when given a problem-solving task. Such haphazard questioning lends many to become lost in a boggle of irrelevant information.

Researchers of late have shifted their concentration to find the basis of problem solving ability and factors related with the problem solving ability. Science as the basis of problem solving ability has been projected in a number of studies. The studies are reviewed in this section.

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Science as the basis of Problem-Solving Ability

Cognitive science illustrates the theoretical insights gained when psychologists, computer scientists, philosopher, anthropologists, linguists, and teachers share together in their study of how the learner comprehends, solves problems and creates new ideas. Glasser (1978)\textsuperscript{157} emphasizes the unique direction of the co-operation team as being the renewed examination of the "internal world of complex human behaviour" rather than the external behaviour of the learner. The focus is shifted from the question "does the student know?" to "how does the student know?". In science education, research is filled with many examples of documentation of what students know correlated with specific student, teacher, and curriculum variable (Butts, 1981)\textsuperscript{158}. Teaching students


\textsuperscript{158} Butts, D. A. Summary of research in science education, 1979, Science Education, 1981, 65 (4).
to acquire that knowledge and teaching them how to apply it in problem contexts are significant goals of science education (Bybes, 1976). However, systematic study of how to translate goals of problem-solving into experience has remained largely unexplored until the recent research emphasis was shifted to information-processing theory.

Norton and Butts (1973) noted that the way students function in problem situations is related to their knowledge of that context. According to Neisser (1976) and cognitive science has resulted in a renewed focus on the student's perception as the initial and most significant concept in understanding complex learning.


Johnson et al. (1980) observed that in perceiving a task, a significant concern is how students search for an idea that will work in helping them understand the problem. This may be a search for a formula or simply a trial and error attempt deriving at possible solutions. Or students may engage in more systematic prototype matching in which they compare reality to concepts to see if they fit. In perception of the task, Winnie and Mark (1977) and Andersen and Smith (1981) noted that the students extract information and meaning from the environment.

Once a problem is perceived, the mind must be engaged to construct a response. Larkin (1980) describes this as what learners do after they have been given a problem context and identified what about that context is the unknown.


The uninterested students with limited knowledge of the problem context will probably engage ideas of similar experience, simulate inference, and resort to non-empirical reasoning about causality. In contrast, more skilled students will tend to focus on known concept or principles, construct inferences and resort to reasoning closely tied to their knowledge base.

Studies on sex difference in problem solving ability are very few and have been taken up only recently. These studies were mainly conducted among school children and college students. The results of these studies show the superiority of male over female in problem-solving ability (Bedell, 1934167; Billings, 1934168; Sweeney, 1957169; Terman and Tyler, 1954170).


Mc Nemar, 1955; Staats, 1957; Priest and Hunsaker, 1969

Maier and Burke, 1967; Maier and Casselman, 1970; Roll, 1970; Constantinople, 1974; Raaheim and Kaufman, 1974; Felen, 1975; Maxwell, 1975;


Contrary to these findings, some of the studies, however, failed to reveal any significant sex difference in problem solving ability. (Raaheim, 1963; Hoffman and Maier, 1961; Mendelsohn, Griswold and Anderson, 1966; Davis, 1966; Strzyzewsky, 1973; Singer, 1975; Westmoreland, 1975; Kumar, 1980; and Kumar and Kapila, 1981).

A few studies have shown the superiority of females over males. (Kumar, 1974; Miles, 1976; Hayes, 1978; Singh, 1979; 193) Studies have also been conducted to reason out the poorer performance of females. Allern (1974) has tried to analyse the problem of sex differences in terms of genetic and environmental factors which might determine it. The exponents of genetic factors are Kumar, (1974) Raaheim and Kaufman, (1974); and Eysenck and Wilson, (1976); and that


of environmental factors are Milton, (1957)\textsuperscript{198} Carey, (1958)\textsuperscript{199} French and Thomas(1958)\textsuperscript{200} Hoffman and Maier, (1961)\textsuperscript{201} and Nance and Sinnott, (1964)\textsuperscript{202} Maier and Burke,(1967)\textsuperscript{203} Colgrove, (1968)\textsuperscript{204} Priestd and Hunsaker (1969)\textsuperscript{205} Loupe(1970)\textsuperscript{206}


Maier and Casselman, (1970) Schneider and Delaney, (1972)

208. Schneider, F.W. and Delaney, J.G. Effect of Individual 
Achievement Motivation on Group Problem Solving Efficien­ 
217. Mills, C.J. Sex Role Related Personality Correlates of Intellectual Ability in Adolescents, Dissertation Ab­ 
Sex difference on genetic basis relates to the pattern of abilities which have been biologically determined. In elementary abilities like sensitivity to touch, pain and auditory discrimination, females are superior to males while males are superior in visual discrimination (Tyler, 1965)\textsuperscript{220}. Where complex abilities are concerned, males are superior to females in spatial ability, Witkin et al.,(1962)\textsuperscript{221} Allern,(1974)\textsuperscript{222} and McWay,(1976)\textsuperscript{223} and women in verbal ability, Maccoby and Jacklin, (1974)\textsuperscript{224} Females, right from birth until death, have been found to excel in expressing themselves in all aspects.


of language usage—writing, spelling, grammar and sentence construction, [Nance and Sinnott, (1964)]^{225} Macy, (1973)\(^{226}\) and Hayes (1978). In verbal reasoning and vocabulary, no significant sex differences have been found (Dunsden and Fraser, (1957)\(^{228}\); Clark, (1959)\(^{229}\); Raaheim and Kaufmann (1963)\(^{230}\).

In mathematical ability, males are found to be superior to females. Though males and females do not differ much on a mechanical type of arithmetic problems, male superiority over females has been revealed in problems involving more

complex mathematical reasoning and manipulation of abstract numerical entities (Burke, 1965; Priestd and Hunsaker, 1969; Maier and Casselman, 1970; Hayes, 1978) Men excel women at mechanical tasks (Deaux and Emsueller, 1974; Falen, 1975; while women are superior in tasks which involve manual dexterity, i.e. light, deft, swift movements of the hands. (Tyler, 1965) Eysenck and Wilson (1956) have

stated the genetic bases of these abilities. "With regard to the primary asymmetry between the sexes, visual, spatial versus linguistic skills, it is interesting to note that this may be related to a similar cerebral asymmetry. The right hemisphere is more concerned with perceptual, motor, spatial and quite generally, non-linguistic skills; the left hemisphere on the other hand, is concerned almost entirely with language. Now there is some evidence that in young children, myelination and the growth of neuronal dendrites in various areas is more advanced in the left hemisphere in girls, and in the right hemisphere in boys, possibly, this may be regarded as evidence for the biological determination of such differences in ability as have been observed."

Researchers have also demonstrated the vital role played by environmental factors on sex differences in problem solving. Sweeney (1953) only has revealed the presence of sex differences after equating the general intelligence, verbal ability, mathematical ability, relevant knowledge and various background factor. Society and culture are believed to play a significant role on the performance of both males and females in problem solving. Arbuthnot (1975) has stressed the need for a systematic and ambitious exploration of the influence

of varied types of socialization practices on the development of cognitive skills and on the development of personality. Some of the studies have revealed that attitude towards problem solving is the main factor which bring about sex differences in this area and that this is susceptible to training and practices. (Nance and Sinnott, 1964; Loupe, 1970; Deaux and Emsueller, 1975;) It has also been found that women in group sessions on being motivated were found to change their attitudes towards problem solving in a positive manner. (Carey, 1958; French and Thomas, 1959; Hoffman and Maier, 1963; Schneider and Delaney 1972; Miles, 1976; Kumar, 1980)

Research finding had also revealed that men and women use same set of problem solving strategies and men excelled women because of their better level of efficiency in using these methods. Maier and Casselman (1970)\textsuperscript{250} Allern, (1974)\textsuperscript{251} and Felen (1975)\textsuperscript{252} have revealed so significant effect on female problem solving by provision of a single hint or modified version of the problem. At the same time Burke (1965)\textsuperscript{253} and Maier and Casselman (1970)\textsuperscript{254} have found that providing a single hint or modified version of the problem did not have a consistent significant effect on female problem solving. On the other hand Colgrove (1968)\textsuperscript{255} Priests and Hunsaker (1969)\textsuperscript{256} Kumar (1974, 1980)\textsuperscript{257,258} and Singer (1975)\textsuperscript{259} found improvement in female performance after receiving experimental instructions. Milton (1957)\textsuperscript{270} found that when the form of the problem was changed from masculine

\begin{itemize}
\item \textsuperscript{252} Felen, B.K., \textit{Op.Cit.}, 1975.
\item \textsuperscript{253} Burke, R.J., \textit{Op.Cit.}, 1965.
\item \textsuperscript{255} Colgrove, M.A., \textit{Op. Cit.}, 1968.
\item \textsuperscript{257} Kumar, D., \textit{Op.Cit.}, 1974.
\item \textsuperscript{258} Kumar, D., \textit{Op.Cit.}, 1980.
\item \textsuperscript{259} Singer, J.E., \textit{Op.Cit.}, 1975.
\end{itemize}
to feminine orientation, sex differences were reduced. The influence of society's concepts about sex-roles on the performance of the female has been explicitly stated by Tyler (1965).261 In any society, it is women who must bear and nourish children. Because of society's concepts about sex-roles, social influences on behaviour must be thought of not only as direct constraints such as discriminatory legislation and unequal educational opportunities, but also as influences operating from within each individual—internalized attitudes that determine what he or she wishes and seeks. Thus, the sociological and cultural emphasis on sex-roles led many investigators to show that sex-role identification does affect the performance of the females. French (1956)262 had also revealed that under certain conditions female performance was lowered.

Milton (1957, 1959)263,264 hypothesized that solving problems is associated with masculine role in our culture. He administered a test designed to measure a person's degree of identification with the masculine role with the cultural male sex-role. Males as a group scored more but there

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were individual differences in males and females. This supports his hypothesis that problem solving ability might be directly related with masculine role-identification. Arbuthnot (1975)\textsuperscript{265} Miles (1976),\textsuperscript{266} and Hulfish (1977)\textsuperscript{267} have shown that masculinity and femininity do affect the performance of the subjects.

Milton (1957)\textsuperscript{268} showed that scores on masculinity-femininity inventory were significantly related to success in solving problems. Girls with higher feminine scores were poor problem solvers than girls with more masculine score. The same is true for boys. Studies by Yonge (1961)\textsuperscript{269} Behrens (1974)\textsuperscript{270} and Suter and Dominko (1975)\textsuperscript{271} have also revealed that girls with high masculine force are better problem solvers than those boys and girls with high feminine scores.

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Studies have also revealed sex difference in problem-solving, numerical reasoning as well as in the solution of reasoning problems in other areas. Working with college students, Sweeney (1953)\textsuperscript{272} found males significantly superior on problems that called for 'restructuring', that is, discarding the first approach and reorganising facts in new ways. This sex difference remained even when groups were equated for general intelligence, verbal and mathematical aptitude relevant knowledge, and a number of background factors.

In a study on high school seniors, Kostic (1954)\textsuperscript{273} found that boys excelled in their ability to transfer, or apply skill and knowledge to new situations. Again, relevant factors such as intelligence, previous knowledge, reading ability, practice effect, and certain personality traits were controlled. Male superiority in transfer of training has


also been confirmed by Hilgard et al (1984)\textsuperscript{274} on study of high schools and college students. These investigations provide promising leads for further research in sex differences specially when considered in conjunction with recent work on the nature of creative and reasoning process. The extent to which these sex differences may result from problem-solving attitudes that may be amenable to training should also be explored.

On numerical tests, the largest differences again favour boys. Such a male advantage fails to appear, however, until the children are well into the elementary school period. Gesell's observation (1940)\textsuperscript{275} on pre-school children shows either negligible sex differences or a slight superiority of girls in the early development of numerical concepts. Terman (1954)\textsuperscript{276} in his surveys on kindergarten and first-grade children yielded no significant sex difference in arithmetic abilities. Among Elementary school children as well as elder subjects Terman (1954)\textsuperscript{277} again found no significant sex difference or, more often, a difference in favour of girls on computation tests.

\begin{itemize}
\item \textsuperscript{274} Hilgard, E.R., Edgren, R.D., and Irvine, R.P., \textit{Errors in transfer following learning with understanding: further studies with Katona's card-trick experiments}, 1984.
\item \textsuperscript{275} Gesell, A., et al. \textit{The first five years of life}, N.Y.: Harper, 1940.
\item \textsuperscript{276} Terman, Op.Cit., 1954.
\item \textsuperscript{277} Terman, 1954 \textit{Ibid}.
\end{itemize}
However, on arithmetic problems and other numerical reasoning tests, males excelled consistently over the females. McNemar, (1942) noticed boys excelling significantly on the tests of arithmetic reasoning, ingenuity and induction on Stanford Binet Scales. On most group tests of intelligence at the elementary, high school, and college levels boys excelled on arithmetic reasoning tests and number series completion. In the case of multiple factor batteries, girls tend to surpass boys on tests of the Number Factor(N) which measured speed and accuracy. Havighurst (1947) Benett, (1952) and Wesman, (1949) found boys to score higher on numerical reasoning tests.

Guetzkov (1951) found men to be superior to women in set-breaking capacity, but not susceptibility to set-breaking.


Tyler (1965)\textsuperscript{283} reports some evidence to show that the difference is primarily a matter of attitude toward problems and is susceptible to training. Carey (1958)\textsuperscript{284} tested the assumption that the differences may be attributed to non-intellectual factors such as reflection of attitudes, and not the result of differences in intelligence, special aptitudes and information. Significant results of the study were that men received significantly high scores on the attitude to problem solving scale than did women; the sex difference in amount of improvement in performance was significant, women responding more favourably than men to attempt to improve problem solving attitude. For women, if problem solving attitude changes, there is change in the performance as well. The study, thus, concluded that sex differences in problem solving performances are attributable in part to sex differences in attitude towards problem solving. The correlations for women's aptitude and attitude scores were highly significant, but there was no relationship between men's aptitude and attitude scores, a finding which, according to Carey indicated that men tend not to admit a dislike for problem solving even when they are lacking in intellectual aptitude.


Milton (1959)\textsuperscript{285} investigated the relationship between sex role and problem solving ability in boys and girls. Twenty four undergraduate males and twenty four undergraduate females were given a set of 20 problems, half with content appropriate to the masculine role and half, with content appropriate to the feminine role. The results confirmed the prediction that when characteristics of problems are altered so as to make them less appropriate to the masculine role, sex differences in problem solving are reduced. In yet another study, Milton (1957)\textsuperscript{286} indicates that there is positive relationship between masculine sex role identification and problem solving ability and when allowance is made for this relationship, the difference between men and women in problem solving ability diminished. Similar results were obtained by Graft and Riddel (1972)\textsuperscript{287} with college students as subjects and Leder's (1974)\textsuperscript{288} analysis of sex differences in mathematics. The results led investigators


to think further along the influence of non-intellectual factors in differential achievement and problem solving ability among boys and girls. These studies have also recognized science as the basis of problem solving ability. Sex differences in problem solving ability has been observed in a number of studies conducted abroad and the male superiority has been recorded. Latest researches however, show that a number of factors are involved in the promotion of problem solving skills among children. The effect of the socio-economic variable, the attitude towards the problem situation, the identification and analysis of the problem are significant. However, the results of these researches are inconclusive and have brought out contradictory results. The review further takes note that the research in this area are conspicuous by their absence in India and especially in tribal regions of North-East India.
Statement of Hypotheses

As is evident from the title of the study and the statement of the problem (Chapter I) the variables, science achievement, science attitudes and the problem solving ability are to be studied as the effect of three independent variables namely sex, socio-economic status (SES) and the type of schools. The research evidence based on various kinds of studies reviewed in this chapter and the variables of science achievement, science attitudes and problem solving ability, however, provides quite contradictory results. This position provides the premise for the following hypotheses tested in the study:

1. Significant sex differences exist in the science achievement of the students.
2. Significant sex differences exist in the science attitudes of the students.
3. Significant sex differences exist in the problem solving ability of the students.
4. Significant differences exist in the science achievement of students from different socio-economic groups.
5. Significant differences exist in the science attitudes of students from different socio-economic groups.
6. Significant differences exist in the problem solving ability of students from different socio-economic groups.

7. Significant differences exist in the science achievement of students studying in Government and Deficit schools.

8. Significant differences exist in the science attitudes of students studying in Government and Deficit Schools.

9. Significant differences exist in the problem solving ability of students studying in Government and Deficit Schools.

10. Positive and significant correlation exist between science achievement and science attitude of male secondary school students.

11. Positive and significant correlation exist between science achievement and problem solving ability of male secondary school students.

12. Positive and significant correlation exist between science attitude and problem solving ability of male secondary school students.

13. Positive and significant correlation exist between science achievement and science attitude of female secondary school students.
14. Positive and significant correlation exist between science achievement and problem solving ability of female secondary school students.

15. Positive and significant correlation exist between science attitude and problem solving ability of female secondary school students.