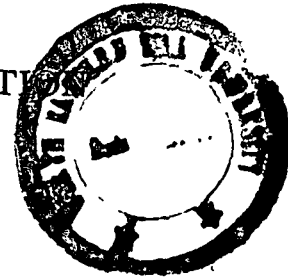


**A STUDY OF  
SCIENCE ACHIEVEMENT, ATTITUDE TOWARD SCIENCE  
AND PROBLEM SOLVING ABILITY AMONG THE  
SECONDARY SCHOOL STUDENTS IN AIZAWL**

*Thesis submitted for the Degree of*  
DOCTOR OF PHILOSOPHY IN EDUCATION  
by  
DARCHHINGPUII



DEPARTMENT OF EDUCATION  
NORTH EASTERN HILL UNIVERSITY  
MIZORAM CAMPUS : AIZAWL  
AUGUST 1988

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C E R T I F I C A T E

Certified that the thesis, '**A Study of Science Achievement, Attitude Toward Science and Problem Solving Ability Among the Secondary School Students in Aizawl**' submitted for the degree of Doctor of Philosophy in Education in The North-Eastern Hill University is the result of bonafide research carried out by Mrs. Darchhingpuii under my supervision and guidance. This thesis or any part thereto has not been submitted for any degree in this or any other University.



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DECLARATION

I do hereby declare that the thesis, 'A Study of Science Achievement, Attitude Toward Science and Problem Solving Ability Among the Secondary School Students in Aizawl' or any part thereto has not been submitted for any degree in the North-Eastern Hill University or any other University.

Place : Aizawl.

Date : 20.8.1988.

*Darchhngpuii*  
(Darchhngpuii)

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**Darchhingpuii**

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C H A P T E R - I : INTRODUCTION

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Need for and significance of the study

Sex difference in student ability

Socio-economic environment : A determining factor

School situation : A significant factor in education

Statement of the Problem

Title of the study

Terminology

Objectives of the study

Limitations of the study

Organisation of the report

---

## INTRODUCTION

Modern societies are characterised by scientific and technological revolutions. In our contemporary civilization and culture, science has become a part and parcel of life. In the advanced countries science has entered the very fabric of life and even in the less advanced countries its impact on life is felt in an ever increasing manner. Science today dominates such a wide area of human activity that it is no longer the concern of a select group of people in a society but has become a part of the everyday job of almost everybody everywhere. As such, today we cannot think of a world without science. The most conspicuous aspect of our civilization today is the pervasive and ramifying impact of science in every department of life, from household management to warfare. Such a remarkably amazing achievement of science as in the present century, did never occur before in the long history of human civilization. Such a situation obviously demands every man's acquaintance with science, both as a product as well as a process. A man without contact with science and its manifestations will be a complete misfit in modern society. If we conceive education as a process for preparation of a

socially efficient citizen, it is imperative that each individual of the society acquires knowledge of science as well as a scientific attitude of mind as a consequent discipline.

In view of the dominating role of science in the modern world, it has been imperative for any nation of the world to promote science education. Rapid industrialisation and technological developments are the special features of the world today. The ever increasing pace of science has created a wide gap between the developed and the under-developed countries and it has, therefore, necessitated the underdeveloped countries to take more vigorous steps towards scientific and industrial development.

The Science Policy Resolution of the Government of India illuminates clearly and concisely the relationship of science to national goals and development. The key to national prosperity ~~is~~ apart from the spirit of the people, lies in modern age, in the effective combination of science and technology with man power and material resources. Therefore, promotion of science education is an important factor in the progress, welfare and security of the nation. The Education Commission (1964-66)<sup>1</sup> was of the opinion that science education must become

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1. Ministry of Education, Education and National Development: Report of the Education Commission 1964-66, New Delhi, NCERT, 1971.

an integral part of school education. A scientific outlook must be developed among the students so that it becomes part of their way of life and culture. The Commission felt that the quality of science teaching at all levels in the country has to be raised considerably so as to achieve its proper objectives and purposes such as, to promote an ever deepening understanding of basic principles; to develop problem solving and analytical skills and ability to apply the skills to the problems of the material environment and social living; and to promote the spirit of enquiry and experimentation. Science strengthens the commitment of man to free enquiry and the quest for truth. It not only loosens the bonds of dogmatism but also acts as a powerful dispeller of fear and superstition. In addition, science deepens pupils' understanding of nature and helps them to understand themselves and their place in the universe.

As a school subject, science occupies a very important place. It consists of a series of subjects or courses of study which are however set apart from other subjects like english, mathematics, social studies etc. Each science subject consists of a body of facts, principles, theories and laws. In contrast with the arts, science is usually identified with logic and

reason. Each particular subject of science has its own inner logic which make one fact derive from another. While physics provides the specific scientific abilities of comprehension, analysis and synthesis and evaluation, chemistry caters to recalling information, skill in experimentation, skill for solving a practical problem and skill in handling and classifying given information. Biology, on the other hand, builds up the abilities of comprehension, application, analysis, synthesis and evaluation (Mehna, 1985)<sup>2</sup>

While science is expanding at a terrific pace, little attention is being paid to the improvement and innovation in the teaching of science and mathematics. In particular, the science curriculum in school and college has been grossly out of date, in content as well as in method and approach, and takes no account of the advancement of the knowledge in the field. The US National Science Foundation and Soviet Academy of Sciences and the Academy of Pedagogical Sciences, have made a pioneering contribution towards initiating a 'revolution' in the teaching of science and mathematics. A significant contribution has also been made by the Nuffield Science Founda-

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2. Mehna, V., "An investigation into some Factors Affecting Academic Achievement in Science of IX Standard Students of Greater Bombay" Reading in Educational Research, Department of Education, University of Bombay, 1985, p.58.

tion which has developed new curriculum materials at the school levels. The movement is now spreading to many countries. Fortunately for the entire process of improving school and college science and mathematics, top university teachers and researchers have become directly involved, the most memorable one being that of Professor Jerald R. Zacharias of the MIT Boston.

It is important to recognize that science is becoming increasingly complex and abstract. The new developments in physics and mathematics make altogether novel demands on abstraction and conceptualization of nature. This emphasises the need from the earliest stage of science education for a proper understanding of the basic principles and the process of scientific abstraction and creative thinking. It must communicate to the pupils a feeling for discovery and creativity, and a realization that science is open-ended and man's greatest intellectual enterprise today. And what is more important, this enterprise is rooted in man's highest aspirations and deepest motivations, and it stresses cooperation above competition. Science teaching at all levels has to be creative. It also means that a deliberate effort should be made to develop in the pupils the habits of concentration and contemplation.

If the quality of science education has to be improved, immediate steps should be taken to improve teaching of the subjects and this emphasizes the importance of activating and renovating the abilities of science teachers. Improved science teaching in schools depends upon teachers properly trained in the methods and techniques of teaching science. One of the main bottlenecks to improve science education in schools in remote and tribal areas is the lack of trained and qualified teachers. In the developed countries, books, pamphlets and magazines relating to the methods and techniques of teaching science are available in plenty.

#### Need for an significance of the study

Science education in Mizoram seems to have serious drawbacks. Science was a neglected subject till recently. Efforts are being made by the Government for the promotion of science education. A separate science promotion wing has been created under the Directorate of Education for the very purpose. With this effort, of late, the students' attitudes towards science subjects hve changed and there is a considerable improvement and interest to take up science subject at the tertiary level. However, the overall picture of science education is not very encouraging. There are only two colleges

offering science subjects and the enrolment seems to be poor in this subject. There is a scarcity of science teachers, and schools are lacking in facilities like laboratory, teaching aids, equipment and even literature for the proper teaching of science. There are a few studies conducted recently on science education. Special mention may be made of a study conducted on college students analysing the achievement, attitudes towards science and interest in science (Darchhingpuii 1982)<sup>3</sup> The present research is attempted on the Secondary School students. The study assumes significance as it examines the problem solving ability among the secondary school students and analyses its relation to achievement and attitudes towards science. The investigation of the related aspects of science are much needed in a remote backward area like Mizoram as the state still lags behind in industrial and scientific advancements. The significance of the study is enhanced as the findings of this research will be helpful for teachers for proper guidance of the students. It is also envisaged that the research will also give meaningful insights for developing programmes for propagation of science in this area.

A theoretical and conceptual framework of the variables involved namely sex, socio-economic environment and the school

3. Darchhingpuii, A study of science achievement and science attitude among male and female college students in Mizoram. Unpublished M.Ed. Dissertation. Aizawl: North Eastern Hill University, 1982.

situation (type of school), has been discussed in the following pages.

#### Sex Difference in Student Ability

The most salient and prominently distinguishable features of human differences are those which separate males from females. Any casual observer can more readily discern difference in sex than in any other dimension of human differences such as race, age or socio-economic status, the reason being the fact that genetically one is either female or male. This genetic difference projects itself especially in the physical difference of two sexes. Studies have thrown further light on the specific and real nature of sex differences - both physical and psychological. The researches relating to sex differences may be summarised under three heads, viz : i) physical aspects ii) intellectual aspects and iii) social aspects. The development of objective and standardized tests made possible during nineteenth thirties quantitative as well as qualitative assessment of sex-typed characteristics behaviours and traits. The purpose of such differential studies was not to prove that females were like males, but to achieve a better understanding of the differences between the sexes upon which constructive and creative could be based. The findings of

such objective studies resulted in expelling the earlier notion of female inferiority. But still women are considered inferior to men in many respects and this may be one of the reasons for the discrimination in providing educational and professional opportunities for individuals on the basis of sex.

Sex differences seem to develop even prior to birth which means that at birth the organism has tendencies to respond differently to external stimuli. The most important biological difference is provided by the sex determining chromosomes. For the female, each body cell contains 22 pairs of chromosomes and two large X chromosomes. The male cell also has 22 pairs together with one X chromosomes and one male determining Y chromosome. The mere presence or absence of the Y chromosome at conception appears to account for much of the variance between the sexes. Many researchers have attempted to compare different aspects of physical and physiological development of human males and females at the infant and childhood stages. A comprehensive review of such studies has been given by Garai and Scheinfeld (1968)<sup>4</sup> and Singer and others (1968).<sup>5</sup>

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4. Garai, J.E., and Scheinfeld, A. "Sex differences in mental and behavioural traits." Genetic Psychology Monographs, 77, 1968. pp. 169-299.
  5. Singer, J.E.; Wesphal, M. and Niswandar K.R., "Sex differences in the incidence of neonatal abnormalities and abnormal performance in early childhood." Child Development, 39, 1968, pp 103-122.

These studies have shown that though more males are conceived than females the ratio of male to female live births are altered as a result of the higher incidence of abortions, miscarriages and still births for males; higher mortality rates for males; more abnormalities for males during neonatal life; and males are more susceptible to various diseases. Most sex-linked non-infectious diseases such as hemophilia and colour vision defects were found more often in males than in females (McClearn 1970)<sup>6</sup>

The influence of sex hormones is considered to be another source of differences in psychological traits. Endocrine studies have shown the crucial role played by the sex hormones during pre-natal life. These hormones are crucial in differentiation of male and female and programme the brain during fetal development which display the masculine or feminine brain structure and function (Scarf 1972)<sup>7</sup> Experimental studies conducted on animals and observation of humans have shown that the relative proportion of the sex hormones - the

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6. McClearn, G.E., 'Genetic influence on behaviour and development' quoted in P.H.Hussen (Ed), Carmichael's manual of Child Psychology, (New York: Wiley, 1970).

7. Scarf, M., "He and She, Sex hormones and Behaviour", Quoted in David R.Heise, Personality Biosocial bases (New York: Rand Mc Nally Company, 1973), p.91.

right concentrations at the right time - determine the degree to which the individual develops masculine or feminine characteristics during adult life. Scarf (1973)<sup>8</sup> cites the comments of Ehrhardt from the results of work carried out both with animals and with human beings, thus ".....hormones before birth may have an organising effect upon behaviour that will appear only much later - that social environment is the mold in which basic tendencies, already present, will be shaped and formed..... that postnatal experiences are actually acting upon a physiological biased substrate." Regarding the post pubertal hormonal differences Money (1972)<sup>9</sup> suggests that the differences between the sexes are not absolute and all-or-none, but a matter of relativity or degree for males and females makes some of all the three sex hormones - androgen, oestrogen and progesterone.

The different roles males and females play in reproductive function are considered by Psychologists like Anastasi (1958)<sup>10</sup> to result in a number of sex differences in interests,

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8. Ibid., p.99

9. Money, J., "Sexual dimorphism and homosexual gender identity," quoted in J.M. Bardwick (ED), Readings on the Psychology of Women, (New York: Harper & Row, Publishers, 1972), pp. 3-13.

10. Anastasi, A., Differential Psychology (3rd ed) New York: Macmillan, 1958)

emotional traits, vocational goals and other intellectual functioning and their differences are pointed out as factors influencing sex differences in play activities, interests and achievements in various fields. Scheinfeld (1965)<sup>11</sup> observed that though males as a group are inherently physically stronger, heavier, taller or more active and more aggressive, they are more susceptible to genetic defects and diseases and less resistant to most biological hazards. Further, Scheinfeld points out the differences in maturational rates of boys and girls. Gap in maturation widens in scope with the progressive increase in age, with women reaching the terminal maturational stage at about 21 and men at about 24. This difference in the maturational rates is supposed to be a cause for psychological differences.

It can be seen that in every society there are differences in socialisation experiences for boys and girls. Even a new mother is not aware of the fact that she is responding differently to her daughter than she would if the child had been a male. This differential treatment from cradle onwards

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11. Scheinfeld, A., Your heredity and environment (Philadelphia: Lippincott, 1965).

is very effectively pointed by Bernard (1975)<sup>12</sup> when she says ".....we have to begin with the admission that we can never really know what the sexes would be like if there were no cultural conditioning, if we did not begin with pink and blue blankets in the nursery, dolls and trucks in the pre-school, ballet and baseball in the pre-teens, cheer leaders and football players in high school and so on....." Barry, Bacon and Child's (1957)<sup>13</sup> findings from cross cultural studies established that most cultures socialise girls for nurturance and responsibility while boys are most often trained for achievement and self-reliance. Also many cultures expect girls to be timid, shy, and obey the orders more strictly than boys. It was noticed by Goldberg and Lewis (1969)<sup>14</sup> that parents behave differently toward girls and boys and even as infants reinforce sex appropriate behaviour.

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12. Jessis Bernard, "Sex differences : An over view" quoted in N.L. Gage and David C. Barliner, Educational Psychology (Chicago: Rand McNally College Publishing Company, (1975), p. 422.
  13. H. Barry, M.Bacon and I.L.Child "A cross cultural survey of some differences in socialisation," Journal of Abnormal and Social Psychology, 55, 1957, 327-332.
  14. Susan Goldberg and Michael Lewis, "Play behaviour in the year old infant, Early sex difference," Child Development, 40, 1969, pp. 21-31.

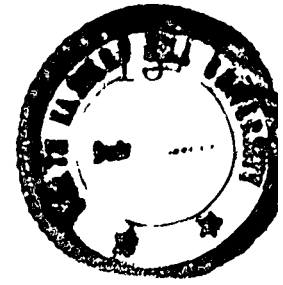
There is preference for male children in most cultures throughout the world. The treatment accorded to and the performance expected from male and female are according to society's prevailing stereotypes. That sex roles and sex stereotypes vary in different times and different places is evident from anthropological and cross cultural studies. As for instance, a study conducted in Taiwan shows that sex role differences are sharply defined and a girl learns quite early that she must differ from boys and as she becomes a woman, she learns that she is not only subserviant to boys and men but to many other women (Wolf 1972)<sup>15</sup>

Occupation has traditionally provided one of the principal areas of sex differences. In primitive societies as in most of the modern societies division of labour between the sexes are observed. According to D'Andrade "the division of labour by sex comes about as a result of generalisation from activities directly related to physical sex differences to activities only indirectly related to these differences, that is, from behaviours which are differentially reinforced as a result of physical differences to behaviours which are anticipatory or similar to such directly conditioned activities."<sup>16</sup>

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15. Margery Wolf, "Women and the Family in Taiwan" quoted in Child Development Abstracts and Bibliography, Vol. 48, 1974.

16. G.D.D'Andrade, "Sex differences and cultural institutions" quoted in David R.Heise, Personality Bio-Social Bases.



Recently, psychologists, sociologists and anthropologists seem to take more interest in studying the differentiation of sex roles within a particular culture. It is pointed out that child rearing practices are different in different cultures and right from infancy onwards boys and girls are reared in different sub-cultures. The term 'sex role' as described by Dreyer (1975)<sup>17</sup> refers to expected social behaviours and attitudes about them which have been assigned by the dominant culture to one sex or the other. In Indian culture, the role of the 'home maker' is played by women, hence this role has been sex typed as more appropriate for women. Usually household tasks are assigned differently to boys and girls. Parents, adults, and even playmates give differential treatment in a multitude of ways to boys and girls. As for instance, cognitive achievement is stressed for boys whereas girls appear to be attuned to interpersonal aspects of the situation. Investigations of Elman and others (1972)<sup>18</sup> reveal that parents

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17. Philip H. Dreyer, "Sex, Sex roles, and Marriage among Youth in the 1970s, quoted in R.J.Havinghurst and P.H. Dreyer Youth. The Seventy fourth year book of the National Society for the study of Education Part I. (Chicago, NSSE. 1975) p. 206.
  18. Elman, J., and Manosevitz, M., "Sex typing in Nursery School Children's Play interests." Developmental Psychology, 7, January, 1972, pp.146-152.

tend to discourage cross-sexed interests in boys more than they do in girls, again suggesting the greater pressure put on boys to achieve a well-defined male identity. The findings of Rosenberg and Sutton (1968)<sup>19</sup> emphasize that sibling-sibling, child-parent as well as parent-child effects are involved in sex role learning. A study by Emmerich (1962)<sup>20</sup> reveals that parents exerted more power toward their 'same sex' than toward their 'opposite sex' children. In a study on nursery school Fagot and Patterson (1969)<sup>21</sup> found that female teachers consistently reinforced feminine behaviours more than masculine behaviours and reinforced boys but not girls when they performed opposite sex behaviours.

D'Andrade found that the quantity and quality of sex role socialisation was very much affected by the subsistence activities and the economic structure of a given society.

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19. B.G.Rosenberg and Smith B. Sutton "Family interaction effects on masculinity-femininity". Journal of Personality and Social Psychology, 8, 1968.
  20. Walate Emmerich, "Variation in the parent role as a function of the parents' sex and the child's sex and age," Marrill-Palmar Quarterly, 8, 1962.
  21. Beverly I. Fagot and G.R.Patterson, "An invivo analysis of reinforcing contingencies for sex-role behaviours in the pre-school child" Developmental Psychology, 1, 1969, pp. 563-568.

This is more prevalent in economically underdeveloped countries. The amount the mother had worked outside the house was found by Stein (1974)<sup>22</sup> to be positively related to the daughters' masculine characteristics and her plans for attitudes to high school. But in a technological society, mothers increased participation in employment and decreased pre-occupation with mothering result in shift in socialisation forces toward more independent training and occupational orientation to girls. Hoffman's (1977)<sup>23</sup> view is that if the adult roles of men and women converge, sex-based differences in child rearing patterns will diminish. Many sex differences will be manifested only in later years, and this helps in increasing the environmental influences. Reviewing a number of studies on differential aptitudes and abilities of boys and girls, many of them become significant only at adolescence, Maccoby (1972)<sup>24</sup> suggests that

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22. Aletha Huston Stein, "The effects of maternal employment and educational attainment on the sex typed attributes of college female", Child Development Abstracts and Bibliography, Vol. 48, 1974.
  23. Louis Wladis Hoffman, "Changes in Family Roles, Socialisation and sex differences", American Psychologist, Vol.32 No.8 Aug, 1977 p. 446.
  24. E.E. Maccoby, "Sex differences in intellectual functioning", quoted in Judith. M.Bardwick, Readings on the Psychology of Woman, pp. cit. pp. 34-44, 1972.

even though there may be some biological basis for these differences, socialisation and a strong social demand for sex typed behaviour may be a more powerful agent in defining them.

#### Socio-economic Environment : A Determining Factor

Socio-economic environment plays a significant role in influencing the academic achievement of students and the formation of favourable attitude towards school subject. Children coming from professional homes are found to be better academically motivated than those from working class homes. Educationists turned their attention to this direction to find the contribution of this variable to academic achievement. It is found that the members of a social class tend to restrict their intimate social relationship to other members of the same class only. Warner and his associates (1949)<sup>25</sup> have defined class as the largest group of people whose members have intimate access to one another. Each social class also has its own 'life style' or way of life marked by a set of mores, values, attitudes and patterns of behaviour. Whenever

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25. Warner, W.L. Meeker, M. and Rells, K.W. Social Class in America. Chicago : Science Research Asociations, 1949.

social intercourse is limited to a consideration of status, or a discrimination between higher and lower, there exists a social class. A social class can be any portion of the community marked off from the rest of the social status. A system of social class involves hierarchy of status groups and the recognition of superior-inferior stratification, with some degree of permanency with the structure.

Social class as a distinct status group provides a precise concept, and one generally applicable to any system of class stratification. It regards those social differentiations arising out of language, locality, function, or specialisation as significant class phenomenon only when they become closely associated with a status hierarchy. The subjective factor of social status, a manifestation of group attitudes, is always related to such objective differences in society as income levels, occupational distinctions, distinctions of birth, race, education and so on. But these objective differences, apart from recognised order of superiority and inferiority, do not establish cohesive groups. It is the sense of status, sustained by economic power and by the distinctive modes of life, and cultural expressions corresponding to them that draws class apart from class. This gives cohesion to each class and stratifies whole society.

The investigations of Warner and Hurt (1941)<sup>26</sup> Davis and Gardener and Gardener (1941)<sup>27</sup> revealed a definite picture of the social class system. Their results are of interest to educators who are seeking a more adequate understanding of the environment and its relation to human learning. The social class theory proposed by them has implications for the socialization and formal education of all youth. According to this theory the members of a community are greatly influenced by a social class order in which they look up on people as being higher<sup>or</sup> lower on the rungs of a social ladder.

Children learn what is considered good and what is bad in a particular social group in which they grow up. This particular segment of culture determines what children learn to value, to enjoy, to neglect or to work for. All these effect children's motives, actions and goals. The effects of these on child rearing and upon classroom procedure are often profound though subtle and hidden. A number of studies have brought out the effects of social class on child training

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26. Warner, W.L. and Hurt, P.S. The Social Life of a modern community and the status system of a modern community, Vols.I and II, Yankee City series. New Haven: Yale University Press, 1941.
27. Davis,A; Gardener, B.B; and Gardener,M.R; Deep South Chicago: Chicago University Press, 1941.

and schooling. Davis and Dollard (1940)<sup>28</sup> studied the life histories of a number of Negro children and came to the conclusion that the effect of social class status was, in general similar for Negro and white populations. The lower class differed markedly from the middle class and the upper class with respect to certain behaviours such as expression and school learning. Warner and others' (1944)<sup>29</sup> research findings supported the hypothesis that 'social class' is a significant determinant of personality in culture. They further observed that the school may serve as a sorting or selecting agency affecting the efforts of individuals to move upwards in the social structure. Diverse life styles are the major distinguishing characteristics of the several social classes. Precisely, it is these different patterns of belief, attitudes and behaviour that gives the class structure its primary educational significance. Since each of the classes has a different way of life, each tends to develop different character and personality in its members.

Mizo society does not have any stratification based on class. Clanship was a basis for segregation of the society


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28. Davis, A. and Dollard, J. Children of Bondage, Washington D.C.: American Council of Education, 1940.
29. Warner, W.L., Havighurst, R.J. and Loeli, M.B. Who shall be educated. New York: Harper and Brothers, 1944.

in ancient times. The village chief had his own authority and dominance over the people. The 'clans' were differentiated as chieftain class and commoners clans. The advent of the British missionaries and the spread of education has brought about social changes in this region and the social stratification based on clanship or chieftainship has lost its value. At present the society is quite egalitarian and there is no demarcation based on clans but slowly the class difference is appearing in the society on the basis of level of education, income, occupation and family facility. The value of education has been highly recognised by the Mizos. At present there is no discrimination on the basis of sex for educational and employment opportunities. Boys and girls enjoy equal opportunities in all walks of life. Parents give equal importance to education of their sons and daughters. Thus, the positive favourable attitude towards education has proved vital in bringing phenomenal changes in the progress of the society.

#### School Situation - A Significant Factor in Education

The environment of school is yet another variable that has no mean importance in the performance of the pupil in various subjects. Psychologists and educationists are unanimous in their conclusion that the influence of the educational

environment is a decisive factor in the academic excellence and attitude formation among the students. Educationists in particular have examined the effect of the school situation on the performance of students. The formal secondary education takes place in a definite educational setting, the types of school organization, the staff position, management and the organizational climate all affect the learning and performance of the students. The different types of school organization in terms of sponsorship and management may affect the educational process differently. The school has long been recognized as a selective socialising agency. Waller (1932)<sup>30</sup> was the first to undertake the qualitative study of the school as a social institution. The precise and systematic studies of the organizational patterns of schools and their influence on learning are very few. Pratap and Raju (1973)<sup>31</sup> find the aided schools in rural areas of Andhra Pradesh ill-organised in terms of management and inadequate in human and material resources resulting in poor student performances. Subrahmanyam's (1982)<sup>32</sup> study highlighted the

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30. Waller, W., The Sociology of Teaching. New York: Wiley, 1932.
31.  Pratap, D.R. and Raju, C.C., Study of Aided Elementary Schools of Srikakulam, Tribal Cultural Research and Training Institute, Hyderabad, 1973.
32. Subrahmanyam, S. Some correlates of reading achievement of primary school children, Ph.D. Education, Sri Venkateswara University, 1982.

importance of conditions at school vis-a-vis pupil achievement. Most of the studies indicate the importance of educational environment provided by the schools in the promotion of better student performance. But, the question still remains as to which type of schools affects the achievement and to what extent.

The Secondary schools in the state of Mizoram fall under two categories, the government schools and the deficit schools. The government schools are under the direct management of the state Directorate of Education. These schools are controlled and financed fully by the government. The deficit schools, on the other hand, are the privately managed schools aided by the government. The government brought all the private secondary schools in the state under the deficit system granting aids. Despite the allocation of grants, it appears that there has been not much improvement in the facilities provided in the deficit schools. The government schools are better staffed with qualified teachers and have better facilities of library, building, furniture etc. Nevertheless, in a previous investigation, it was observed that the government schools with better staff equipments and facilities were surpassed by the deficit

schools in terms of student motivation (Sailo, 1982)<sup>33</sup>. Student performance is also found to be much better in deficit schools than government schools on the basis of the secondary school leaving certificate examination results. (Thanhawla, 1983)<sup>34</sup>

As is evident from the foregoing discussion that student performance is dependent on a number of factors. There is ample evidence to infer that the sex differences, socio-economic environment and the school situation are significant factors affecting the achievement. It appears that not much work has been done in investigating the variables like sex, socio-economic environment and type of school on pupil performance in Mizoram. This further reiterates the need and relevance of the present research.

#### Statement of the Problem

The problem under investigation is designed with a view to analyse the achievement in science, attitude towards

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33. Sailo, L. Affective correlates of achievement motivation among high school students in Aizawl. Unpublished M.Ed Dissertation. Aizawl: North Eastern Hill University, 1982.
  34. Thanhawla. An Investigation into the causes of failure in science and mathematics in high school leaving certificate examination in Mizoram. Unpublished M.Ed Dissertation. Aizawl: North Eastern Hill University, 1983.

science , and the problem solving ability among the secondary school students. The science achievement was obtained by a standardized Science Achievement Test (Lalduhsanga, 1983)<sup>35</sup> The study employed a five-point Likert scale to measure the attitude of the students towards science. This Science Attitude Scale (Grewal, 1977)<sup>36</sup> has been adapted to Mizoram in a previous study (Darchhingpuii, 1982).<sup>37</sup> The problem solving ability of the students was measured by a Problem Solving Ability Test (PSAT) specially prepared by the investigator for the purpose of the study.

The investigation is further extended to examine the influence of factors sex, socio-economic status (SES) and type

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35. Lalduhsanga, J. A study of personality factor patterns of low, normal and high achievers in secondary school science, Unpublished M.Ed Dissertation. Aizawl: North Eastern Hill University, 1983.
  36. Grewal, A., Manual for science attitude scale. Agra: National Psychological Corporation, 1977.
  37. Darchhingpuii, A study of science achievement and science attitudes among male and female college students in Mizoram. Unpublished M.Ed Dissertation, Aizawl: North Eastern Hills University, 1982.

of school on each of the main variables under study, the science achievement, science attitude and the problem solving ability. The interaction effects of the independent variables, sex, SES and type of school on the three main variables have also been investigated.

Title of the Study:

A STUDY OF SCIENCE ACHIEVEMENT, ATTITUDE TOWARD SCIENCE AND PROBLEM SOLVING ABILITY AMONG THE SECONDARY SCHOOL STUDENTS IN AIZAWL.

Terminology

1. Science Achievement: Science Achievement in the present study has been taken as the accomplishment in science by the scores obtained by the students on an objective test in science.
2. Science Attitude: Science Attitude has been defined as the opinion or position taken with respect to a psychological object in the field of science (Moore, 1970) and has been taken as a generalised attitude toward the universe of science content and being measured in terms of favourableness or unfavourableness estimated from the scores on an attitude scale.

3. Problem Solving Ability (PSA<sup>Q</sup>): The skill of the students in understanding and analysing a problem and applying the scientific knowledge and method to solve them is designated as the problem solving ability in the present research and is being measured by a Problem Solving Ability Test (PSAT) specially developed for the students.  
(refer related research in Chapter II for further details)

#### Objectives of the Study:

The major objectives of the study are the following:

1. To study the science achievement, attitude towards science, and problem solving ability of the secondary school students in Aizawl.
2. To find the inter-relationships of science achievement, attitude towards science vis-a-vis the problem solving ability.
3. To examine the relative effect of sex, socio-economic status and type of school on science achievement, science attitude and problem solving ability.

#### Limitations of Study:

The study was subjected to the following limitations:

1. The study was confined to students of standard IX of the secondary schools of Aizawl town.

2. Only three experimental variables were examined. Other important variables as science interest, aptitude, involvement in science activities were not considered.
3. The Problem Solving Ability Test (PSAT) used was specifically devised for the investigation. The reliability and validity of the test have been established, however, development of norms for different sex groups, SES groups for each class could be taken up later as a separate study.

#### The Organization of the Report:

The research report has been divided into six chapters. The introductory chapter presents the research theme together with the theoretical and conceptual framework of the study and enunciates the major objectives of the research. A review of the related studies has been carried out in Chapter II. The research related to science achievement, science attitudes and problem solving ability has been reviewed separately and presented in separate sections.

A brief survey of the development of education in Mizoram with special reference to science education is undertaken in Chapter III.

The method and procedure adopted for the study are explained in Chapter IV. Details regarding the selection of sample, the choice of the tools for the study, construction and standardization of the Problem Solving Ability Test (PSAT), collection and classification of data and the statistical techniques applied for the analysis of data are described in this chapter.

Chapter V deals with the analysis of the data to test the major hypotheses advanced in the research. The tenability of the hypotheses and the discussion of the results appear at the end of this chapter.


The concluding chapter consists of the summary of the study, together with the salient findings and their educational implications.

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C H A P T E R - 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.

### Section I : Review of Research related to Science Achievement

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 organisational 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)<sup>1</sup> at the middle school (DeLuca 1979; Alaimo 1979; McDuffie 1979)<sup>2,3,4</sup> at the high school (Stephenson, 1979; Cohen, 1979;)<sup>5,6</sup> and among college students

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1. Smith, W.S & Litman, C.I. Early Adolescent girls' and boys' learning of a spatial visualization skill, Science Education, 1979 63 (5), 671-676.
  2. DeLuca, F.P. Application and Analysis of an electronic equivalent of Piaget's first chemical experiment. Journal of Research in Science Teaching, 1979 16(1), 1-11.
  3. Alaimo, S.J. A Study of factors influencing value preferences in environmental problems of seventh-through twelfth-grade students. Doctoral dissertation, Stat University of New York at Buffalo. Dissertation Abstracts International, 1979, 39(9).
  4. McDuffie, T.E., Jr. Predicting success in ISCS level 11. Journal of Research in Science Teaching, 1979, 16(10), 39-44.
  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.
  6. Cohen, M.P. Scientific interest and verbal problem-solving: Are they related? School Science and Mathematics, 1979, 79(5), 404-408.

(Andrews, 1979; Walker, 1979)<sup>7,8</sup> 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)<sup>9,10,11,12</sup> Students' previous science experience appears to have little correlation with their science achievement. Werline (1979)<sup>13</sup> reported that older children had more knowledge about

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7. Andrews, M.H., and Andrews, L. First-year chemistry grades and SAT match scores. Journal of Chemical Education, 1979, 56(4), 231-232.
  8. Walker, R.A. Effect of sequenced instruction in inventory Mendelian genetics on Piagetian cognitive development in college students (Doctoral dissertation, Ball State University). Dissertation Abstracts International, 1979, 39(10), 6048A.
  9. Burrows, C. and Okey, J.R. The effects of a mastery learning strategy on achievement. Journal of Research in Science Teaching, 1979, 16(1), 33-37.
  10. Nussbaum, The effect of the SCIS'S "relativity" unit on the child's conception of space. Journal of Research in Science Teaching, 1979, 16(1) 45-51.
  11. Howe, A.C., and Early, M. Reading and reasoning in ISCS Class. Science Education, 1979, 63(1), 15-23.
  12. Brown, F.K., & Butts, D.P. A study of the use of a diagnostic testing in teaching basic principles of human psychology. Journal of Research in Science Teaching, 1979, 16(3), 206-210.
  13. Werline, D.P. A school community model for the stewardship of school site and neighbourhood outdoor laboratories and an evaluation for their use by selected-fourth and fifth grade pupils for environmental education (Doctoral dissertation, Boston college). Dissertation Abstracts International, 1979, 40(5) 2432A.

their environment than did younger students. McDuffie(1979)<sup>14</sup> 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)<sup>15</sup> that student ethnic origin is closely associated with achievement. Lattart (1978)<sup>16</sup> found equally strong relationships between ethnic origin, parental background, and urban or rural home location. In a study of scientific literacy among Georgia students, McNeill and Butts (1981)<sup>17</sup> however, found no evidence of a relationship between urban-rural home location and scientific literacy.

14. McDuffie, T.E. Op.Cit. 1979.
15. National Assessment of Educational Progress. The Third Assessment of Science, 1976-1977. Denver: NAEP, 1978.
16. Lattart, D.E. The Influence of Knowledge on Young People's Perceptions about Wildlife (Final report to the National Wildlife Federation). June, 1978.
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.

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)<sup>18,19</sup> 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)<sup>20</sup> and on college students by Learned and Wood (1938)<sup>21</sup>

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18. Terman, L.M. and Tyler, L.E., Psychological Sex Differences. In L.Carmicheal (Ed.). Manual of Child Psychology, New York : Wiley 1954.
  19. Traxler, A.E., and Spaulding, Geraldin. Sex differences in achievement of independent school pupils as measured by Standford Achievement Tesdt, Form K. Educational Research Bulletin, 1954, No.63, 69-80.
  20. Jordan, A.M. Sex differences in mental traits. High School. J., 1937, 20, 254-261.
  21. Learned, W.S., and Wood, B.D. The student and his knowledge. Carnegie Found. Advance Teaching Bulletin., 1938, No.29.

Edgerton and Britt (1944)<sup>22</sup> and Edgerton and Britt (1947)<sup>23</sup> 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)<sup>24</sup> in his survey of the reading habits of gifted children, found that girls read

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22. Edgerton, H.A., and Britt, S.H. Sex differences in the Science Talent Test. Science, 1944, 100, 192-193.
  23. Edgerton, H.A., and Britt, S.H. Technical aspects of the Fourth Annual Science Talent Search. Educational Psychology Measure, 1947, 7, 3-21.
  24. Terman, L.M., Genetic studies of genius. Vol.I. Standford University, California: Standford University Press. 1925.

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)<sup>25</sup> 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)<sup>26</sup> in his study of 202 boys and 188 girls in

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25. Lincoln, E.A. Sex differences in the growth of American school children. Baltimore: Warwick and York, 1927.

26. Lentz, T.F. Sex differences in school marks with achievement test scores constant. School and Society, 1929, 29, 65-68.

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, eventhough 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)<sup>27</sup> while analysing 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)<sup>28</sup> 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-

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27. Summerskill, J., and Darling, C.D. Sex differences in adjustment to college. J. Educ. Psychol., 1955, 46, 355-361.
28. Gordon, Mary A. A study in the applicability of the same minimum qualifying scores for technical schools to white males, WAF, and Negro males. HRCC, Air Res. Devlpm. Command, Tech, Rep. 53. 34.1953.

minantly verbal. Another possible factor, especially in the early school grades, is the neatness and general superiority of girls' hand-writing, which may affect grades on written work. In investigations on both elementary and high school groups, Lincoln (1927)<sup>29</sup> and Zazzo (1948)<sup>30</sup> 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)<sup>31</sup> In this investigation

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29. Lincoln, E.A., Op.Cit., 1927.

30. Zazzo, R., Premiere contribution des psychologues scolaires a la psychologic differentielle des sexes. Enfance, 1948, 1, 168-175.

31. Hartshorne, H., May, M.A., and Maller, J.B., Studies in the nature of character. Vol.11. N.Y.: Macmilan, 1929.



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)<sup>32</sup> Anastasi (1958),<sup>33</sup> and Maccoby (1966).<sup>34</sup> 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)<sup>35</sup> emphasized that the dif-

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32. Tyler, L.E., The Psychology of Human Differences, Newyork: Appleton, Century Crofts, 1956.
33. Anastasi, A., Differential Psychology : Individual and Group Differences in Behaviour. New York. Mcmillan, 1958.
34. Maccoby, E.E., The Development of Sex Differences. California, Stanford University Press, 1966.
35. Tyler, L.E., Sex Differences in Ebel R.L.(Ed.) Encyclopedia of Educational Research, 4th edn. Macmillan, Toronto, 1969, pp. 1217-21.

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)<sup>36</sup> 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

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36. Sherman, J.A., Sex-related Cognitive Differences : An Essay on Evidence. Illinois. Thomas, Springfield, 1978.

interest in research that sought evidence for the equality of the sexes. Ellis (1894)<sup>37</sup> argued that there was social significance in the hypotheses of greater male variability for the development of civilization. However, Pearson, in (1897)<sup>38</sup> 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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37. Ellis, Henry, The Transfer of Learning. New York: The Macmillan Company, 1965.

38. Pearson, K., The Chances of death and other studies in evolution. London : Arnold, 1897. Vol. 1.

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)<sup>39</sup> 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

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39. Peterson A.C., et al. Sex differences. In : Mitzel H.E. (Ed.) Encyclopedia of Educational Research. New York : Free Press 1982. pp. 1696-712.

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)<sup>40</sup> 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.

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40. Tyler, L.E., The Psychology of Human Difference.  
New York: Appleton Century Crofts, 1956.

Keeves (1973)<sup>41</sup> 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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41. Keeves, J.P., Differences between the sexes in Mathematics and science courses. Int. Tev. Educ.19 : 1973, 47-63.

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  $\square$  prior knowledges of mathematics and science.

Walker (1976)<sup>42</sup> 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.

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42. Walker, D.A., The IEA Six Subject Survey : An Empirical Study of Education in Twenty-One Countries. Almqvist and Wiksell, Stockholm.

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)<sup>43</sup> 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

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43. Moss, J.D., Towards Equality : Progress by Girls in Mathematics in Australian Secondary Schools. Australian Council for Educational Research, Hawthorn, Victoria, 1982.

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 mathematics 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)<sup>44</sup> 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

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44. Tyler, L.E., 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)<sup>45</sup> 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

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45. Maccoby, E.E., and Jacklin, C.N., The psychology of Sex Differences. Standord University Press, Stanford, California, 1974.

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)<sup>46</sup> found significant sex differences associated with the superior performance of boys recorded with respect to spatial abilities. Sherman (1978)<sup>47</sup> 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).<sup>48</sup>

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 partialled out. However, it is not possible to conclude from this that the sex differences in

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46. Petersen, A.C., et.al. Op.Cit., 1982.

47. Sherman, J.A., Op.Cit., 1978.

48. Maccoby, E.E., and Jacklin, C.N. Op.Cit., 1974.

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)<sup>49</sup> 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,

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49. Fennem, E., and Sherman, J.A. Sex-related differences in mathematics achievement, spatial visualization and effective factors, American Educational Research Journal; 47; 1977, 51-71.

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)<sup>50</sup> and Wittig and Petersen (1979)<sup>51</sup> 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)<sup>52</sup> 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

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50. Sherman, J.A., Op.Cit., 1978.

51. Wittig, M.A., and Petersen, A.C., (Eds.) Sex-related Differences in Cognitive Functioning : Development Issue. Academic Press, New York, 1979.

52. Ljung, B.O., The Adolescent spurt in Mental Growth. Almqvist and Wiksell, Stockholm, 1965.

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)<sup>53</sup> 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)<sup>54</sup> reviewed the studies on the effect of sex-role as a mediator of intellectual functioning,

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53. Keeves, J.P., Op.Cit. 1973.

54. Wittig, M.A., and Petersen, A.C., Op.Cit. 1979.

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)<sup>55</sup> 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)<sup>56</sup> strongly endorse the hypothesis

55. Meece, J.L., Parson, J.E., Sex differences in Mathematics achievement : Toward a model of academic choice. Psychol. Bull. 91. 1982, 324-48.

56. Parson, J.E., Kaczala, C.M., and Meece, J.L., Socialization of achievement attitudes and beliefs : Classroom influences. Child Development. 53 : 1982, 322-39.

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)<sup>57</sup> have reported that pupils from higher socio-economic status excelled in scholastic performance. Singh (1965)<sup>58</sup> found scholastic performance to be positively correlated

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57. Bennur, C.S., and Abraham, D.A. Study of the relationship between socio-economic status and academic achievement of pupils of rural and urban high schools. Journal of Karnatak University (Social Science) 1973, 9, 33-39.
58. Singh, B.N., Some non-intellectual correlates of academic achievement, unpublished Ph.D. Thesis, Patna University, 1965.,

with father's education. Studies conducted by Curry, (1962)<sup>59</sup> Anand, (1973)<sup>60</sup> 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)<sup>61</sup> 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)<sup>62</sup>,

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59. Curry, R.L., "The effect of socio-economic status on the scholastic achievement of sixth grade children," British Journal of Education and Psychology. 32(1), 1962, pp. 46-49./
60. Anand, C.L., "A study of the effect of socio-economic environment and medium of instruction on the mental abilities and the academic achievement of children in Mysore State." Ph.D, Education., Mysore University, 1973.
61. Lalithama, K.N., 'Some Factors Affecting Achievement of Secondary School Pupils in Mathematics,' Ph.D.Education. Kerala University, 1975.
- 62,. Chopra, S.L., "Socio-economic background and failure in the high school examination," Education and Psychological measurements, 2,1966. pp. 496-497.

Verma, (1971)<sup>63</sup>; Reddi, (1973)<sup>64</sup>; Abraham, (1974)<sup>65</sup>; Prakashchandra, (1975)<sup>66</sup>; Saini, (1977)<sup>67</sup> and, Ganapathy and Singh, (1981)<sup>68</sup> also revealed a positive and significant relationship between academic achievement and socio-economic status of pupils. Again, a study conducted by Contractor (1984)<sup>69</sup> 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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63. Verma, D., "Student Failure; Few Observation," The progress of Education, XLVI, 3, 1971, pp 82-85.
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.
65. Abraham, M., "Some factors relating to under achievement in English of secondary school pupils," Ph.D. Education, Kerala University, 1974.
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.
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.
68. Ganapathy, M., & Raghuram Singh, M., "The impact of socio-economic conditions on achievement," Experiment in Education, 9(8), 1981, pp 144-177.
69. Contractor, B.M., A Study of Some Background Factors underlying scholastic performance. Journal of Education and Psychology, Vol.XXXI No.4 Jan.1984 pp 215-219.

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)<sup>70</sup> Srivastava (1967)<sup>71</sup> Bernstein (1968)<sup>72</sup> Jha, (1970)<sup>73</sup> Sudama (1973)<sup>74</sup> and Ahluwalia and Shyam (1975)<sup>75</sup>

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70. Rao, D.G., 'A Study of Some Factors Related to Scholastic Achievement' Ph.D. Education, Delhi University, 1965.
71. Srivastava, A.K., 'An Investigation into the Factors Related to Educational Under-achievement,' Ph.D. Psychology, Patna University, 1967.
72. Bernstein, B., "Some sociological determinants of perception and enquiry into sub-cultural differences," British Journal of Sociology, 9, 1968, pp.159.
73. Jha, V., An Investigation into Some Factors Related to Achievement in Science by Students in Secondary Schools., Ph.D. Education, Patna University, 1970.
74. Sudama, G.R., "A Study of the effect of library use on academic achievement of Post-graduate students in the M. S. University of Baroda," Ph.D. Education, M.S. University of Baroda, 1973.
75. Ahluwalia, S.P., and Shyam, D., "A Study of relationship between socio-economic status and academic achievement of high school students," Journal of Educational Research and Extension, 12, 17, 1975 pp 1-5.

Sharma and Bhargava (1980)<sup>76</sup> which revealed very little to negligible impact of SES on academic achievement. Miller (1970)<sup>77</sup> concluded that factors associated with achievement of the children are generally less associated with social class. Besides, the finding of Bansal (1977)<sup>78</sup> 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.

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76. Sharma, V.P., and Bhargava, M., "Academic attainment and prolonged deprivation, Journal of Education and Psychology, 37, 4, 1980.
  77. Miller, G.W., "Factors in school achievement and social class," Journal of Educational Psychology. Vol.61 (4), 1970, pp 260-269.
  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, 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)<sup>79</sup> in Springfield, Illinois and Fram (1946)<sup>80</sup> 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)<sup>81</sup> 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

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79. Jewell, Lucille. "A study of the reading readiness of under privileged children". Unpublished M.A. thesis, Iowa, State University of Iowa, 1941.

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

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)<sup>82</sup> show that students grades are correlated positively with social-class position. Warner and associates (1949)<sup>83</sup> 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.

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82. Hollingshead, A.B., and Redlich, F.C. Social class and Mental illness. New York, Wiley, 1958.

83. Warner, W.L., and Associates. Democracy in Jonesville. New York, Harper and Bros. 1949 pp 205-206.

Abrahamson (1951)<sup>84</sup> 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)<sup>85</sup> has demonstrated that children of parents who work with their hands are likely to run into trouble in school works. Campbell (1952)<sup>86</sup> observed that certain aspect of the home background greatly affected secondary school achievement. Sewel, Haller and Strans (1957)<sup>87</sup> 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

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84. Abrahamson, Stephen. "A study of relationship between the social class background of Junior high school students and the rewards and punsihments of Junior High School Ph.D. Dissertation, New York University, 1951. Univer-sity Microfilms Publiscations No:3437.
85. Davis, Allison. "Education for the conservation of human resources". Progressive education - preliminary report, May 1950, pp.221-226.
86. Campbell, W.J., "The influence of home environment on the Educationist Progress of selected secondary school children. British Journal of Educational Psycho-logy, Vol,122, 1952, pp 89-100.
87. Sewel, William H; Haller, Archie, and Murray A.S., "Social status and educational and occupational aspiration" American Sociological Review, Vol: XII, No.1, 1957, pp. 67-73.

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)<sup>88</sup> 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)<sup>89</sup> 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)<sup>90</sup> examined the hypothesis that certain factors in school, home and communi-

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88. Klausmier, H.G., "Physical, Behavioural and other Characteristics of high and low achieving children is Favoured-Environment". Journal of Educational Research Vol.51, 1958, pp 1,573-581.
89. Coster, John K., "Some characteristics of high school pupils from three income groups" Journal of Educational Psychology, (April, 1959) p-62.
90. Youmans, E.Grant., Factors in Educational attainment. Rural Sociology, Vol.24, No.1, March 1959 pp.21-28.

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 influential in their children's educational attainments, especially in the low status group. Singh (1965)<sup>91</sup> 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

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91. Singh, B.N., Some non-intellectual correlates of academic achievement. Unpublished Ph.D. Thesis, Patna University, 1965.

be gained. Seigel and Duff (1960)<sup>92</sup> 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)<sup>93</sup> 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)<sup>94</sup> six factors were found to reveal

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92. Seigel, L., & Duff, C.L., "Biographical factors Associated with Academic over and under Achievement". Journal of Educational Psychology: Vol:51, 1960.pp. 43-46.
93. Hunt, J.G., "A study of non intellectual factors related to academic achievement among college seniors at Ball State Teachers College". Dissertation abstracts, Vol.22, 1961, p.157.
94. Frankel, E., "A comparative study of over achieving and under achieving high school boys of high intellectual ability". Journal of Educational Research, Vol.53, No.5, January 1961, pp 172-180.

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)<sup>95</sup> 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. Lindgred and Guedes (1963)<sup>96</sup> 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

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.
96. Lindgred 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)<sup>97</sup> studied "Children's estimate of their school work ability, as function of race, 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)<sup>98</sup> has examined the relationship between SES factor

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97. Wylie, Ruth C., "Children's estimate of their School work ability as a function of sex, race and Socio-economic level." Journal of personality. Vol.31, No.2, June, 1963, pp 203-225
98. Mathur, "Effects of SES on achievement and behaviour of Higher Secondary School Students". Ph.D.thesis, Agra, 1963.

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)<sup>99</sup> 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)<sup>100</sup>

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99. Bruckman, J.R., "The relationship between Achievement motivation, and sex, age, social class, school stream and Intelligence." Journal of Soc'and Clin.Psychol.1966.

100. Hoffman, M.L., Mitos, S.B., and Protz, R.E. "Achievement Striving social class and Test Anxiety" Journal of abnormal and social psychology. 1958, pp. 56, 401-403.

Desai (1970)<sup>101</sup> studied n Achievement of the pupils and socio-economic status. The findings reveal that pupils of high and middle socio-economic status score higher in n 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 n 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) n 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 n Achievement (4.94) than the low and the high income group (3.71, 2.00) though the difference is not significant.

Pathak (1973)<sup>102</sup> studied the n Achievement according to school status. The findings reveal that the highest mean

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101. Desai, D.B., Achievement Motivation in High School Students, (Memo), M.B.Patel College of Education, Vallabh Vidyanagar, 1970.
102. Pathak, C.C., "A study of Achievement motive, educational norms and school performances of high school pupils." Unpublished Ph.D. Thesis. Sardar Patel University, 1973.

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

Parikh, (1975)<sup>103</sup> 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 n Achievement score than the children of the parents having low educational (4.22) and low income level. Phutela (1975)<sup>104</sup> studied the relationship between SES and n Achievement. The findings reveal that n 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)<sup>105</sup> boys of fathers belonging to professional occupation showed the highest n Achievement followed by those from semi-professional occupations and then by those from skilled, the semi-skilled and the unemployed showing the least.

103. Parikh, Prabibha, A; "A study of the achievement motivation, school performance and educational norms of secondary school pupils of standard VIII, IX, and in the city of Bombay". Unpublished Ph.D.thesis. Bombay University, Bombay, 1975.
104. Phutela, R.L., "A study of some selected motivational factors in relation to Academic achievement and socio-economic status among the College students in the states of Haryana and Punjab." Unpublished Ph.D. thesis, CASE, M.S. University, Baroda, 1976.
105. Gokulnathan, P.P., and Mehta, P., "Achievement motive in Tribal and Non-tribal Assamese Secondary School adolescents" Indian Educational Review NCERT, New Delhi, Jan 1972, pp 7, 67-89

Rao (1975)<sup>106</sup> studied socio-economic status, as one of the variable affecting  $n_p$  Achievement. The findings reveal that there is significant difference in the  $n_p$  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  $n_p$  Achievement level. The development of  $n_p$  Achievement in the children and young people is party due to the educational level of the head of the family, under whose care, guidance and discipline they are brought up. Choksi (1973)<sup>107</sup> found that the high SES pupils have higher  $n_p$  Achievement than the middle and low SES pupils. The difference is significant at .05 level between high and low SES on their  $n_p$  Achievement score.

In another study Bokil (1956)<sup>108</sup> attempted to ascertain comparative examination efficiency of boys and girls of

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106. Rao, K.S., "Study of self perception, Achievement motivation, and Academic performance of the prospective secondary school teachers". Unpublished Ph.D. thesis. CASE, M.S. University, Baroda 1975.
107. Choksi, A.J., "A study of Achievement motivation, adjustment, self concept and Anxiety in Relation to Socio-economic status of the pupils of ninth standard of the English Medium schools of Baroda." M.Ed. Dissertation, M.S. University, Baroda, 1973.
108. Bokil, S.R., "Study of SSC Examination Results (Sex and Age as Factors)", Research and Investigation Section, Maharashtra State Board of Secondary Education, Poona, 1956.

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)<sup>109</sup> 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.

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109. Buddhi Raja, "An Analytical Study of the results of the High School Leaving Certificate (HSLC) Examination in Mizoram. Unpublished M.Ed. Dissertation, North-Eastern Hill University, 1981.

Lalduhsanga (1983)<sup>110</sup> 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.

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110. Lalduhsanga, J., "A study of personality factor patterns of low, normal and high achievers in secondary school science". Un-published M.Ed. Dissertation, NEHU, 1983.

Science achievement among the secondary students in Aizawl in relation to intelligence and socio-economic status was analysed by Sudhir and Muralidharan Pillai (1987)<sup>111</sup>. 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)<sup>112</sup> 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.

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111. Sudhir, M.A., and Muralidharan Pillai, P.G., Science Achievement in relation to Intelligence and Socio-economic status : A study of secondary school students in Aizawl. Indian Journal of Psychometry and Education, Vol.18(1), Jan 1987 pp 37-44.
112. Sudhir, M.A., and Darchhingpuii, Science Achievement and Science attitudes among College students. Journal of the Institute of Educational Research. Vol.II, No.3, Sept. 1987 pp. 5-10.

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)<sup>113</sup> reviewed 54 studies in the United States, Gardner (1975)<sup>114</sup> referred to more than 200 British, Australian and United States Studies, while Ormerod and Duckworth (1975)<sup>115</sup> 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)<sup>116</sup> 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

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113. Aiken, L.R., Aiken, D.R., Recent research on attitudes concerning science. Science education, 1982. 53: 295-305.
114. Gardner, P.L., Attitudes to science: A review. Science Education; 2: 1-41, 1975.
115. Ormerod, M.B., and Duckworth, D., Pupils attitudes to Science : A Review of Research. National Foundation for Educational Research, Slough. 1975.
116. Haladyna, T., and Shaughnessy, J., Attitudes toward science : A quantitative synthesis. Science Education, 1982.

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.

In spite 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)<sup>117</sup>. Similarly, a meta-analysis of 49 studies conducted by Haladyna and Shaughnessy (1982)<sup>118</sup> found a median correlation of +0.15 between scores on various achievement and attitude measure. The strength

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117. Comber, L.C., and Keeves, J., Science Education in Nineteen countries: An Empirical Study. Wiley, New York, 1983.

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)<sup>119</sup>.

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

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119. Gardner, P.L., Attitudes to science: A review. Science Education. 2: 1-41, 1975.

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)<sup>120</sup> 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

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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)<sup>121</sup> 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)<sup>122</sup>. 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.

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121. Comber, L.C., and Keeves, J., Op.Cit. 1973.

122. Gardner. Op.Cit., 1975.

Neale and Proshek (1967)<sup>123</sup> and Glick (1970)<sup>124</sup> 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)<sup>125,126</sup> 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

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123. Neale, D.C., and Proshek, J.M., School related attitudes of culturally disadvantaged elementary school children. Journal of Educational Psychology, 58, 1967, 238-244.
124. Glick, O., Sixth graders' attitudes toward school and interpersonal conditions in the classroom. Journal of Experimental Education, 38, 1970, 17-22.
125. Yee, A.H., Factors involved in determining the relationship between teachers' and pupils' attitudes. Austin, Texas: University of Texas. 1966.
126. Yee, A.H., Source and direction of causal influence in teacher pupil relationships. Journal of Education Psychology, 1968, 59, 275-282.

attitudes, Coster (1958)<sup>127</sup> 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)<sup>128</sup> found that female high school students held more favourable attitude towards teachers than the male students. Gregersen and Travers (1968)<sup>129</sup> 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)<sup>130</sup> 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.

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127. Coster, J.K., Attitudes toward school of high school pupils from three income levels. Journal of Education Psychology, 1958, 49, 61-66.
128. Leeds, C.H., and Cook, W.W., The construction and differential value of a scale for determining teacher-pupil attitudes. Journal of Experimental Education, 1947, 16, 149-159.
129. Gregersen, G.F., and Travers, R.M.W.. A study of the child's concept of the teacher. Journal of Educational Research, 1968, 61, 324-327.
130. Jackson, P.W. Life in Classrooms. New York, Holt, Rinehart and Winston, 1968.

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)<sup>131,132</sup> After surveying 8,156 high school boys and girls, Coleman (1959)<sup>133</sup> 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)<sup>134</sup>

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131. Demos, G.D., Attitudes of student ethnic groups on issues related to education. California Journal of Educational Research, 1960, 11, 204-206, 224.
132. Dunn, J.A., The approach-avoidance paradigm as a model for the analysis of school anxiety. Journal of Educational Psychology, 1968, 59, 388-394.
133. Coleman, J.S., Academic achievement and the structure of competition. Harvard Educational Review, 1959, 29, 330-351.
134. Lavin, D.E., The prediction of academic performance. A theoretical Analysis and Review of Research. New York, Russel Sage Foundation, 1965.

Astin reports the findings of a study done by Slee (1975)<sup>135</sup> 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)<sup>136</sup> which presented evidence of differential factor pattern of attitude. Barrilleux (1961)<sup>137</sup> 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.

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135. Slee, F.W., "Feminine Image Factor in girls attitudes to schools subjects, quoted by Helen Astin" Young women and their roles," In, Youth : The Seventy Fourth Year Book of N.S.S.E. part 1: Chicago: N.S.S.E. 1975.
136. Diggory, J.A., "Sex differences in the organisation of attitudes" quoted in Ebel (Ed.) Encyclopedia of Educational Research, London. The Macmillan Company, p.1219.
137. Barrilleaux, L.E., "High School science achievement as related to interest and IQ", quoted in L.E. Tylor, Op.Cit., p. 1961.

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)<sup>138</sup> 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)<sup>139</sup> 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.

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138. Lewis, R.Aikan, Jr. and Dorothy R.Aikan "Recent research on attitudes concerning science." Science Education, Vol.53, 4, October 1969
139. Daniel C. Neale, Noel Gill and Werner Tismer, "Relationship between attitudes toward school subjects and school achievement" The Journal of Educational Research, Vol. 63, No.5, January, 1970.

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)<sup>140</sup> 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)<sup>141</sup> 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.

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140. Edwards, T.R., and Wilson, A.B., The specialization of interest and academic achievement. Havard Educational Review, 28, 1958, p.196.
141. Mayer, G.R. "Factors accompanying the scientific interest of a selected group of English secondary pupils." Australian Journal of Education, 5, 1961, pp. 27-40.

A swing away trend from science was noticed in Britain since 1960's by the Dainton Committee for scientific policy. Duckworth and Entwistle (1974)<sup>142</sup> detected sex difference in two main aspects in science. Even the potential scientists reported physics and chemistry difficult even though they were quite interesting.

The relationship between favourable scholastic attitudes and level of academic achievement is functional, rather than causal. This indicates that the academic success helps to promote satisfaction with school which, in turn increases the possibility of future successes. Bloom, (1971)<sup>143</sup> Jackson, (1968)<sup>144</sup> and Aiken (1970)<sup>145</sup> 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

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142. Duckworth, D., and Entwistle, N.W., "The swing from science. A perspective from Hind sight." Educational Research, 17. 1, November, 1974.
143. Bloom, B.S., Affective consequences of school achievement. In J.H.Block (Ed.), Mastery Learning. New York: Holt, Rinehart and Winston, 1971, pp. 13-28.
144. Jackson, P.W., Life in classroom. New York: Holt, Rinehart and Winston, 1968.
145. Aiken, L.R., Jr. Attitudes towards Mathematics. Review of Education Research, 1970, 40, 551-596.

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)<sup>146</sup>, Khan and Roberts (1971)<sup>147</sup>

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

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146. Holtzman, W.H., and Brown, W.F., Evaluating the study habits and attitudes of high school students. Journal of Educational Psychology, 1968, 59, 404-409.
147. Khan, S.B., and Roberts, D.M., Factorial stability of academically relevant effective characteristics. Measurement and Evaluation in Guidance, 1971, 3, 209-212.

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)<sup>148</sup> and Welch, (1979)<sup>149</sup> 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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148. Ormerod and Duckworth Op.cit, 1975.

149. Welch W. Twenty years of Science curriculum development: A look back. Review of Research in Education. 7: 282-306.

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)<sup>150</sup> 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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150<sup>(1)</sup> Darchhingpuii "A study of science achievement and science attitudes among male and female college students in Mizoram". M.Ed.Dissertation, North-Eastern Hill University. Aizawl, 1982.

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

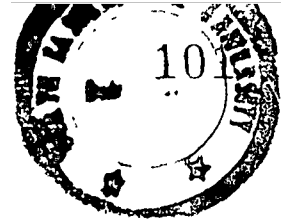
or readily available. There is a need that is left unsatisfied or a goal that is not attained, and the individual has to employ all his physical and mental resources, knowledge, skills and attitudes to make an integrated approach to the situation.

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 frame work 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 humanbeings 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)<sup>151</sup> adults with high IQs usually maintain the ability until late years in life (Arenberg, 1974)<sup>152</sup> 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)<sup>153</sup> 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)<sup>154</sup> and Cijfer, (1966)<sup>155</sup> 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

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151. Stork, P.A., Looft, W.R., & Hooper, F.H. Interrelationships among Piagetian tasks, and traditional measures of cognitive abilities in mature and aged adults. Journal of Gerontology, 1972, 27, 161-465.
152. Arenberg, D.A., A longitudinal study of problem-solving in adults. Journal of Gerontology, 1974, 29, 650-658.
153. Arenberg, D., Concept of problem solving in young and old adults. Journal of Gerontology, 1968, 23, 279-282.
154. Walford, A.T., Aging and Human Skill. London: Oxford University Press, 1958.
155. Cijfer, E., An experiment on some differences in logical thinking between Dutch medical people, under and over the age of thirty-five. Acta Psychologica, 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)<sup>156</sup> 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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156. Jerome, E.A. Decay of heuristic process in the aged. In C. Tibbits & W. Donahue (Eds.) Social and Psychological Aspects of Aging. New York: Columbia University Press, 1962.

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)<sup>157</sup> 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)<sup>158</sup>. Teaching students

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157. Glasser, R., The contributions of B.F. Skinner to education. In P. Suppes (Ed.), Impact of Research in Education :--Some case studies. Washington, D.C.: National Academy of Education, 1978.
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)<sup>159</sup>. 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)<sup>160</sup> noted that the way students function in problem situations is related to their knowledge of that context. According to Neisser (1976)<sup>161</sup> and Gagne (1965)<sup>162</sup> cognitive science has resulted in a renewed focus on the student's perception as the initial and most significant concept in understanding complex learning.

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159. Bybes, R.W., Transformations in Elementary Science Education. Essay written for the National Science Teachers Association Bicentennial competition on the History of Science Education, March 1976. (Mimes).
160. Norton, R., & Butts, D., A developmental Study in Assessing Children's Ability to Solve Problems in Science. Abstracts of the National Association for Research in Science Teaching. Fortysixth Annual Meeting, ERIC, 1973.
161. Neisser, U., Cognition and Reality : Principles and Implications of Cognitive Psychology. San Francisco: Freeman 1976.
162. Gagne, R.M., The Conditions of Learning. New York, Holt, Rinehart, 1965.

Johnson et.al. (1980)<sup>163</sup> 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)<sup>164</sup> and Andersen and Smith (1981)<sup>165</sup> 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)<sup>166</sup> describes this as what learners do after they have been given a problem context and identified what about that context is the unknown.

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163. Johnson, P. : Ahlgness, A. : Blount, J : & Petil, N. Scientific reasoning : Garden paths and blind alleys. In J.Robinson (Ed.), Research in Science Education : New Questions, New Directions. Louisville, Ky. : Center for Educational Research and Evaluation, 1981, pp. 87-114.
164. Winnie, P., & Mark, P. Reconceptualizing research on teaching, Journal of Educational Psychology, 1977, 69, 668-678.
165. Andersen, C., & Smith, E. Patterns in the Use of Elementary School Science Programme Materials: An Observational Study (National Association for Research in Science Teaching Bastract) Columbus, Ohio : 1981.
166. Larkin, J. Understanding and Problem Solving in Physics. In J.Robinson (Ed.) Research in Science Education: New Questions, New Diretions. Louisville, Ky. Center for Educational Research and Evaluation, 1981, pp.116-130

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, 1934<sup>167</sup>; Billings, 1934<sup>168</sup>; Sweeney, 1957<sup>169</sup>; Terman and Tyler, 1954<sup>170</sup>)

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167. Bedell, R.C. The Relationship Between the Ability to Recall and the Ability to Invert in Specific Learning Situations. Science Educ., 18: 158-162, 1934
168. Billings, M.L. Problem-solving in Different Fields of Endeavour, American Journal of Psychology, 46: 259-272, 1934.
169. Sweeney, E.J., Sex Differences in Problem Solving, Technical Report Stanford University. Stanford. 1953.
170. Terman, L.M. and Tyler, L.E. Psychological Sex Differences. In L.Carmichael (Ed.), Manual of Child Psychology, New York: Wiley 1954.

Mc Nemar, 1955;<sup>171</sup> Staats, 1957<sup>172</sup> Priest and Hunsaker, 1969<sup>173</sup>  
 Maier and Burke, 1967;<sup>174</sup> Maier and Casselman, 1970<sup>175</sup> Roll,  
 1970;<sup>176</sup> Constantinople, 1974<sup>177</sup> Raaheim and Kaufman, 1974;<sup>178</sup>  
 Felen, 1975;<sup>179</sup> Maxwell, 1975;<sup>180</sup>)

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171. Mc Nemar, O.W. An Attempt to Differentiate Between Individuals with High and Low Reasoning Ability. American Journal of Psychology., 68: 20-36, 1955.
172. Staats, A.W. Verbal and Instrumental Response Hierarchies and their Relationship to Problem Solving. American Journal of Psychology., 70: 442-446, 1957.
173. Priest, R.E. and Hunsaker, P.L. Compensating for a Female's Disadvantage in Problem Solving. Journal of Experimental Research. Personality. 4: 57-64, 1969.
174. Maier, N.R.F. and Burke, R.J. Response Availability as a Factor in the Problem Solving Performance of Males and Females. Journal of Personality Social Psychology., 5: 304-310, 1967.
175. Maier, N.R.F. and Casselman, G.G. Locating the Difficulty in Insight Problems: Individual and Sex Differences. Psychol. Rep., 26: 103-117. 1970.
176. Roll, S. Sex Differences in Problem Solving as a Function of Content and Order of Presentation. Psychonomic Science, 19: 97, 1970.
177. Constantinople, A. Analytural Ability and Perceived Similarity to Parents. Psychol. Rep., 35: 1335-1345, 1974.
178. Raaheim, K. and Kaufmann, G. Sex Role - Related Behaviour. I.Q. and Problem Solving in 15-16 Yrs. Olds, J. Gen. Psychol. 90: 233-236, 1974.
179. Felen, B.K. An Analysis of Science Problem Solving Among Male and Female Students in Grade on Through Twelve. Diss. Abstr., 27: 2508, 1975.
180. Maxwell, A.A. An Exploratory Study of Secondary School Geometry Students: Problem Solving Related to Convergent Productivity. Diss. Abstr. 35: 4987, 1975.

Contrary to these findings, some of the studies, however, failed to reveal any significant sex difference in problem solving ability. (Raaheim, 1963<sup>181</sup> Hoffman and Maier, 1961;<sup>182</sup> Mendelsohn, Griswold and Anderson, 1966;<sup>183</sup> Davis, 1966;<sup>184</sup> Strzyzewsky, 1973;<sup>185</sup> Singer, 1975;<sup>186</sup> Westmoreland, 1975;<sup>187</sup> Kumar, 1980;<sup>188</sup> and Kumar and Kapila, 1981;<sup>189</sup>).

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181. Raaheim, K. Sex Differences on Problem Solving Tasks. Scand. J. Psychol., 4: 161-164, 1963.
182. Hofdfman, L.R. and Maier, N.R.F. Sex Differences; Sex Composition and Group Problem Solving. Journal of Abnormal Social Psychology., 63: 435-436, 1961.
183. Mendelsohn, C.A; Griswold, B.B; and Anderson, M.L. Individual Differences in Anagram Solving Ability. Psychol.Rev., 19: 799-809, 1966.
184. Davis, G.A. Current Status of Research and Theory in Human Problem Solving. Psychol, Bull., 66: 36-54, 1966.
185. Strzyzewsky, S. Youth from Bydgoszes. Primary Schools in the light of J.C.Raven's Progressive Matrices Test. Przegland Psychologicany, 16: 61-70, 1973.
186. Singer, J.E.; Sexual Mythology; A Social Learning Approach to the Elimination of Sex Role Stereotyped Behaviour in Women. Dissertation Abstr., 34: 2484, 1975.
187. Westmoreland, J.S.; First Grade Entrants' Arithmetic Problem Solving Behaviour as Influenced by Language Variation and Sex. Dissertation Abstr., 35: 5796, 1975.
188. Kumar, D., The Role of Motivating Instructions in Insightful Problem Solving in Males and Females. Communicatd to Psychologia Japan, 1980.
189. Kumar, D. and Kapila, A.; Sex Differences in Problem Solving as a Function of Extraversion and Masculinity, Communicated to Acta Psychologica, 1981.

A few studies have shown the superiority of females over males. (Kumar,1974;<sup>190</sup> Miles,1976;<sup>191</sup> Hayes,1978;<sup>192</sup> Singh, 1979;<sup>193</sup>) Studies have also been conducted to reason out the poorer performance of females. Allern (1974)<sup>194</sup> has tried to analyse the problem of sex differences in terms of genetic and environmental factors which might determine it. The experiments of genetic factors are Kumar,(1974)<sup>195</sup> Raaheim and Kaufman, (1974);<sup>196</sup> and Eysenck and Wilson, (1976);<sup>197</sup> and that

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190. Kumar,D. An Experimental Study of Problem Solving Behaviour as a Function of Personality Drive and Practicce. Unpublished Doctoral Dissertation, Punjab University, 1974.
191. Miles,I.G. Competitive Achievement of Performance in Women as a Function of Achievement Motivation; Sex Role Attitude and Sex Appropriateness of Achievement Tasks in Intra and Inter Sex Competitive Situations. Diss.Abstr., 37: 6449, 1976.
192. Hayes,T.R. Interpersonal and Nonpersonal Problem Solving: A comparison with respect to Subjects Sex, Sex role Orientation and Problem Orientation. Diss.Abstr., 38: 6155, 1978.
193. Singh, K.A. A Study of Problem Solving Behaviour as a Function of Intelligence and Extraversion. Unpublished M.Phil. Dissertation; H.P.University; 1979.
194. Allern,M.J., Sex Differences in Spatial Problem Solving Styles. Percept. Mottor Skills, 41: 435-440, 1975.
195. Kumar,D. An Experimental Study of Problem Solving Behaviour as a Function of Personality Drive and Practice. Unpublished Doctoral Dissertation, Pubjab Univesity, 1974.
196. Raaheim, K. and Kaufmann,G. Op.Cit, 1974.
197. Eysenck,H.J. and Wilson,C.D. A Text-book of Psychology. University Parle Press Baltimore, 1956.

of environmental factors are Milton, (1957)<sup>198</sup> Carey,(1958)<sup>199</sup>  
 French and Thomas(1958)<sup>200</sup> Hoffman and Maier, (1961)<sup>201</sup> and  
 Nance and Sinnott, (1964)<sup>202</sup> Maier and Burke,(1967)<sup>203</sup> Col-  
 grove, (1968)<sup>204</sup> Priestd and Hunsaker (1969)<sup>205</sup> Loupe(1970)<sup>206</sup>

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198. Milton, G.A. The Effects of Sex Role Identification Upon Problem Solving Skills, Journal of Abnormal and Social Psychology., 55: 208-212, 1957.
199. Carey, G.L. Sex Differences in Problem-Solving Performance as a Function of Attitude Difference. Journal of Abnormal and Social Psychology, 56:256-260, 1958.
200. French, E.G. and Thomas, F.H. The Relation of Achievement Motivation to Problem-solving Effectiveness. Journal of Abnormal and Social Psychology, 56: 58, 1958.
201. Hoffman, L.R. and Maier, N.R.F. Op.Cit. 1961.
202. Nance, R.D. Sinnott, W. Levels of Difficulty and Consistency of Performance in Anagram Solving. Psychological Report. 14: 895-898, 1964.
203. Maier, N.R.F. and Burke, R.J., Op.Cit., 1967.
204. Colgrove, M.A. Stimulating Creative Problem Solving. Innovative Set. Psychological Report, 22: 1205-1211, 1968.
205. Priestd, R.E. and Hunsaker, P.L. Op.Cit. 1969.
206. Loupe, M.Y. The Training of Problem Solving and Enquiry. Dissertation Abstracts., 30: 4831, 1970.

Maier and Casselman,(1970)<sup>207</sup> Schneider and Delaney, (1972)<sup>208</sup>  
 Allern,(1974)<sup>209</sup> Arbuthnot,(1975)<sup>210</sup> Felen,(1975)<sup>211</sup> Singer,  
 (1975)<sup>212</sup> Wash,(1975)<sup>213</sup> Westmoreland,(1975)<sup>214</sup> Miles,(1976)<sup>215</sup>  
 Hulfish,(1977)<sup>216</sup> Mills(1978)<sup>217</sup> Singh,(1979)<sup>218</sup> and Kumar  
 (1980)<sup>219</sup>

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207. Maier,N.R.F. and Caselman,G.G. Op.Cit; 1970.
208. Schneider,F.W. and Delaney, J.G. Effect of Individual Achievement Motivation on Group Problem Solving Efficiency. Journal of Social Psychology, 2: 291-298, 1972.
209. Allern, M.J. Sex Differences in Spatial Problem Solving Styles. Percept. Mottor Skills, 39: 843-846, 1974.
210. Arbuthnot,J. Sex, Sex Role Identity and Cognitive Style. Percept. Mottor Skills, 41: 435-440, 1975.
211. Felen, B.K. An Analysis of Science Problem Solving Among Male and Female Students in Grade one Through Twelve. Dissertation Abstracts, 27: 2508, 1975.
212. Singer, J.G. Op.Cit; 1975.
213. Wash, D.H. Sex Role Differentiation in Problem Solving Groups. Dissertation Abstracts, 35: 3569, 1975.
214. Westmoreland, J.S. Op.Cit; 1975
215. Miles, I.G. Op.Cit; 1976.
216. Hulfish, S.M. The Relationship of Role Identification and Self-esteem to Sex Differences in the Embedded Figure Test. Dissertation Abstract., 37: 5355, 1977.
217. Mills, C.J. Sex Role Related Personality Correlates of Intellectual Ability in Adolescents, Dissertation Abstract, 38: 1936, 1978.
218. Singh, K. Op.Cit; 1979.
219. Kumar, D. Op.cit; 1980.

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)<sup>220</sup>. Where complex abilities are concerned, males are superior to females in spatial ability, Witkin et al, (1962)<sup>221</sup> Allern, (1974)<sup>222</sup> and McWay, (1976)<sup>223</sup> and women in verbal ability, Maccoby and Jacklin, (1974)<sup>224</sup> Females, right from birth until death, have been found to excel in expressing themselves in all aspects

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220. Tyler, L.E. The Psychology of Human Differences. Vakils: Bombay, 1965.
221. Witkin, H.A., Dyk, R.B., Faterson, H.F., Goodenough, D.R., and Kerp, S.A., Psychological Differentiation. New York: Wiley, 1962.
222. Allern, M.J., Op.Cit., 1974.
223. McWay, J.D. Jr. The Relationship of Sex Role Identification to Psychological Differentiation. Dissertation Abstracts. 37: 1916, 1976.
224. Maccoby, E.E., and Jacklin, C.N., The Psychology of Sex Differences. Stanford, California: Stanford University Press 1974.

of language usage-writing, spelling, grammar and sentence construction, [Nance and Sinnott, (1964)<sup>225</sup> Macy,(1973)<sup>226</sup> and Hayes (1978)]<sup>227</sup> In verbal reasoning and vocabulary, no significant sex differences have been found (Dunsden and Fraser, (1957)<sup>228</sup>; Clark, (1959)<sup>229</sup>; Raaheim and Kaufmann (1963)<sup>230</sup>)

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

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225. Nance, R.D. and Sinnott, W., Op.Cit., 1964.
226. Macy, A.W., A Study of Interaction Between Personality Traits, I.Q. and Achievement in Negro and White 4th, Grade Children,Dissertation Abstract. 34:1145, 1973.
227. Hayes, T.R., Op.Cit..., 1970
228. Dunsden. J.I., and Fraser, R., A Study of the Performance of 2000 Children in Four Vocabulary Test. British Journal of Statistical Psychology., 10: 1-16, 1957.
229. Clark, W.W., Boys and Girls - Are there Significant Ability and Achievement Differences? Phi Delta Kapan, 41: 73-76, 1959.
230. Raaheim, K., and Kaufmann, G., Op.Cit., 1963.

complex mathematical reasoning and manipulation of abstract numerical entities (Burke, 1965;<sup>231</sup> Priestd and Hunsaker, 1969)<sup>232</sup> Maier and Casselman, 1970;<sup>233</sup> Hayes, 1978)<sup>234</sup> Men excel women at mechanical tasks (Deaux and Emsueller, 1974;<sup>235</sup> Felen, 1975;<sup>236</sup> while women are superior in tasks which involve manual dexterity, i.e. light, deft, swift movements of the hands. (Tyler, 1965)<sup>237</sup> Eysenck and Wilson (1956)<sup>238</sup> have

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231. Burke, R.J., Sex Differences in Recognising the Correct Answer to a Problem. Psychological Report., 17: 532-534, 1965.
232. Priestd, R.E. and Hunsaker, P.L., Op.Cit., 1969.
233. Maier, N.R.F., and Casselmann, G.G., Op.Cit., 1970.
234. Hayes, T.R., Op.Cit., 1978.
235. Deaux, K., and Emsueller, T., Explanations of Successful Performance on Sex linked Tasks. What is Skill for the Male is Luck for the Female. Journal of Personality and Social Psychology., 29: 886, 1974.
236. Felen, B.K., Op.Cit., 1975.
237. Tyler, L.E., Op.Cit., 1965.
238. Eysenck, H.J., and Wilson, C.D., A Text-book of Psychology, University Parle Press, Baltimore, 1956.

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)<sup>239</sup> 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)<sup>240</sup> has stressed the need for a systematic and ambitious exploration of the influence

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239. Sweeney, E.J., Op.Cit., 1953.

240. Arbuthnot, J., Op.Cit., 1975.

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;<sup>241</sup> Loupe, 1970;<sup>242</sup> Deaux and Emsueller, 1975;)<sup>243</sup> 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;<sup>244</sup> French and Thomas, 1959;<sup>245</sup> Hoffman and Maier, 1963;<sup>246</sup> Schneider and Delaney 1972;<sup>247</sup> Miles, 1976;<sup>248</sup> Kumar, 1980)<sup>249</sup>

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241. Nance, R.D., and Sinnott, W., Op.Cit., 1964.
242. Loupe, M.Y., Op.Cit., 1970.
243. Deaux, K., and Emsueller, T., Op.Cit., 1974.
244. Carey, G.L., Op.Cit., 1958.
245. French, E.G. and Thomas, F.H., The Relation of Achievement Motivation to Problem-Solving Effectiveness. Journal of Abnormal and Social Psychology, 1956.
246. Hoffmann, L.R., and Maier, N.R.F., Op.Cit., 1963.
247. Schneider, F.W. and Delaney, J.G. Op.Cit.; 1972.
248. Miles, T.G., Op.Cit.; 1972.
249. Kumar, D., Op.Cit.; 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)<sup>250</sup> Allern, (1974)<sup>251</sup> and Felen (1975)<sup>252</sup> 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)<sup>253</sup> and Maier and Casselman (1970)<sup>254</sup> 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)<sup>255</sup> Priestd and Hunsaker (1969)<sup>256</sup> Kumar (1974, 1980)<sup>257,258</sup> and Singer (1975)<sup>259</sup> found improvement in female performance after receiving experimental instructions. Milton (1957)<sup>270</sup> found that when the form of the problem was changed from masculine

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250. Maier, N.R.F., and Casselman,G.G., Op.Cit., 1970.

251. Allern, M.J., Op.Cit., 1974.

252. Felen, B.K., Op.Cit., 1975.

253. Burke, R.J., Op.Cit., 1965.

254. Maier, N.R.F., and Casselman,G.G., Op.Cit. 1970.

255. Colgrove, M.A., Op. Cit., 1968.

256. Priestd, R.E., and Hunsaker, P.L., Op.Cit., 1969.

257. Kumar, D., Op.Cit.,1974.

258. Kumar, D., Op.Cit., 1980.

259. Singer, J.E., Op.Cit., 1975.

260. Milton, G.A. The Effects of Sex Role Identification Upon Problem Solving Skills, Journal of Abnormal and Social Psychology, 55: 202-212, 1957.

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)<sup>261</sup> 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)<sup>262</sup> had also revealed that under certain conditions female performance was lowered.

Milton (1957, 1959)<sup>263,264</sup> 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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261. Tyler, L.E., Op.Cit; 1965.

262. French, E.G., and Thomas, F.H., Op.Cit; 1956.

263. Milton, G.A., Op.Cit; 1957

264. Milton, G.A., "Sex differences in problem solving as a function of role appropriateness of the problem context." Psychological Reports, 5, 1959, pp.705-708.

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)<sup>265</sup> Miles (1976),<sup>266</sup> and Hulfish (1977)<sup>267</sup> have shown that masculinity and femininity do affect the performance of the subjects.

Milton (1957)<sup>268</sup> 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)<sup>269</sup> Behrens (1974)<sup>270</sup> and Suter and Dominko (1975)<sup>271</sup> 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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265. Arbuthnot, J., Op.Cit; 1975.
266. Miles, I.G., Op.Cit; 1976.
267. Hulfish, S.M., Op.Cit; 1977.
268. Milton, G.A., Op.Cit; 1957.
269. Yonge, G.D., The Use of Masculinity-femininity Measures to Account for Sex Differences in Problem Solving. California. Journal of Educational Research.,12: 208-212, 1961.
270. Behrens, M.G., Effects of Global-analytical Style, Female Role Orientation and Fear of Success on Problem Solving Behaviour. Dissertation Abstract.,34:3517,1974.
271. Suter, B., and Dominko, G., Masculinity-Femininity in Creative College Women. Psychological Abstracts., 54: 11836, 1975.

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)<sup>272</sup> 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)<sup>273</sup> 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

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272. Sweeney, E.J., Sex differences in problem solving. Stanford University., Dept. Psychol., Tech. Rep. No. 1, Dec, 1, 1953.

273. Kosti, M.M., A study of transfer: sex differences in the reasoning process. J.Educ. Psychol., 1954, 45, 449-458.

also been confirmed by Hilgard et.al (1984)<sup>274</sup> 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)<sup>275</sup> on pre-school children shows either negligible sex differences or a slight superiority of girls in the early development of numerical concepts. Terman (1954)<sup>276</sup> 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)<sup>277</sup> again found no significant sex difference or, more often, a difference in favour of girls on computation tests.

274. Hilgard, E.R., Edgren, R.D., and Irvine, R.P., Errors in transfer following learning with understanding: further studies with Katona's card-trick experiments, 1984.

275. Gesell, A., et al. The first five years of life. N.Y. : Harper, 1940.

276. Terman, Op.Cit., 1954.

277. Terman, 1954 Ibid.

However, on arithmetic problems and other numerical reasoning tests, males excelled consistently over the females. McNemar, (1942)<sup>278</sup> 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)<sup>279</sup> Bennett, (1952)<sup>280</sup> and Wesman, (1949)<sup>281</sup> found boys to score higher on numerical reasoning tests.

Guetzkov (1951)<sup>282</sup> found men to be superior to women in set-breaking capacity, but not susceptibility to set-breaking.

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278. McNemar, O., The revision of the Stanford-Binet Scale: an analysis of the standardization data. Boston: Houghton Mifflin, 1942.
279. Havighurst, R.J., and Breese, Fay, H., Relation between ability and social status in a midwestern community: 111, Primary mental abilities. Journal of Educational Psychology, 1947, 38, 241-247.
280. Bennet, G.K., Seashore, H.G., and Wesman, A.G., Differential Aptitude Tests: Manual. (2nd Ed.) N.Y:Psychol. Corp. 1952.
281. Wesman, A.G., Separation of sex groups in test reporting. Journal of Educational Psychology, 1949,40,223-229.
282. Guetzkov, H., "An analysis of the operation of set in problem solving behaviour," Journal of General Psychology, 45, 1951, pp 219-224.

Tyler (1965)<sup>283</sup> reports some evidence to show that the difference is primarily a matter of attitude toward problems and is susceptible to training. Carey (1958)<sup>284</sup> 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.

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283. Tyler, L., Op.Cit, 1965.

284. Carey, Gloria, L., "Sex differences in problem solving performance as a function of attitude differences." The Journal of Abnormal and Social Psychology, 56, No.2 March, 1958, pp. 256-60.

Milton (1959)<sup>285</sup> 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)<sup>286</sup> 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)<sup>287</sup> with college students as subjects and Leder's (1974)<sup>288</sup> analysis of sex differences in mathematics. The results led investigators

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285. Milton, G.A., Op.Cit, 1959.

286. Milton, G.A., "The effect of sex-role identification upon problem solving skill." Journal of Abnormal and Social Psychology, 55, 1957, pp.208-12.

287. Graft, R.G., and Jeanne C. Riddel, "Sex differences in problem solving as a function of problem context," The Journal of Educational Research, Vol.65, No.10, July-August, 1972.

288. Leder, G.C., Sex differences in Mathematics problem appeal as a function of problem context. The Journal of Educational Research, Vol.67, No.8, April, 1974.

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.



## C H A P T E R - III

DEVELOPMENT OF EDUCATION IN MIZORAMA brief account of Mizoram

Mizoram is a hilly area in the north eastern corner of India with an area of 21,090 square kilometers. It has international borders on its three sides. The east and the south are bounded by Burma, and the west by Bangladesh. This area, formerly known as Lushai Hills was one of the districts of Assam and it was called the Lushai Hills district till 1954 when it was renamed the Mizo District. In 1971, the land was elevated to the status of Union Territory by the North-Eastern Re-organisation Act, 1971 under the name Mizoram which means the land of the Mizos.

The tropic of cancer passes through the land at a place called Thenzawl which is 50 miles south of Aizawl, the capital of the State. Mizoram has a pleasant climate of a cool summer with the temperature ranging from 20 degree centigrade to 29 degree centigrade and a temperate winter with the temperature ranging from 1 degree centigrade to 21 degree centigrade.

The total population of the land is 4,93,757 as per 1981 census and the density of population is 23. The literacy rate is very high among the Mizos, much higher than the all India average. It has 59.88% literates surpassed only by Chandigarh, Kerala and Delhi. Aizawl, the capital has a population

of 74,493 with a literacy rate of 76.45% which is the second highest literacy rate of Urban area in India.<sup>1</sup>

#### Indigeneous System of Education In Lushai Hills

Before the advent of the British there was no organised or formal system of education in the Lushai Hills. Without a written language instructions were imparted symbolically, mostly oral-verbal in format and content. Family played a vital role as an informal agency of education for the children. The children received their education informally mostly from their parents. Boys learnt their traits from their fathers and girls from their mothers. The most suitable time for parents to teach their children was meal time when all the members of the family sat in a circle on the floor, eating food from a large common wooden plate. It was at this time that the father, who was the head of the family distributed work among the family members, gave necessary instructions for the work and spoke words of advice or caution to his children, and discussed family affairs with other members.

Girls obtained training in rearing children, cooking food, weaving and other domestic work from their mothers, grand mothers and other elderly women of the family. Apart

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1. Census of India (1981) Series 31 : Mizoram.

from this, they had to accompany their parents to the 'jhum' for cultivation. Boys also had to accompany and assist their elders in the jhum cultivation. This process helped the children to master the practice of jhum cultivation. Even today, the practice is being followed in the remote rural villages of Mizoram. Apart from this, boys were specially trained in traditional trades like carpentry, basketry and blacksmithy by elderly men in the community. In this way, in the ancient Mizo society, family occupied an important and prominent place and served as an effective agency of education. The mother who told folk tales, sang the folklores, and showed the folkways and the father who gave advice and set an example for behaviour and manners were the best teachers. In this informal context, the role of the father was specially significant in that he gave necessary instructions and corrected the behaviour and the manners of children from time to time.

'Zawlbuk': the traditional informal agency of Education.

In the traditional Mizo society, the 'Zawlbuk' or the bachelors' barrack was one of the very powerful and characteristics institutions. It can be considered as an indigenous informal agency for the socialization and the education of the youth. Here, the boys acquired the rudiments of knowledge and received training in discipline, and art of warfare, and learnt the Lushai customs and way of life.

Zawlbuk was a dormitory where all the young men of the village lodged till they got married, received training in the community life which made them fit for adult life in the tough atmosphere of lonely and warring people. As formal education had not yet found its way, 'Zawlbuk' stood out prominent as an institution of indigenous cradle of education and socialization.

The primary purpose of Zawlbuk was protection of the village against the attack by other villages. In olden days villages were constantly at war with one another and surprise attacks by neighbouring villages were not infrequent. This situation called for an arrangement which would enable and facilitate immediate and collective action by the young men of the village. From this initial concern, a Zawlbuk served a number of functions and became the most important institution in the life of a Mizo youth.

Zawlbuk was built and maintained by communal efforts and the whole village contributed free labour for its construction. Being the centre of village life, it functioned as the most potent institutionalised mechanism of social control. Every man in the village learnt all the discipline that had ever been possible in the Mizo social life from Zawlbuk. The inmates were supposed to take their turn for their daily chore of activities in the various duties for which the Zawlbuk

was responsible. All the boys in the village from the age of ten till they attained puberty attended the Zawlbuk regularly and their main responsibility was to supply firewood for the Zawlbuk. Children, except those of the chief's, were under compulsion to attend their duty in the Zawlbuk. One or two boys were commissioned to fetch drinking water at night. The boys so selected were exempted from supplying the firewood. Monitors were appointed to discipline the young boys from the time they joined this duty. The monitor had the right to punish anyone who failed to perform the common task. In the enforcement of the Zawlbuk discipline, no parent is supposed to have any say nor would the chief interfere. The inculcation of desirable habits and cherished values was the fundamental consideration in organizing the zawlbuk activities. An action which was not socially acceptable or even slight deviation from established social norms of behaviour and conduct used to be severely dealt with.

Highly important as it was as the center of informal education for the boys, it gradually lost its existence under the influence of Christianity and the spread of education in the land. The introduction of formal education through establishment of schools and the church activities stood in the way of Zawlbuk way of living. The young boys began to find it difficult to spare time to collect firewood for the Zawlbuk.

The young men also could no longer attend to the activities of Zawlbuk as they had joined the school. Thus, the influence of Christian religion supported by formal education led to the abolition of this indigenous informal educational institution in this tribal society.

Education in British Mizoram (1892-1947).

The educational history of Mizoram can be traced back to 1894 when the two missionaries of London Baptist Mission namely Rev.J.H. Lorrain and F.W. Savidge landed and settled at Aizawl. These missionaries started learning the language and realizing the extreme need and importance, developed a new alphabet for Mizo language. The simple Roman script with a phonetic Hunterian system of orthography was followed as closely as possible.<sup>2</sup> The birth of the script to the Lushai language virtually laid the foundation for formal education among the Mizos. The Baptist missionaries Savidge and Lorrain may be considered as the founding fathers of formal education and Lushai language.<sup>3</sup>

The main purpose of the missionary education was to enable the people to read the Bible and the Hymn Book thus enlightening the Mizos with the gospel of Jesus Christ.<sup>4</sup>

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2. J.H.Lorrain, Dictionary of the Lushai Language. The Asiatic Society, Calcutta, 1975, p.VIII (Introduction).
  3. E.L. Mendus, The Diary of a Jungle Missionary (Liverpool) Foreign Mission Office, 16 Falkner Street, 1956).
  4. L.N.Tluanga, Revised Draft Scheme for Reorganisation of Mizoram, Aizawl. Department of Education, Govt.of Mizoram p. 1.

Inspite of the initial resistance and superstition, the ignorant Mizos soon became ardent lovers of learning and knowledge. The consistently high rate of literacy in this rapidly transforming tribal territory is a testimony for this. The population and literacy of Mizoram (1901-1981) and the progress of education in Mizoram (1947-1986) are presented in Appendix 11 and 12.

The first school was opened on 1.4.1897 at MacDonald Hill in Aizawl by Rev.Savidge and J.H. Lorrain, the two Baptist missionaries. In this school 68 boys were enrolled and were given elementary education. The school commissioned successfully for a while but had to be closed as the missionaries devoted their time fully to the literary work such as translation of some sections of the Bible (Gospel of St.John, St.Luke, Acts of the Apostles) and brought out Lushai - English Dictionary in the same year.<sup>5</sup> However, the converts were given lessons in reading and writing on Sunday. Sunday was the free time for them to learn the scripts and the classes were held during their free time on every<sup>3</sup> Sunday in which the adults were taught reading and writing. Alphabet charts were freely distributed. Thus, sunday schools began to be popular among the Lushais and gradually it was transformed into Bible Study hour which is the best attended church service even today.

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5. J.M.Lloyed, On Every High Hill, (Liverpool Foreign Office, 1964).

In 1898 three government primary schools were opened in three places - Aijal, Lunglei and Tlabung. During the year, 27 young chiefs and selected men from villages were given education in the government school in Aijal. They were given free ration during their stay in Aijal.<sup>6</sup> In the same year, Rev. Edwin Rowland took over the charge of schools in Lushai Hills. In the mean time, the school at MacDonald Hill had been reopened by Rev. D.E. Jones, a Welsh missionary in 1897. The attendance in these schools was considerably poor in the beginning probably because of lack of interest on the part of the children as well as the parents. However, inspite of many hurdles in the beginning, the schools continued to function. The students were chiefly boys and the girls attending the schools usually had to carry their younger brothers or sisters on their backs. The teaching was of the simplest type imparting only the art of reading and writing. Those who could read and write were appointed as teachers. They acted not only as school teachers, but as evangelists and pastors. About the development of education, Lloyd says: "The school began to produce teachers as well as scholars and thus the foundations of the present Lushai Primary School system began to be laid. The Lushais were ever ready to pass on what they had learnt, however little. Many who had learnt only the alphabet succeeded

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6. Dr. A.C. Ray, Mizoram : Dynamics of Change, Calcutta: Pearn Publishers, 1982.

in passing on that knowledge to others. Many of the youths who came to that school at Aijal were found to have that facility of expression and felicity of illustration which mark the born teacher. And very soon some were sent on fairly lengthy visits to various villages. They brought the rudiments of education to people who had never seen a book. In a little over a generation the Lushai Hills had a higher percentage of people able to read and write than any other part of India.<sup>7</sup> The teachers having become Christians themselves, spread the gospel, along with education, throughout the district.

The education in the villages of Lushai Hills had a humble beginning in 1901 when 3 primary experimental schools were started in Khawrihnim, Phulpui and Chhingchhip villages. However, these schools failed to function after a few months. However, in 1903, 9 permanent primary schools were established simultaneously in the villages and the first primary school examination was held in the same year from 25th June to 3rd July. In this examination 27 candidates appeared and 19 of them passed the examination.<sup>8</sup> The top five successful candidates were awarded a stipend of Rs.3/- each per month for a period of 2 years.

In 1903, Sir Bamfield Fuller, Chief Commissioner of Assam visited Aijal. He was very much impressed by the

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7. J.M. Lloyd, Op.Cit.,

8. C. Lalchawimawia, Mizoram Zirna Tobul, Zirna Eng. No.49 p. 22-24, May 1988.

superior performance of the missionary schools. He then ordered the amalgamation of the government school with the missionary school and directed that all primary education would henceforth be in charge of the mission who would be given grant for this purpose.<sup>9</sup> From that year onwards till the taking over of the schools by the Government of Assam and subsequently by the District Council, missions were the official agencies of education among the Lushais for about 50 years.

The Middle English Schools were opened in 1906 at Aijal and Lunglei and the first Middle School examination was conducted in 1909.<sup>10</sup> Regarding the schools at Aijal, Rev. Rowland reported that the number of primary schools increased to 15 during 1903-04 and the Lushais on rolls crossed well over 400 but the attendance fluctuated considerably.<sup>11</sup> Aijal, being the heart of the village schools and centre of educational activities, students from distant villages came and resided at Aijal attending the Upper Primary and Lower Primary Schools. The situation showed slight improvement within two decades of missionary activities when the Lushais showed keen desire to educate their children. This indirectly led to the increase in number of students and schools. In 1906, the government intro-

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9. Administration Report of the Lushai Hills for the year 1903-04, Government of Assam, Shillong, 1904, p.8.
  10. Lalbiakliana, Mizoram Zirna Chanchin, (Aizawl, Social Education Wing, Education Department, 1979).
  11. Lalrimawia, British Policy to the Education of the Lushais upto 1947, Historical Journal of Mizoram, September, 1982.

duced 6 scholarships of Rs.10/- per month for 10 years, opening an opportunity to the promising Lushais to obtain higher education until such time as there was a high school in the Lushai Hills. The objective was to make trained Lushai young men available for appointment as clerks, sub-overseers, hospital assistants, etc.<sup>12</sup>

In 1944, the first government middle school was opened at Aijal. With the opening of more middle schools and increase in enrolment, the need for opening high school was more strongly felt and the attitude of the people towards education began to be changed in a positive direction. As a result of this, the first high school was opened in 1944 at Aijal with 56 students. The attempt was possible only through Public Funds and donations.<sup>13</sup> The expansion of education during 1894 to 1944 was due mainly to the sincere efforts of the missionaries and their own funds, a progress which has placed Lushais very high up in the standards of literacy, as gauged from the All India Census Report for 1931, which discloses the percentage of literacy as being as high as 12.9%, an incidence<sup>13</sup> further increased to 19.3 in the 1941 census. This incidence<sup>13</sup> is remarkable, compared to the 2.2 figure of the Naga Hills Census

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12. Administration Report of the Lushai Hills for the year 1906-07, Government of Assam, Shillong, 1907, p-11.

13. Lalrimawia, Op.Cit

of 1931. This incidence covers those who can both read and write.<sup>14</sup>

Although there was considerable expansion of primary education during the British period, the quality of education especially that of science education left much to be desired. During the British regime emphasis was only on primary education and no encouragement was given for further education.<sup>15</sup> However, a certain number of Lushais managed to finish matriculation course at high schools outside their own territory after the middle school education. Another serious limitation of middle english schools was the lack of an integrated course for the study. No curriculum had ever been devised specially to suit the peculiar needs of the Lushais, the agricultural people living in a hilly land, economically poor and geographically remote. The curriculum never met the needs of backward people, destined to live out their lives in a hard land amid an agricultural setting.<sup>16</sup> Importance was not given to vocational education. What was required for the Lushais was the practical training in agriculture and traditional vocation. Savidge, the honorary Inspector of Schools, expressed his views on the curriculum of the primary and middle schools in 1916 as

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14. A.G. McCall, Lushai Chrysallis (London : Luzac and Co. Ltd., 1949)

15. Dr. A.C. Ray, Op.cit.

16. A.G.McCall, Op.cit.

follows: "The Lushais are keen on education and the progress made during the years has been satisfactory. It is important, however, to remember that when we have educated sufficient boys to fill the Government posts available, there will be little for educated youths to do unless their education has been such as to enable them to develop agriculture and other resources of the district. I think the educational authorities of the district realise this.<sup>17</sup>" The widespread primary and middle level education ultimately brought a big chunk of the young people away from agricultural pursuits. They, however, remained without any employment as there was practically no other economic activity in the area. These frustrated young people were the main catalytic agents for the disturbances in 1966.<sup>18</sup>

While tracing the drawbacks of education during the British period, the lack of science courses in the curriculum ought to be highlighted as it had a far reaching effect and continue to affect the present day science education. In spite of the fact that people became open to the world outside through the British contacts, the door of knowledge in science and technology was kept closed to the people in Lushai Hills.

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17. Administration Report of the Lushai Hills for the year 1915-16, Government of Assam, Shillong, 1916, p.16

18. Dr, A. C. Ray, Op.Cit.

Apart from this, the initial negligence of science-education was responsible for formation of unfavourable attitudes and even a fear complex toward the study of science subjects. The lack of interest in science, the negative value-orientations and a feeling of insecurity and inferiority to undertake science courses at higher level of education (college education) and the overall lack of promotion in science education may be linked with the defective system of the missionary education in Mizoram.

Education in Post Independent Lushai Hills (1947-1972).

The progress and expansion of education after independence was considerably higher than that under the British missionaries. Although the first high school was opened at Aijal in 1944, it was only in 1948 that the first matriculation examination was conducted under the Gauhati University, Assam. Of the 25 candidates appeared, 20 passed the examination. In 1949, 22 candidates appeared in the examination out of which 22 came out successful.<sup>19</sup> The student enrolment and the number of successful candidates in matriculation examination during the first ten years in the Lushai Hills are presented in Appendix 13.

In 1950, two high schools were opened, one at Lunglei and the other at Champhai. From 1955 onwards, the enrolment

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19. Lalhmuaka, Zoram Zirna lam chhinchhiahna, Aizawl; Tribal Research Institute, 1981.

increased considerably. A number of boys and girls who matriculated from the high schools at Lushai Hills joined colleges and graduated from colleges outside the land. However, it is worth mentioning that very few matriculates joined science course at the college level. Those who took the science subjects subsequently went for engineering and medical courses. Thus, there were hardly any science graduates for high schools. State had to depend on science graduates from outside Mizoram to employ as teachers at the secondary level. Lack of qualified teachers for science subjects is a major constraint to the promotion of education at the secondary and tertiary levels even today.

As the education during the British period was marked by negligence of middle and high school education, an attempt was made since 1947, to correct the imbalance created by this neglect. As a result, there was very rapid increase in the number of primary, middle and high schools during the two decades from 1950-1970.

When under the sixth schedule of the Constitution of India which conferred on the then Lushai Hills district, the status of Autonomous District and the Mizo District Council was inaugurated on the 25th April, 1952, changes were brought about in administration of the land. More schools were opened and creation of posts of inspectors of schools from 1952 onwards strengthened

the supervisory task of education department. Thus, there was remarkable expansion and improvement of school education during this period. In 1972 when the district attained the status of a Union Territory, it had 36 pre-primary schools, 390 primary schools, with 1308 teachers, 190 middle schools, 80 high schools and 3 colleges. The percentage of literacy increased to 53.79 in 1971 from that of 0.93 in 1901.<sup>20</sup>

#### Education in Mizoram since 1972.

There has been tremendous expansion and development in the field of education in Mizoram since 1972 when it attained the status of a Union Territory. Along with changes in other fields of development, department of education also has undergone changes in its organization and functions. Several middle schools and high schools were taken over by the Government and quite a number of them were brought under the deficit system of grant in aid. A separate Directorate of Education was created. For effective improvement of education in the state, several wings were opened under the Directorate of Education. These wings were to take care of various aspects of education. The separate wings under the directorate of education include State Council of Educational Research and Training (SCERT), Science Promotion Wing, Mizoram Institute of Education (M.I.E), Teachers'

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20. Census of India, Population Totals, Mizoram (1901-1971).

Training Institute (TTI), Mizoram Hindi Training Institute, Mizoram State Museum, Scholarship Board, State Archives, State Library, Tribal Research Institute, Art and Culture and Adult and Non-formal Education Units. Brief descriptions of the functions of the separate wings are given below. However, the programmes of the State Council of Educational Research and Training, the Science Promotion Wing and Teachers' Training Institute for school teachers are discussed in detail as they are directly related with qualitative improvement of the general education as well as the science education in the State.

The Tribal Research Institute since its inception undertakes systematic study and research in all aspects of tribal life and economy which will help the government in formulating the development and welfare schemes for the tribal people. The Mizoram Scholarship Board was established in 1974 to provide financial assistance to the scheduled caste and scheduled tribe students studying pre-matriculation stage within Mizoram and students studying post-matriculation in and outside the state. The scholarship board also carries out other important activities like conduct of Sainik school entrance test, All India Approved Residential Merit Scholarship entrance test; All India Military College Dehradun entrance examination; talented children from rural areas scholarship Block-wise examination. These tests and examinations are held yearly at Aizawl. Apart from

this the board also provides financial assistance of Rs.200/- per month per head to the Mizos who take the Indian Administrative Service coaching courses. The state archives wing collects all important old records from Mizoram and Assam states and even from the British library in London. The state museum wing has made remarkable progress in collecting and preserving varied Mizo historical monuments. An attempt is being made to expand and strengthen the number of exhibits and museum items. Library facilities have also been considerably improved with the opening of a state library at Aizawl, district libraries at Lunglei and Saiha, and sub-divisional libraries at Aizawl, Kolasib and Champhai.

#### The Mizoram Board of School Education

The Mizoram Board of School Education came into being and started functioning from 23rd December, 1976. The Board is an autonomous statutory body. The most important function of the Board is conduct of public examinations at various stages of school education which consists of three stages - primary, middle and high school stages of education. The Mizoram Board of School Education is responsible for conduct of the following :-

- (1) High School Leaving Certificate Examination, (at the end of class ten)

- (2) Middle School Leaving Certificate Examination, (at the end of class six)
- (3) Primary Scholarship Examination, (at the end of class three)
- (4) Teachers' Training Institute Semester Examinations, (for both Middle and Primary School Teachers)

Apart from these, production of school text books, revision of school syllaby and curriculum planning are certain other duties of the Board. For science subjects for the schools, the Academic officer is in charge of preparation of text books as well as curriculum planning.

The state library is functioning as an agent for promotion of library services to cover the whole of Mizoram. The art and culture wing of the directorate also contributes a lot in preserving the culture of Mizo society. It publishes and reprints books on Mizo customs, conducts cultural programmes in and outside the state and organises seminars, art exhibition, painting and singing competitions throughout the state. The music and fine arts branch of the art and culture wing offers courses in traditional Mizo music as well as western music and folk dances.

#### State Council of Educational Research and Training

The State Council of Educational Research and Training (SCERT) was established in 1980 as per <sup>the</sup> recommendation of the

Working Group set up by the Ministry of Education at the instance of Planning Commission in 1977. The main objective of setting up the SCERT is improvement of qualitative and quantitative aspects of school education and teacher education. The projects and programmes undertaken by SCERT are listed below:

- (a) National Population Education Programme.
- (b) Educational Technology Programme.
- (c) Integrated Education of Disabled Children.
- (d) Improvement of English Teaching at Secondary Schools through the District Centre for English set up in the Institute.
- (e) UNICEF Assisted Education Projects - Nutrition/Health Education & Environmental Sanitation (NHEES-Project IA) - Developmental Activities in Community Education and Participation (DACEP - Project III). - Comprehensive Access to Primary Education (CAPE - Project V).
- (f) Asian Programme of Educational Innovation for Development/(APEID).
- (g) Fifth All India Education Survey.
- (h) Non-Formal Education Programme.
- (i) Educational & Vocational Guidance Services.
- (j) National Scheme of In-Service Training of School Teachers.

(k) Operation Blackboard.

For the effective implementation of the various schemes, SCERT had a number of constituent wings. These wings are assigned specific tasks. The names of the different wings under SCERT and their functions are mentioned below :

1. Administrative Wing.
2. Teacher Education & Extension Wing.
3. Educatinal & Vocational Guidance Unit.
4. Population Education Cell.
5. Special Education Cell.
6. Educational Technology Cell.
7. Research & Development
8. Curriculum Development & Evaluation Wing.
9. Language Promotion Unit.

Being an Institute concerned with qualitative improvement of school education as well as teacher education in the State, the SCERT took itself to the task of experimenting various educational programmes and projects. For this purpose, all the wings and units are assigned specific tasks.

#### Administrative Wing

The administrative wing of the Council headed by a Deputy Director has the following objectives:-

- (1) To oversee the progress and problems of implementation of various schemes and project of the SCERT.

- (2) To co-ordinate various wings and units in their respective works and tasks.
- (3) To organise training/orientation courses for educational officers, supervisors and heads of schools in educational management and planning.
- (4) To act as liaison agent between the Government and the National Council of Educational Research and Training (NCERT).

Teacher Education & Extension Wing:

This wing is held responsible for implementation of National Scheme for In-service training of school teachers, formulated by the Ministry of Human Resource Development, Government of India. The objectives of the scheme are to familiarise the teachers with the salient features of National Policy on Education, and to make them aware of their role in bringing about the meaningful change. Training courses were organised for the teachers of primary, middle and high schools. During 1987-1988, 702 teachers were given training under the resource persons drawn from various wings of the education department. Teacher Education and Extension Wing will continue to attach great importance to this Massive Teachers' Training Programme, as it is felt necessary to bring awareness about the new dimensions and thrusts laid down in the National Policy on Education (1986). This kind of in-service education and training become

most important mode to meet new expectations as a result of the New Policy. When fully developed, this wing will look after all programmes relating to teacher education including the Pedagogical and Documentation Centre.

#### Educational & Vocational Guidance Unit

The role of Vocational Guidance and Counselling in the context of growing unemployment, changing technology and increasing number of educated youths can hardly be over-emphasised. Thus, with a view to providing guidance and counselling services to the students of high schools, Educational and Vocational Guidance Unit was set up under SCERT in 1981. The unit is manned by an Assistant Vocational Guidance Officer. The Unit has introduced guidance services at the high school level with the following objectives:

- I) To create a guidance consciousness and understanding among the headmasters and teachers of high schools.
- II) To train guidance personnel for the secondary schools.
- III) To provide academic and technical guidance to teachers working in the guidance cell of the secondary schools.
- IV) To act as supervising and consulting agency for the administrative as well as teaching personnel working at the school level.

- V) To procure and prepare useful educational and occupational material as and when necessary and supply the same to the guidance cell of the secondary schools.
- VI) To construct, standardise or adopt psychological tests for use in the SCERT and secondary schools.
- VII) To prepare and publish guidance aids: tools, bulletins and news letter for use in schools.
- VIII) To conduct research studies as may be necessary for the preparation of materials, and for the evaluation of guidance programmes.
- IX) The primary objective is to help young students in the identification and development of their abilities and interest, thereby helping them to plan for a better and brighter future.

#### Population Education Cell

In 1982, Mizoram joined the National Education Project launched in 1980, by the Ministry of Education and Culture, Govt. of India. The primary goal of the Project is to enrich the existing school curriculum by including more relevant, related population concepts in the curriculum, which will have far reaching consequences in improving the quality of life of the people. The major objectives of the project are as follows:

- (a) To develop among the students a keen insight into the inter-relationship between population change and the process of socio-economic development vis-a-vis the individual, the family, the society, and the nation and the world.
- (b) To develop an awareness among the students and the teachers about the population situation in the country.
- (c) To provide population education its rightful place in the curriculum of the formal as well as the non-formal programme of education in Mizoram.
- (d) To develop desirable attitudes and behaviour in the students and the teachers as well as in the community at large towards the population issues so that they may arrive at rational decisions about the size of the family when they become responsible citizens thereby contributing towards improvement of the quality of life.

The curriculum objectives of Population Education is determined taking into consideration the national objectives, the objectives of school curricula and the age of the students.

The curricular objectives are the following:-

- (1) To create awareness among people about the quality of life in relation to population change.

- (2) To place population as a focal point of the developmental process of Society and to ensure that people become problem solvers and not problem makers.
- (3) To emphasise the positive role of population as a human resource developed through education, health facilities and nutrition so that qualitative improvement of human resources is ensured.
- (4) To endeavour to develop positive attitudes towards science and technology towards liquidation of poverty.
- (5) To promote desirable attitude towards work, to help develop productivity consciousness.

The SCERT is instrumental in implementing population education in the secondary school curricula. The subject is introduced by the Integrated Approach. At present, the Cell has taken up the task of introducing population education in the curriculum of teachers' training programme for the primary and middle school teachers. As for the secondary school teachers, population education exists as one of the subjects at the Mizoram Institute of Education.

#### Special Education Cell:

Set up in 1984, the Cell is looking after a Centrally sponsored scheme known as 'Integrated Education for the Disabled Children' (IEDC). The National Policy on Education 1986 recommends education of the children with locomotor handicaps

and other mild handicaps in common schools. The objectives of the scheme are the following:-

- I) To place disabled children in schools and to integrate them with normal children with an aim of eliminating social distance and distinction between the normal and disabled children.
- II) To assess disabled children with a view to identifying the nature of their disabilities etc.
- III) To promote national efforts to provide disabled children with proper assistance, care and guidance to ensue their full integration into society.

The scheme of integrated education for the disabled children is being implemented in a number of primary schools in Mizoram. The successful implementation of the IEDC depends on the responsiveness of the administrators and teachers in the school. As such, the cell organised training courses for teachers associated with the scheme. Financial assistance of Rs.15 lakhs (Rs.10 lakhs being salary of Resource Teachers) is obtained from the Central Government.

#### Educational Technology Cell (CSS).

The Educational Technology Cell was set up in the year 1984 - 1985 by the State Government with the assistance of Central Government for the improvement of education at all levels with the help of mass media and modern educational

technologies including radio and television.

The Cell aims to achieve various objectives such as universalisation of Primary Education, Adult Education, Vocationalisation of Education, quality improvement etc. by making use of scientific and technological innovations and devices. With a view to achieve these objectives, the Educational Technology Cell was opened in the SCERT with 4 gazetted officers and 7 supporting staff. Since its inception, this cell has taken steps for making efficient use of Mass Media and Modern Technologies. For the effective implementation of educational technology programme in Mizoram, schemes are submitted every year to the Central Government.

The Cell organised orientation course and workshops for the development of teaching aids and radio scripts. Steps were also taken for production of tape slides.

Research and Development Wing:-

To provide studies and investigations in the various problems of education, General Research and Development Wing plays an important part. This Wing is staffed with one Educational Research Officer and one Assistant Research Officer. This Wing looks after the Associated Centre for Asian Programme of Educational Innovation for Development (APEID) in which SCERT is one of the associated Centres. The main activities

of this wing are given below:

- I) To conduct research studies and investigation into various educational problems.
- II) To conduct educational survey within the state from time to time and for that matter to collect vital educational statistics of the state education system.
- III) To conduct National Talent Search Examination every year.
- IV) Preparation and publication of educational magazine.
- V) To experiment and practise innovative ideas and thoughts in the school system with the help of teachers. This is under the Asian Programme of Educational Innovation for Development (APEID).

Language Promotion Wing:

The District Centre for English was set up in the SCERT, Aizawl, in 1985 as per recommendations of two conferences of English Language Teaching Institutes, Education Secretaries, Directors of Education and other Educational Administrators, held at CIEFL, Hyderabad during 1979 and 1981. The following are the objectives of the District Centre for English:

- (1) to provide saturation level training to all teachers of English in the state especially in the rural areas, through short orientation courses followed by long term professional support and guidance through correspondence programmes.

- (2) to impart saturation level training to high school teachers in the most economical way and in the shortest possible period of time.
- (3) to identify and develop leadership potential among high school teachers of English who could be given higher and more intensive training course and whose services could be utilised by the state govt. in the ELT programme.
- (4) to provide consultancy service and academic support to the school administration at the district level.
- (5) to serve as an ELT Resource Centre by building up a library of ELT reference materials, additional reading materials, audio-visual aids, etc.
- (6) to provide non-formal learning of English for school drop-outs, professional groups and disadvantaged sections of society.
- (7) The District Centre is also expected to function as a Resource Centre catering to the needs of the schools in the state.

THE SCIENCE PROMOTION WING

Since Mizoram became a Union Territory in 1972 and had its own Directorate of Education, one of the steps taken was to improve and reorganise the teaching of science in schools. In 1972, the Government of Mizoram signed an agreement with the NCERT to take up the Unicef Project for improvement and reorganisation of the teaching of science at school stage. A separate wing of Science Promotion was established in June 1973 to carry out various tasks under this project.

The UNICEF project was carried out in 50 selected Primary schools and 30 selected Middle schools in Mizoram. The project was intended to strengthen the science curricula of classes A, B, I, II, III in Primary schools and for classes IV, V and VI in the Middle schools. The project was launched during 1973 - 76 keeping in view the following objectives:

1. To inculcate the spirit of scientific enquiry among students.
2. To develop the habit of scientific temper and attitudes in the minds of the students.
3. To catch up the development of science in advanced states
4. To remove superstitions among the students through scientific means.
5. To produce technically qualified persons.
6. To promote science in higher learning.

Preparation of textbooks and other instructional materials and the training of the teachers were the specific activities carried out through the project.

#### Preparation of Instructional Materials

- (1) Text Books for classes - A, B, I, II, III, IV, V, VI
- (2) Guide Books for classes A, B, I, II, III, IV, V, VI
- (3) Kit Guide Books for classes III, IV, V, and VI

The teachers were given training in the following aspects:

- (1) Objectives of UNICEF Project
- (2) Uses of Science kits
- (3) Method of Teaching Science
- (4) Practical and Demonstration in Science
- (5) Science hobbies and Improvisation
- (6) Scientific Methodology
- (7) Science corner

Apart from bearing the 75% of the cost of training of 50 Primary school teachers and 30 Middle school teachers, the UNICEF also donated papers for printing the various text books and guide books. The same is also borne by the UNICEF at the universalisation stage following the pilot stage of 3 years. The resource persons of the State of Mizoram had been trained by NCERT from 1974 to 1978.

After three years of introduction the project was universalised. Science subject was introduced in all stages of school education as compulsory subject for all school students. Similar actions as in Pilot stage have been carried out for all the schools. The teachers were trained for a period of 10-15 days in the first phase. The trained persons were again re-oriented after a lapse of 5 or 6 years. About 120 teachers received such training yearly during the last 10 years.

#### Science Curriculum

The NCERT syllabus have been taken up in Mizoram. For classes I to V the science curriculum includes the environmental science covering the following topics:

- (1) Our Universe
- (2) Rocks and Minerals
- (3) Weather, Air and Water
- (4) Work, Force and Energy
- (5) Matter and Materials
- (6) Living things
- (7) Human body, Health and Hygiene
- (8) Housing and Clothing
- (9) Living things
  - (a) animals
  - (b) plants
- (10) Safety and First Aid.

For classes VI-VII, the science syllabus is mainly carried out in separate disciplines of physics, chemistry and life science subjects. The standard of science curriculum from I - VII is the same as that of the rest of the country. The curriculum of classes VIII, IX and X was not able to bring to the national standard of the NCERT for want of qualified science teachers. However, it is proposed to upgrade the standard of science curricula with effect from 1990 by following the National Syllabus under NPE 86.

Apart from this, the Science Promotion Wing, after its inception has carried out a number of activities for the promotion of science for the students, teachers as well as for the public as given below :

- 1) Conduction of science exhibitions, science seminars for high school students.
- 2) Provision of incentives in the form of cash award for proficiency in science and also in mathematics subjects.
- 3) Establishment of science laboratory in schools and in the office of Science Promotion for training purposes.
- 4) Equipping science laboratories with furniture.
- 5) Establishment of Science gallery and computer education in the office of Science Promotion Officer.

In order to popularise science, the Department of Education is publishing an educational journal "Zirna Eng" in which articles on science are published from time to time. A purely science journal is also published monthly by the Mizoram Science and Mathematics Teachers Association. The following text books have been brought out by this association:

1. Science is Doing Class I
2. Science is Doing Class II
3. Science is Doing Class III
4. Science is Doing Class IV
5. Science is Doing Class V
6. Teachers Guide for classes I and II Text
7. Teachers Guide for class III Text
8. Teachers Guide for class IV Text
9. Teachers Guide for class V Text
10. Kit Guide for Physics for class VI
11. Kit Guide for Biology for class VI
12. Kit Guide for classes III-V
13. Physics Part I for class VI
14. Biology Part I for class VI
15. Science for class VII
16. Physics for class VIII
17. Chemistry for class VIII
18. Biology for class VIII

19. Integrated Science for Class IX

20. Integrated Science for Class X.

Science Exhibition in the high schools of Mizoram is held every year in collaboration with the NCERT. A substantial grant of Rupees ten thousand is donated to Mizoram every year for conduction of science exhibition. The results of the best ten exhibits are sent to NCERT for selection of participation in the National Science Exhibition held every year. About 10-20 schools participate in the science exhibition each year. Mizoram also participates at the Eastern India Science Camp organised by the National Council of Science Museum. About 25 students are sent for the camp each year. The number of students participating in the state level science exhibition is about 150 every year and five were selected to participate at the national level. The objectives of these competitions are mentioned below:

1. Encourage the pupils in the
  - (i) development of interest in science and scientific skills;
  - (ii) habit of exploration and creativity;
  - (iii) critical thinking in the design and development of apparatus for various investigations.
2. Induce healthy competition amongst participating students.

3. Familiarise the students with the
  - (i) changing profiles of scientific ideas,
  - (ii) inter-relation between science and technology;
  - (iii) relationship of scientific facts, methods and technology.
4. Discover the areas in which guidance is required for developing scientific talent at the different stages.
5. Integrate scientific ideas related to daily life situations.

Another important activity undertaken for the promotion of science education is a three-tier-science-seminar organised at District, State and National levels. About ten schools participate from each of the districts of Aizawl, Lunglei and Chhimtuipui. The best two winners of the district level seminar then participate at the state level seminar and the top winner of the state level is selected for the national level seminar held at Delhi in the month of October every year.

Since 1978 the Department of Education, Mizoram has been organising science seminar for the high school students every year. The main purposes of the seminar are (1) to encourage the students and help them have interest in the study of science subjects, (2) to inculcate a spirit of scientific enquiry and analytical thinking in the minds of young students. For the first four years, the Government of Mizoram, in collaboration

with Birla Industrial Technological Museum, Calcutta organised the seminars but now the Government of Mizoram in collaboration with the National Council of Educational Research and Training (NCERT) organises these seminars. The seminar topics prepared and conducted so far are cited below:-

- 1978 - Life and Work of Albert Einstein.
- 1979 - Science, a boon or a curse for children
- 1980 - Solar Eclipse
- 1981 - Renewable Source of Energy
- 1982 - Space and mankind
- 1983 - Communication today and tomorrow
- 1984 - Environment and Human survival
- 1985 - We and the Ocean
- 1986 - Green Revolution and our future
- 1987 - Pollute and Perish 'Conserve and Flourish'

The seminar topic for 1988 will be 'INFORMATION REVOLUTION'. The selection of the seminar topic is not done from the government of Mizoram but from Delhi at the national level. The science promotion wing, under the Directorate of Education, has been given the task and responsibility of conducting science seminars for High schools and were found to be very effective towards promotion of science education in Mizoram.

As a result of the efforts made by the Education Department, the following results were achieved with regard to

the teaching of science in Mizoram.

1. The learning of science has become a joy among the students and it has also become one of the most favourite and interesting subjects of studies for the students.
2. Percentage of pass in science subjects at the H.S.L.C. examination has gone up year by year. Pass percentage in science subjects at the 1987 H.S.L.C. examination was 54.72 while the overall pass percentage was 38.10.
3. Number of students taking up science courses at higher level of education such as pre-university and college levels also has considerably increased. Many students are now going for technical courses in various colleges outside the state.
4. It is hoped and expected that shortage of technical man power in Mizoram will be met with in a few years time. At present there are about 800 students taking up various courses in Agriculture, Medicine, Engineering, Forestry, Veterinary and allied science subjects.

The Science Promotion Wing of the Education Department have chalked out a number of schemes as future plans for improvement of science education. The following are some of the schemes

for the promotion of science in the State :-

- (1) Establishment of laboratory and supply of equipments and books in all high schools under centrally sponsored scheme which is to start from 1988.
- (2) Introduction of practical classes in high schools by 1990 and provision of science laboratory to all the secondary schools.
- (3) Upgradation of science teaching in all schools.
- (4) Provision of more incentives to students for taking up higher studies in science and mathematics .
- (5) Establishment of Science college is also under consideration.

#### Status of Teacher Education in Mizoram

Due to the rapid increase of primary schools in Mizoram, the need for teacher education was strongly felt. The first training course for Primary School teachers was conducted at Aizawl by Mr. Pasena who had undergone B.T. training in England in 1923-1924.<sup>21</sup> The intake capacity of this course was 12 and it was of 3 months duration and the course of study included method of teaching, school administration, child psychology and content subjects. The duration of the course was lengthened to one year in 1927 and the course of study

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21. Lalthangliana: Mizoram Institute of Education, A Case Study. Unpublished M.Ed Dissertation, North Eastern Hill University, Aizawl, 1983 p.7.

was expanded by adding subjects like arts, mother tongue, science and geography. The training classes were attached to the Bible Shool until 1939. In 1940 a separate teacher training institute was opened at Aizawl with an aid of Rs.3000/- from the Government of India. In 1943, this institute was shifted to an interior village, Sialsuk for fear of Japanese invasion during the second world war.<sup>22</sup> In 1932 an English Missionary H.W. Carter started a 2 year course of teacher training for Primary School Teachers in South Mizoram with the intake capacity of only three students. The course of study included subjects like method of teaching, english and child psychology. In 1934 the intake capacity was raised to six and twelve in 1937. The curriculum of the course contained subjects such as mathematics, mother tongue, english, history, general geography, method of teaching and child psychology. This training course was continued till 1957 and was attached to the Middle English school of Serkawn. As the missionaries were not allowed to supervise M.E. School of Serkawn, a separate teacher training institute was opened in 1952 and subjects like Hindi, general science and commercial geography were added to the existing

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22. Source: Mr. C. Rokhuma, Instructor of TTI(Rtd.) Aizawl from 1947-1974 and Mr. Muka, Secretary. Mizoram Presbyterian Synod.

course of study. This institute continued to function until it was replaced by the Government Teachers' Training Institute opened in Lunglei in 1974.<sup>23</sup> In 1953, a Basic Training Centre was opened at Aizawl. With the establishment of this centre for Primary School teachers, the existing teacher training institute managed by the missionaries was abolished. The duration of the course was two years and the course of study included subjects like mathematics, general science, mother tongue, school organisation and crafts, carpentry, sewing, etc. A normal training school for training of middle school teachers was established in 1970<sup>24</sup> which had really improved the quality of middle school education in Mizoram. In 1974, these two training institutes were amalgamated into one institution and was then named the "Under Graduate Teachers' Training Institute" (U.G.T.T.I). In the same year, another Teachers Training Institute was opened at Lunglei for the Primary and Middle School Teachers of Lunglei and Chhimtuipui Districts. The UGTTI was later renamed as Teachers' Training Institute' (TTI) and now it is proposed

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23. Source of Information: Mr.Suakkunga, formerly a master of the Teachers Training Institute, Serkawn.

24. L.N.Tluanga, Education in Mizoram: Retrospect and Prospect, MBSE Journal. Aizawl, Mizoram Board of School Education, 1981.

to be upgraded into a District Institute of Education and Training (DIET).

Prior to 1975 there was no training institute for secondary school teachers in Mizoram. After independence, the number of schools as well as teachers increased considerably. Secondary school teachers were deputed by the Government to undergo professional training outside Mizoram. This involved a huge amount of expenditure on the part of the Government. In 1975, the first training college for secondary school teachers was established at Aizawl under the name 'Mizoram Institute of Education' (MIE). This institute is affiliated to North Eastern Hill University (NEHU). The college offers B.Ed course of one year duration. Since its inception till 1984, 90% of the available seats were reserved for in-service teachers, the remaining 10% were for pre-service. From 1985 onwards all the seats have been reserved for the in-service teachers only. Secondary school teachers from all over the state undertake professional training from the MIE every year. Selection for deputation from the schools is made on the basis of seniority in service of the teachers. The year-wise breakup of the enrolment of the teacher-trainees and the result of the Mizoram Institute of Education is given in Appendix 14.

### Higher Education in Mizoram

The opening of a night college at Aizawl in 1956 was another salient landmark in the history of education in Mizoram. In the initial stage classes were held at night. This enabled the Mizos working in the offices and various fields to pursue further studies. This college was taken over by the Government in 1965. The night classes were shifted as regular day college and the college was provincialised as Pachhunga Memorial Government College. In 1964, the first college in the south Mizo District was opened. At present there are 11 colleges in the whole of Mizoram. One of them is a Women's College. One is Government college, another one is a University constituent college and the rest are deficit colleges. However, when compared to other parts of India, the higher education in Mizoram is at an infant stage, and has a long way to go in the path of progress and improvement. Most of the colleges do not have adequate facilities and are housed in rented buildings. Some of them even lack proper classrooms, library and laboratory. Out of 11 colleges, only 2 are offering science courses. Of these two colleges, B.Sc course is offered in Pachhunga University College, Aizawl, while the Government college at Lunglei offers only the science course at the pre-university level. The

rest are Arts colleges. Commerce is offered in Hrangbana College and Home Science in Zirtiri Women College, Aizawl. Professional courses such as Engineering, Medicine, Veterinary Science, Agricultural Science etc. do not figure at the tertiary level. However, Government selects students on the basis of merit and sends them for higher studies in professional streams in colleges outside Mizoram. The enrolment in science courses at Pre-University and Graduate levels are very few and details shown in Appendix 15 shows a gradual decrease. In this age of science and technology when leading nations strive and vie for scientific and technological advancement, it stands to reason that unless strong emphasis is laid on the need for improvement in science education in Mizoram this territory shall be left far behind in its march towards progress. Steps must be taken to remedy this serious drawback in science education

#### Relevance of the present Research

The foregoing review of the development of education in Mizoram indicates that while there is an appreciable progress in education at all levels, the state of science education leaves much to be desired. Although the State has achieved considerably high percentage of literacy (59.88 in 1981 census) there is a low pass percentage and achievement

at high school leaving certificate examination in science subjects. Students who go for higher studies opt for arts subjects. As such, the enrolment in science stream is very low when compared to arts subjects. It is also noticed that many wind up their studies at Pre-university level and very few continue their studies offering biology or life sciences. As such the system fails to promote science education in general and is unable to produce graduates in science with physics, chemistry and mathematics. There may be a number of reasons for this serious drawback in science education. It may be due to lack of interest in science on the part of the students, lack of positive attitude towards science and lack of encouragement on the part of the parents. It has also been noticed that there is a shortage of qualified teachers at the school and college levels. Another interesting observation is that majority of students who go for science courses in colleges are boys.

Although there is a lot of effort for the promotion of science in the state, scientific studies analysing the factors related to students' attitudes and achievement in science are conspicuous by their absence. Therefore, it seems significant and highly worthwhile to undertake the present investigation. The study also assumes significance as it is a pioneering

attempt to identify the constraints of science education and shall contribute to bring about improvement and expansion of science education in the state of Mizoram.

## C H A P T E R - IV : METHOD OF STUDY

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The Setting of the Study

The Sample

Tools used

Science Achievement Test (SAT)

Science Attitude Scale (SAS)

Problem Solving Ability Test (PSAT)

PSAT : Its Final Form

Reliability

Validity

Socio-economic status Index (SESI)

Collection of Data

Tabulation of Data

Statistical Techniques of Analysis

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### METHOD OF STUDY

This chapter deals with the methodology adopted in the present investigation. The chapter has been divided into the following parts:

- (i) The setting of the study
- (ii) The sample
- (iii) Tools used
- (iv) Collection of data
- (v) Tabulation of data
- (vi) Statistical techniques for analysis.

#### The Setting of the Study

The study has been carried out on secondary school students of Aizawl town, the capital of the State of Mizoram. Situated in North-East India, the state has a population of 49,375 and has retained a consistently high rate of literacy- 53.79% in 1971 and 59.88% in 1981. Administratively the state has three districts - Aizawl, Lunglei and Chhimituipui districts. For educational purposes, the state has been divided into seven sub-divisions. The Aizawl district comprises four educational sub-divisions, i.e. Kolasib, Champhai, Aizawl west sub-division and Aizawl east sub-divisions. The present study is confined to the students of secondary schools of Aizawl town. There are 21 secondary schools in Aizawl town, 11

schools are under the Aizawl east sub-division and 10 are under the Aizawl west sub-division.

### The Sample

The universe of the study constituted the students on rolls of class IX in the secondary schools of Aizawl town. A stratified random sample of 812 students was selected for the purpose of the study after giving proper weightage to sex, age and type of school. Cluster sampling technique using class as a unit was employed for the selection of the sample. The design of multi-stage randomization of clusters was employed. For this, the schools were randomly selected, keeping in view the sex-ratio, age differences, and the type of schools under study. Thus, out of the 17 schools selected, 2 were government high schools and the rest were deficit high schools. Of the two girls' high schools in the state, one was represented in the sample. The students were chosen at random from class IX of these schools. The sample of 812 students included 352 boys and 460 girls. The details of the final sample selected for the study are given in Table 1.

T A B L E 1

DETAILS OF SAMPLE SELECTED FOR THE STUDY

Sl.	Name of the School	Type of school Government/ Deficit	Class IX		Total
			Boys	Girls	
1.	Chaltlang High School	Deficit	26	13	39
2.	Central High School	Deficit	23	16	39
3.	J.L. High School	Deficit	25	27	52
4.	K.V.M. High School	Deficit	14	26	40
5.	Synod High school	Deficit	25	24	49
6.	Hrangchhuana High School	Deficit	18	21	39
7.	Ch.Chhunga High School	Deficit	18	17	35
8.	Aizawl High School	Deficit	16	16	32
9.	Govt. High School	Govt.	41	44	85
10.	Helen Lowry High School	Deficit	17	15	32
11.	Zemabawk High school	Deficit	20	24	48
12.	Durtlang High School	Deficit	15	39	54
13.	Modern High School	Deficit	11	26	37
14.	Pianghleia High School	deficit	17	21	38
15.	Republic High School	Deficit	28	43	71
16.	St. Paul's High School	Deficit	38	53	91
17.	Mamawii Girls' High School	Govt.		35	35
Total:			352	460	812

### Tools Used

The following tools have been used for the purpose of data collection in the study:

- (i) Science Achievement Test (Lalduhsanga, 1983)
- (ii) Science Attitude Scale (Grewal, 1977)
- (iii) Problem Solving Ability Test - Specifically developed and standardized for the study by the investigator
- (iv) Socio-economic Status Index (Lalrinkimi, 1988)

### Science Achievement Test (SAT)

The Achievement in science of the students were assessed by a standardized Science Achievement Test developed in the Department of Education of North-Eastern Hill University, Aizawl (Lalduhsanga, 1983)<sup>1</sup> The test contained 50 items of science subjects - physics, chemistry, botany and zoology for class VIII of the secondary school syllabus. The questions were of multiple choice type for achieving greater objectivity and certain diagrams were also included to test the skill of the pupils. The test was intended to measure the objectives of knowledge, understanding, application and skill in science of the pupils.

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1. Lalduhsanga, J., "A study of personality factor patterns of low, normal and high achievers in secondary school science". Unpublished M.Ed. dissertation, NEHU, 1983.

The test has been standardized on a sample of 300 high school students and norms are available. The test-retest ( $r = .80$ ,  $p < .01$ ) and split-half ( $r = .93$ ,  $p < .01$ ) reliability of the test was found to be very high. The validity of the test was determined by correlating the test scores with the student marks in the terminal examination. The substantially high correlation between the test scores and terminal marks of the students ( $r = .77$ ,  $p < .01$ ) proved the validity of the test. A copy of the Science Achievement Test is attached as appendix 1.

#### Science Attitude Scale (SAS)


The attitude of the pupils toward science is measured using the scale developed by Grewal (1977)<sup>2</sup>. It is a five point Likert type forcing scale consisting of twenty items designed to assess the attitude of the individual towards science. The 20-item scale was translated into Mizo. The English version of the attitude scale and its Mizo translation appear as appendix 2 and 3. The scale contained ten positive and ten negative statements. For each of the positive items on the scale are assigned a weightage ranging from four (Strongly Agree) to zero (Strongly Disagree). In the case of the negative items, the scoring scheme is reversed ranging from zero (Strongly Agree) to four (Strongly Disagree). The scoring key with the positive and negative items are given in Table 2.

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2. Grewal, A., Manual for Science Attitude Scale, Agra: National Psychological Corporation, 1977.

T A B L E - 2SCORING SCHEME FOR THE SCIENCE ATTITUDE SCALE

Positive Statements	Strongly Agree (SA)	Agree (A)	Unde- cided (U)	Dis- agree (D)	Strongly Disagree (SD)
Item No.					
2,4,6,8,10,12,14,16,18,20	4	3	2	1	0
Negative Statements					
Item No.					
1,3,5,7,9,11,13,15,17,19	0	1	2	3	4

The attitude scores of a subject taking the test is the sum total of scores on all the twenty items on the scale. A total score is obtained by summing the scores on individual items checked by the students. Thus, a maximum score of 80 is possible to be obtained by each student. The validity and the reliability of the scale reported by Grewal (1977) while developing the scale is found to be quite satisfactory. The split-half reliability and test-retest reliability were .87 and .77 respectively. The reliability of the Science Attitude Scale has been re-established by the test-retest method on a sample of 24 students in an earlier study conducted in Mizoram (Darchhingpuii).<sup>3</sup> The reliability  co-efficient was found to be quite satisfactory ( $r=.5355$   $p<.01$ ).

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3. Darchhingpuii. "A study of science achievement and science attitudes among male and female college students in Mizoram. M.Ed. Dissertation, North Eastern Hill University, Aizawl, 1982.

### Problem Solving Ability Test (PSAT)

Development and standardization of a Problem Solving Ability Test for the secondary school students have been undertaken in the present study. The investigator felt the need for developing the test as there were no tests readily available for measuring problem solving ability in science. An Indian test developed by Dubey<sup>4</sup> measured the mathematical problem solving ability of students in the age group of 12 to 17 years. This test was consulted during the construction of the present test. Apart from this, the test developed by Pillai (1979)<sup>5</sup> on attitude towards problem solving was also referred to while developing the test items in this study.

In developing the Problem Solving Ability Test, the usual steps of preparing the preliminary draft, consulting the experts, the try-out, the item analysis, establishing the reliability and validity were undertaken. The details are as follows:

The test covered practical problems related to science faced by students in real life situations. As such, the universe of test covered items from health, first-aid, environmental science, applied physics, chemistry, biology and nutrition.

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4. Dubey, L.N., Manual for Problem Solving Ability Test. Agra, National Psychological Corporation.
  5. Pillai, K.S., "Sex differences in certain personality and aptitudinal dimensions related to science achievement", Unpublished Ph.D Thesis. University of Calicut, 1978.

A preliminary draft of 40 items was prepared. These items were sent to five experts for their comments and also to locate the correct response on each of the items. On the basis of the experts' evaluation, the items were modified, some were dropped and the scoring key was prepared. Thus, the draft test after the experts' evaluation contained 34 items. The draft test was administered to sample of 100 class IX students selected at random from two secondary schools in Aizawl. The details of sample for try-out of the test are given in Table.3.

T A B L E      3

SAMPLE SELECTED FOR ITEM ANALYSIS AND FOR ESTABLISHING  
THE RELIABILITY AND VALIDITY

Name of the Schools	Class IX		
	Boys	Girls	Total
1. K.V.M. High School	25	25	50
2. Govt. High School	25	25	50
Total	50	50	100

The item analysis was done by correlating the individual item scores to the total scores. Product Moment method was applied for computing the co-efficients of correlation and only those items which yield statistically significant results were considered for the final test. Thus, twenty items on the merit of their co-efficients were selected for the final test. Details regarding the item analysis data are given in Table 4.

T A B L E - 4

ITEM ANALYSIS DATA FOR THE  
PROBLEM SOLVING ABILITY TEST (PSAT)

Area/Item	No.in the Draft Test	Coeffi- cient of Corre- lation	Level of Signifi cance	Accep- ted or Rejec- ted.	Sl.No.of the se- lected items in the final Test.
(1)	(2)	(3)	(4)	(5)	(6)
<u>Health and Hygiene</u>					
Diseases	1	0.204	.05	Rejected	
Physical exercise	8	0.6404	.01	Accepted	4
Balanced diet	19	0.122	NS	Rejected	
Preventive measures for Cholera epidemic	20	0.458	.01	Accepted	11
Treatment for Convulsion	29	0.391	.01	Accepted	17

(1)	(2)	(3)	(4)	(5)	(6)
<u>First Aid</u>					
Dog bite	2	0.591	.01	Accepted	1
Accidental fire	10	0.802	.01	Accepted	5
Treatment for insectbite	13	0.156	NS	Rejected	
Treatment for bleeding from nose	15	0.473	.01	Accepted	8
Artificial respiration	23	0.176	NS	Rejected	
<u>Environmental Science</u>					
Air pollution	3	0.039	NS	Rejected	
Soil Erosion	4	0.180	NS	Rejected	
Soil conservation	9	0.211	.05	Rejected	
Cooling of water	14	0.352	.01	Accepted	7
Afforestation	30	0.203	.05	Accepted	18
<u>Applied Nutrition</u>					
Treatment for food poisoning	7	0.572	.01	Accepted	3
Detection of spoilage of eggs.	11	0.614	.01	Accepted	6
Feeding the infant	12	0.108	NS	Rejected	
Deficiency diseases	22	0.055	NS	Rejected	
Prevention of spoilage of milk	27	0.615	.01	Accepted	15

(1)	(2)	(3)	(4)	(5)	(6)
<u>Applied Physics</u>					
Expansion of glass	16	0.620	.01	Accepted	9
Electrical devices	17	0.009	NS	Rejected	
Formation of image	18	0.544	.01	Accepted	10
Echo formation	26	0.442	.01	Accepted	14
Electric shock	28	0.528	.01	Accepted	16
<u>Applied Chemistry</u>					
Rusting of iron	5	0.755	.01	Accepted	2
Water pollution	6	0.211	.05	Rejected	
Removal of stain from cloth	21	0.181	NS	Rejected	
Poisonous gas	24	0.502	.01	Accepted	12
Chemical reaction	25	0.716	.01	Accepted	13
<u>Jumbled word puzzle</u>					
Scientific equipments as labour saving devices	31	0.195	.05	Rejected	
Social evils of drugs	32	0.448	.01	Accepted	19
<u>Crossword puzzle</u>					
The universe and the solar system	33	0.154	NS	Rejected	
Scientists and their inventions.	34	0.669	.01	Accepted	20

### PSAT : Its Final Form

The problem Solving Ability Test consisted of 18 multiple choice questions carrying a weightage of 1 mark each for the correct reponse, a 'cross-word puzzle' with a weightage of 12 marks and 'jumbled word puzzle' carrying 10 marks. A separate answer sheet was prepared which contained necessary instructions to the candidate taking the test. The final form of the Problem Solving Ability Test is presented as appendix 4 and a copy of the answer sheet is attached as appendix 5.

### Reliability

The reliability of the Problem Solving Ability Test was determined by test-retest and split-half methods. The test was administered to the same 35 students from K.V.M. high school in Aizawl after a gap of one month. The test scores of the students for the first and second administration were correlated and a co-efficient of .602 was obtained which was significant at .01 level. In the split-half method, the student scores (N=35) on the odd and even item were correlated, the obtained value of  $r=0.64$  (after Spearman-Brown prophecy correction) was significant at .01 level. Substantially high coefficients of correlation by both the methods proved the reliability of the Problem Solving Ability Test.

### Validity

For establishing the validity of Problem Solving Ability Test, the test scores were correlated with the teachers' ratings (N=35). For this, the teachers were requested to rate the students' ability in problem solving in agreement or disagreement on a five point continuum. The teachers' ratings when correlated with the test scores returned a validity coefficient of 0.75 which was found statistically significant at .01 level. The scores of Problem Solving Ability was correlated with the students' scores on Dubey's Mathematical Problem Solving Ability Test and the resultant value of 0.816 was found to be quite high with .01 level of significance.

### Socio-economic Status Index (SESI)

The Socio-economic Status Index developed in the Department of Education, North-Eastern Hill University, Aizawl by Lalrinkimi (1988) has been used in this study for measuring the socio-economic status.<sup>6</sup> The following five factors have been taken as indicators of socio-economic status: (i) education, (ii) occupation, (iii) house ownership or rental status, (iv) condition of the house - roof, floor, number of rooms, lighting system, latrine, means of water, means of cooking, game facilities and (v) family facility. The responses on the above five factors were arranged into a rating scale. The facility score has been computed se-

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6. Lalrinkimi, "A Study of Socio-educatioal Correlates of Modernity in Mizoram. Unpublished Ph.D Thesis, North Eastern Hill University, Aizawl, 1988.

parately and then classified into five categories. Items - watch and pressure cooker were assigned score of one each; electric fan, radio, sewing machine, electric press and cycle scores of two each; tape recorder, record player, camera and typewriter scores of three each; and television, car, jeep, truck, bus, refrigerator and telephone scores of five each. The subjects received scores against the total number of items possessed by them. The scores, thus, obtained were grouped into five categories. The weightage assigned to each of the items - education, occupation, house rental status, condition of the house and the family facility are furnished in Table 5. The total score for the family or the person, indicating his overall socio-economic status (SES) was obtained by adding up the weightages assigned to the subject on the above factors.

The subjects were then classified into two groups: high and low on SES. For this, the total scores on SES of all the subjects were considered. The mean scores of the group was taken as the criterion for classification. Those who got an SES above the mean score were grouped as the high and the rest were placed in the low SES group. The scores on the family facility can be taken separately and the groups can be formed on the same basis. A copy of the Personal Data Sheet eliciting information on the socio-economic status is given in appendix 6.

### Collection of Data

The investigator personally visited the schools selected for the study. Permission of the headmasters to conduct the study in their schools was first obtained. The co-operation of the science teachers of the schools was also sought for administering the tests. For Science Achievement Test, an announcement was made one week before it was administered so that the students could come prepared for the test. A set of type-written instructions were given to each testee and the tests in science achievement, science attitude and problem solving ability were administered in that sequence. Administration of the tests was done during school hours and it took two days for the completion of all the tests in each school. Science Achievement Test was administered on the first day. Students completed the test with an average timing of almost an hour. On the second day, the Science Attitude scale and the Problem-solving Ability Test were administered to the same students. The students took an average of one hour to complete these two tests. The Science Attitude scale was completed within 20 minutes and the Problem Solving Ability Test with an average timing of 40 minutes.

Responsive Categories and Scores Assigned to Each Item Used in Socio-Economic Status Index (SESI)

Sl No	Items	S c o r e s					A s s i g n e d	
		0	1	2	3	4	5	
1.	Education	Illiterate	Literate & Primary	Middle	High	Intermediate	College	
2.	Occupation	Unemployed	Unskilled	Skilled	Indepen- dent.	Semi-profession	Profession	
3.	House Ownership	Rented			Owned			
4.	Condition of House							
	(a) Roof		Thatched		Tin		Cement	
	(b) Floor		Bamboo or Mud		Wood	Brick	Cement	
	(c) Rooms		1-2	3-4	5-6	7 and above		
	(d) Means of Cooking Food	Wood	Charcoal	Kerosene	Cooking gas			
	(e) Means of Water	Pond		Rain			Tap connec- tion.	
	(f) Latrine		Pit				Septic.	
	(g) Lighting	Kerosene Lamp.					Electricity	
5.	Facility Score	Nil	1 - 14	15 - 24	25 - 34	53 - 44	45 and above.	

### Tabulation of Data

The data collected for the study were examined carefully. After screening the incomplete answer sheets, 812 scripts were available for final analysis. The responses on the Science Achievement Test, Science Attitude Scale and Problem Solving Ability Test were scored using the standard schemes described earlier in the Chapter. Each student was assigned a serial number and their details regarding sex, age, parental education, parental occupation, socio-economic status and the scores on Science Achievement Test, Science Attitude Scale and Problem Solving Ability Test were entered in a tabulation sheet.

### Statistical Techniques of Analysis

The following statistical techniques were used for the analysis of data:-

1. Descriptive statistics.

Measures of central tendency, dispersion, skewness and kurtosis were employed to know the nature of score distribution.

2. Test of significance for mean differences

The difference between the mean scores in science achievement, science attitude and problem solving ability of the sub-groups based on sex, age, parental education, parental occupation, socio-economic status and type of schools was tested for

significance using 't' test (Garrett, 1966).<sup>6</sup>

3. Analysis of variance.

The technique of analysis of variance (ANOVA) was employed to study the interaction effects of sex, parental education and socio-economic status.<sup>7</sup> The three way classification of analysis of variance with (2X2X2) factorial design was employed to test the effects of sex, parental education and socio-economic status on science achievement, science attitude and problem solving ability.

4. Pearson Product-moment correlation

Product-moment method was applied to compute the correlation between the test scores on different variables. The co-efficients of correlation were tested for significance by comparing the value with the table values for corresponding degrees of freedom and were interpreted following the scheme suggested by Garrett (1966)<sup>8</sup>.

The data in the present study were analysed by computer assistance using the SPSS and PC at the Computer Centre, International Institute of Population Sciences, (IIPS), Bombay.

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6. Garrett, H.E., Statistic in Psychology and Education, Bombay: Vakils, Feffer and Simons Pvt.Ltd., 1966.
7. Lindquist, E.P., Statistical Analysis in Educational Research. New Delhi: IBM, 1970.
8. Garrett, H.E., op.cit; P.175-180.

C H A P T E R      V      :      ANALYSIS OF DATA, RESULTS  
DISCUSSION

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Analysis of Achievement Test Scores

Analysis of Science Attitude Scores

Problem Solving Ability Scores

Sex Difference in Science Achievement

Sex Difference in Science Attitude

Sex Difference in Problem Solving Ability

Science Achievement by Socio-Economic Status

Science Attitude by Socio-Economic Status

Problem Solving Ability by Socio-Economic Status

Science Achievement by Parental Education

Science Attitude by Parental Education

Problem Solving Ability by Parental Education

Science Achievement by Parental Occupation

Science Attitude by Parental Occupation

Problem Solving Ability by Parental Occupation

Science Achievement by Family Facility

Science Attitude by Family Facility

Problem Solving Ability by Family Facility

Science Achievement by Type of School

Science Attitude by Type of School

Problem Solving Ability by Type of School

Results

Discussion

C H A P T E R - V.ANALYSIS OF DATA

The method and procedure of collecting the data have been discussed in the preceding chapter. The present chapter deals with the details of the analysis of the data.

Before taking up the detailed analysis of the scores on the Science Achievement Test (SAT), Science Attitude Scale (SAS) and the Problem Solving Ability (PSAT), the nature of the distribution of scores on the various tests was studied. This was done with a view to examine whether the conditions and basic assumptions for the statistical techniques applied for analysis have been satisfied or not. For this, the response sheets of 812 students selected for the study were scored using the scoring key for each test (detailed in Chapter IV) and the scores were subjected for statistical treatment.

The frequency distribution of scores on the SAT, SES and PSAT are shown in the following pages. Graphical presentation of the score distributions are given in figures 1, 2 and 3 for SAT, SAS and PSAT respectively. The descriptive statistics such as mean, median, mode, standard deviation, variance, kurtosis and skewness computed for the scores are presented in Table 6.

SCACHI SCIENCE ACHIEVEMENTS SCORES

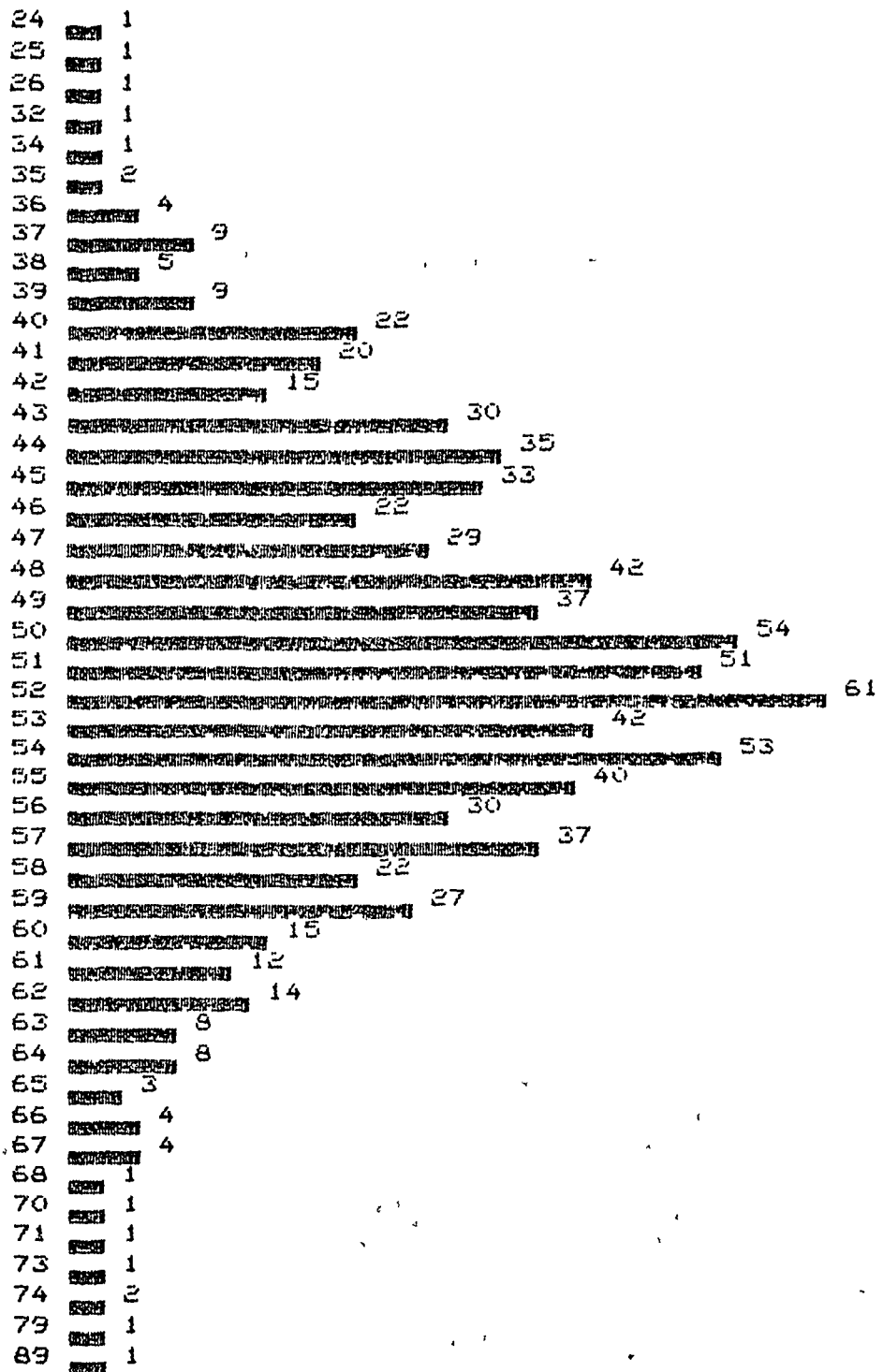
Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
	0	4	.5	.5	.5
	1	1	.1	.1	.6
	3	1	.1	.1	.7
	5	1	.1	.1	.9
	6	1	.1	.1	1.0
	8	2	.2	.2	1.2
	9	1	.1	.1	1.4
	10	1	.1	.1	1.5
	12	6	.7	.7	2.2
	13	14	1.7	1.7	3.9
	14	11	1.4	1.4	5.3
	15	12	1.5	1.5	6.8
	16	18	2.2	2.2	9.0
	17	34	4.2	4.2	13.2
	18	20	2.5	2.5	15.6
	19	35	4.3	4.3	20.0
	20	46	5.7	5.7	25.6
	21	55	6.8	6.8	32.4
	22	45	5.5	5.5	37.9
	23	70	8.6	8.6	46.6
	24	61	7.5	7.5	54.1
	25	46	5.7	5.7	59.7
	26	53	6.5	6.5	66.3
	27	39	4.8	4.8	71.1
	28	43	5.3	5.3	76.4
	29	40	4.9	4.9	81.3
	30	27	3.3	3.3	84.6
	31	27	3.3	3.3	87.9
	32	22	2.7	2.7	90.6
	33	18	2.2	2.2	92.9
	34	21	2.6	2.6	95.4
	35	12	1.5	1.5	96.9
	36	7	.9	.9	97.8
	37	4	.5	.5	98.3
	38	3	.4	.4	98.6
	39	3	.4	.4	99.0
	40	1	.1	.1	99.1
	41	3	.4	.4	99.5
	42	1	.1	.1	99.6
	43	1	.1	.1	99.8
	47	2	.2	.2	100.0
	.	2	.2	MISSING	
TOTAL		814	100.0	100.0	



## SCATTI SCIENCE ATTITUDES SCORES

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
	24	1	.1	.1	.1
	25	1	.1	.1	.2
	26	1	.1	.1	.4
	32	1	.1	.1	.5
	34	1	.1	.1	.6
	35	2	.2	.2	.9
	36	4	.5	.5	1.4
	37	9	1.1	1.1	2.5
	38	5	.6	.6	3.1
	39	9	1.1	1.1	4.2
	40	22	2.7	2.7	6.9
	41	20	2.5	2.5	9.4
	42	15	1.8	1.8	11.2
	43	30	3.7	3.7	14.9
	44	35	4.3	4.3	19.2
	45	33	4.1	4.1	23.3
	46	22	2.7	2.7	26.0
	47	29	3.6	3.6	29.6
	48	42	5.2	5.2	34.7
	49	37	4.5	4.6	39.3
	50	54	6.6	6.7	45.9
	51	51	6.3	6.3	52.2
	52	61	7.5	7.5	59.7
	53	42	5.2	5.2	64.9
	54	53	6.5	6.5	71.4
	55	40	4.9	4.9	76.4
	56	30	3.7	3.7	80.0
	57	37	4.5	4.6	84.6
	58	22	2.7	2.7	87.3
	59	27	3.3	3.3	90.6
	60	15	1.8	1.8	92.5
	61	12	1.5	1.5	94.0
	62	14	1.7	1.7	95.7
	63	8	1.0	1.0	96.7
	64	8	1.0	1.0	97.7
	65	3	.4	.4	98.0
	66	4	.5	.5	98.5
	67	4	.5	.5	99.0
	68	1	.1	.1	99.1
	70	1	.1	.1	99.3
	71	1	.1	.1	99.4
	73	1	.1	.1	99.5
	74	2	.2	.2	99.8
	79	1	.1	.1	99.9
	89	1	.1	.1	100.0
	.	2	.2	MISSING	
	TOTAL	814	100.0	100.0	

SCATTI SCIENCE ATTITUDES SCORES



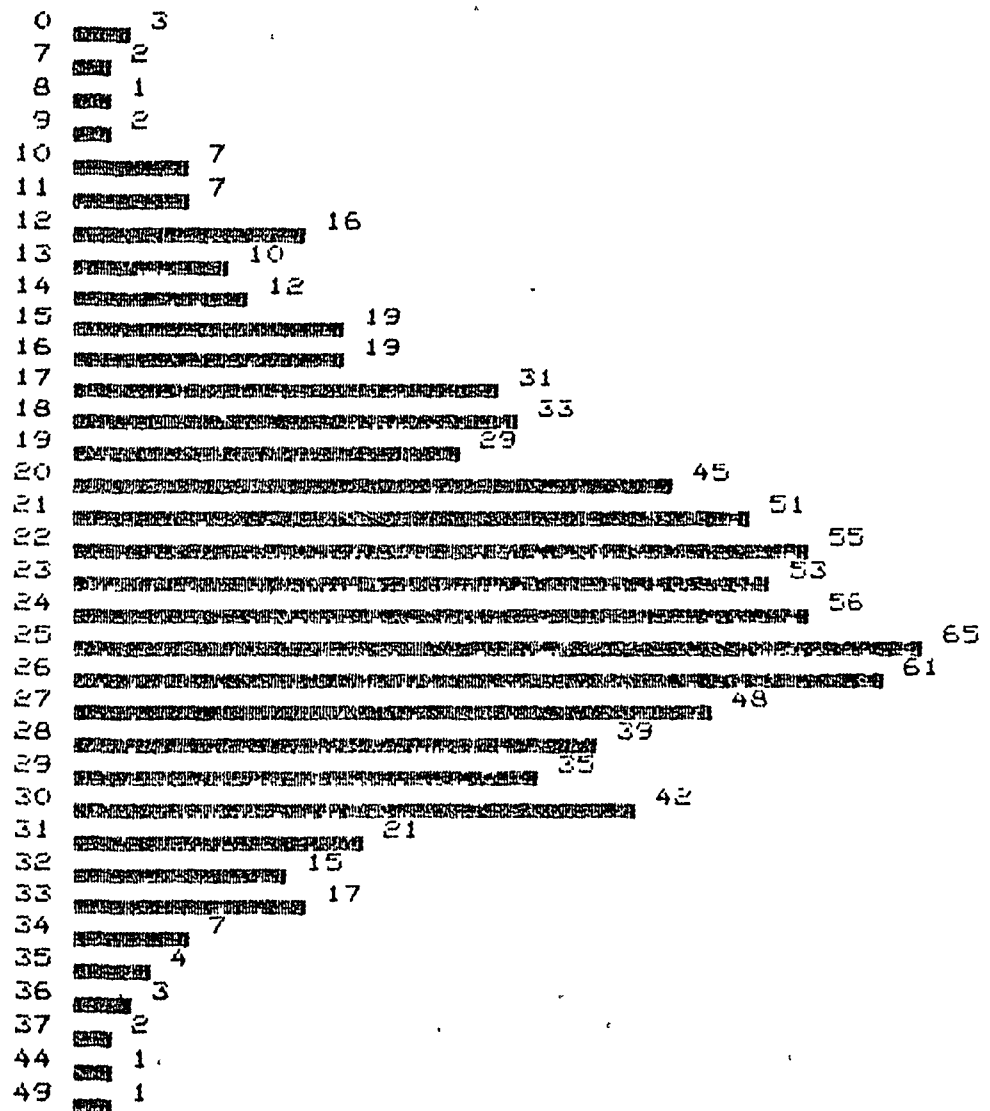
Mean	50.909	Std Err	.248	Median	51.000
Mode	52.000	Std Dev	7.064	Variance	49.893
Kurtosis	1.492	S E Kurt	.171	Skewness	.185
S E Skew	.085	Range	65.000	Minimum	24.000
Maximum	89.000	Sum	41338.000		

Valid Cases 812 Missing Cases 2

## PSAT PROBLEM SOLVING ABILITY TEST SCORES

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
	0	3	.4	.4	.4
	7	2	.2	.2	.6
	8	1	.1	.1	.7
	9	2	.2	.2	1.0
	10	7	.9	.9	1.8
	11	7	.9	.9	2.7
	12	16	2.0	2.0	4.7
	13	10	1.2	1.2	5.9
	14	12	1.5	1.5	7.4
	15	19	2.3	2.3	9.7
	16	19	2.3	2.3	12.1
	17	31	3.8	3.8	15.9
	18	33	4.1	4.1	20.0
	19	29	3.6	3.6	23.5
	20	45	5.5	5.5	29.1
	21	51	6.3	6.3	35.3
	22	55	6.8	6.8	42.1
	23	53	6.5	6.5	48.6
	24	56	6.9	6.9	55.5
	25	65	8.0	8.0	63.5
	26	61	7.5	7.5	71.1
	27	48	5.9	5.9	77.0
	28	39	4.8	4.8	81.8
	29	35	4.3	4.3	86.1
	30	42	5.2	5.2	91.3
	31	21	2.6	2.6	93.8
	32	15	1.8	1.8	95.7
	33	17	2.1	2.1	97.8
	34	7	.9	.9	98.6
	35	4	.5	.5	99.1
	36	3	.4	.4	99.5
	37	2	.2	.2	99.8
	44	1	.1	.1	99.9
	49	1	.1	.1	100.0
	.	2	.2	MISSING	
	TOTAL	814	100.0	100.0	

PSAT PROBLEM SOLVING ABILITY TEST SCORES



Mean	23.277	Std Err	.205	Median	24.000
Mode	25.000	Std Dev	5.833	Variance	34.023
Kurtosis	.891	S E Kurt	.171	Skewness	-.303
S E Skew	.086	Range	49.000	Minimum	0.0
Maximum	49.000	Sum	18901.000		

Valid Cases 812 Missing Cases 2

TABLE - 6

Mean, median, mode, standard deviation, variance, range, skewness and kurtosis of scores on Science Achievement Test (SAT), Science Attitude Scale (SAS) and Problem Solving Ability Test (PSAT)

Variable	Science Achievement Test Scores	Science Attitude Scale Scores	Problem Solving Ability Test Scores
Mean	24.218	50.909	23.277
Median	24.000	51.000	24.000
Mode	23.000	52.00	25.00
Standard Deviation	6.301	7.064	5.833
Variance	39.705	49.893	34.023
Range	47.000	65.000	49.000
Skewness (Sk)	-0.134	0.185	-0.303
Standard Error Sk	0.086	0.086	0.086
Kurtosis (Ku)	1.229	1.492	0.891
Standard Error Ku	0.171	0.171	0.171
Inference	$p > .05$	$p > .05$	$p > .05$

The normality of the score distribution was tested on the basis of the measures of central tendency, dispersion, skewness and kurtosis, and was judged by the following criteria:

- (i) closeness of the measures of central tendency
- (ii) low value of skewness and
- (iii) value of Kurtosis (Ku) being close to that of Normal Probability Curve (NPC) - Ku for NPC is 0.263.

The closeness of the measures of central tendency, the negligible value of skewness and the nearness of value of kurtosis to that of NPC indicate that the score distribution approximate to normality to a great extent on the SAT, SAS and PSAT. The scores were skewed negatively on the Science Achievement Test (-.134) and Problem Solving Ability Test (-.303) while Science Attitude Scores showed slight positive skewness (.185). It was noted that none of the variables exhibited extreme skewness or asymmetry as the values were less than one in all the cases (Odell, 1957). The value of kurtosis calculated for the three variables and the standard error of kurtosis indicated that the variations are within the acceptable limits of chance fluctuations, and the score distributions conformed to normality thereby fulfilling the conditions and assumptions basic for the statistical techniques of analysis of variance and 't' test.

The study employed the factorial (2x2x2) design of analysis of variance to test the effects of socio-economic status (SES), sex, and the type of school on each of the experimental variables of science achievement, science attitude and problem solving ability. The three way classification treated the male and female students separately on the basis of their socio-economic status into two groups of low and high SES. The sample was further subdivided into two based on the type of school in which the students study as the government and deficit schools.

The following four basic assumptions underlying the technique of analysis of variance (Guilford, 1956) were tested prior to the actual application of the technique:

- (i) observation within experimentally homogenous sets should be from normally distributed populations.
- (ii) the sampling within sets should be random and mutually exclusive.
- (iii) variances from within the various sets must be approximately equal, and
- (iv) the contribution of the local sample must be additive.

The normality of the scores on the Science Achievement Test, Science Attitude Scale and the Problem Solving Ability Test was tested by the measures of central tendency, dispersion, skewness and kurtosis. The score distribution

was found to be normal in each of the three variables under study. The second assumption of analysis of variance was satisfied in assigning random and mutually exclusive cases in each cell of the 2x2x2 factorial design. Bartlett's test of homogeneity of variance was applied for the three variables of science achievement, science attitude and problem solving ability. The chi square values were found to be insignificant in all the three variables revealing the homogeneity of variances. Thus, the third assumption was also fulfilled. The fourth assumption of additivity of variance was also found satisfied because the variances of the scores of each variable can be added up separately. Subsequently, calculations were done to arrive at meaningful results and the analysis of variance was applied to scores on the science achievement test, science attitude scale and the problem solving ability test. The mean difference between the test scores of the various groups were compared applying 't' test once the F test yielded statistically significant results. This was done in order to ascertain the significance of difference and the nature of difference in scores between the groups. Thus, the hypotheses advanced for the study were tested and the details are given in the following pages:

Analysis of Science Achievement Test Scores

The scores of the students on the Science Achievement Test (SAT) were subjected to the technique of analysis of variance. The F ratios were calculated for the three main sources of variance, sex, socio-economic status and the type of school. The two way classification analysis taking two factors at a time has also been carried out. The F ratio for the three way interaction taking all the three variables was also computed. The results of the analysis are presented in Table 7.

TABLE - 7

SUMMARY OF ANALYSIS OF VARIANCE ON SCIENCE ACHIEVEMENT TEST SCORES

Source of variation	Sum of square	Degree of Freedom	Mean square	F	Significance of F.
Main Effects	3.443	3	1.148	4.728	.003
Sex	2.014	1	2.014	8.297	.004
SES	1.129	1	1.129	4.653	.031
Type of school	0.300	1	0.300	1.235	.267
2-way Interactions	2.313	3	0.771	3.176	.024
Sex X SES	1.170	1	1.170	4.818	.028
SES X Type of school	1.112	1	1.112	4.582	.033
3-way Interactions					
Sex X SES X Type of school	1.008	1	1.008	4.154	.042
Explained	6.764	7	0.966	3.981	.000
Residual	187.872	774	0.243		
Total	194.636	781	0.249		

It is revealed from Table 7 that significant differences in science achievement exist on variables sex ( $F=8.297$   $p < .05$ ) and socio-economic status ( $F=4.653$   $p < .05$ ). However, the type of school as a variable failed to differentiate the science achievement among the secondary school students. The two-way interactions taking sex and SES ( $F=4.818$   $p < .05$ ) and SES and type of school ( $F=4.582$   $p < .05$ ) also showed significant differences. The interactions between sex and type of school did not reveal any differences, while the 3-way interactions taking sex X SES X type of school revealed statistically significant difference at .05 level.

#### Analysis of Science Attitude Scores

The scores of the students on the Science Attitude Scale (SAS) were analysed by computing F values for three main sources of variance, sex, socio-economic status and the type of school. The two way and the three way interaction effects of the factors were also tested. The results obtained for the analysis are given in Table 8.

TABLE - 8

SUMMARY OF ANALYSIS OF VARIANCE ON SCIENCE ATTITUDE SCORES

Source of variation	Sum of squares	Degree of Freedom	Mean square	F	Significance of F.
Main Effects	1.958	3	0.653	2.617	.050
Sex	0.175	1	0.175	0.702	.402
SES	1.253	1	1.253	5.025	.025
Type of school	0.530	1	0.530	2.125	.145
2-way Interactions	0.130	3	0.043	0.174	.914
Sex X SES	0.006	1	0.006	0.026	.873
Sex X Type of school	0.075	1	0.075	0.302	.583
SES X Type of school	0.050	1	0.050	0.200	.655
3-way Interactions					
Sex X SES X Type of school	0.013	1	0.013	0.054	.817
Explained	2.101	7	0.300	1.204	.298
Residual	192.985	774	0.249		
Total	195.086	781	0.250		

The analysis recognised significant differences in the science attitude on the variable socio-economic status ( $F=5.025$   $p < .05$ ). Sex and the type of school did not show any difference in the science attitudes as the F values were not significant at any level of confidence. The two-way interactions and the three-way interactions involving sex, socio-economic status and the type of school also did not reveal attitudes of the students. The results clearly indicate the significance of the socio-economic status as a factor influencing the attitude towards science.

#### Problem Solving Ability Test Scores

The main effects of the variables sex, socio-economic status and type of school for the scores on PSAT were tested by computing the F ratios. The interaction effects of the three variables were also examined. The results are shown in Table 9.

TABLE - 9

SUMMARY OF ANALYSIS OF VARIANCE ON PROBLEM SOLVING  
ABILITY TEST SCORES

Source of variation	Sum of squares	DF	Mean square	F	Significance of F.
Main Effects	4.572	3	1.524	6.212	.000
Sex	0.010	1	0.010	0.039	.843
SES	1.240	1	1.240	5.053	.025
Type of school	3.323	1	3.323	13.544	.000
2-Way Interaction	0.420	3	0.140	0.571	.635
Sex X SES	0.014	1	0.014	0.057	.812
Sex X Type of School	0.015	1	0.015	0.061	.806
SES X Type of school.	1.383	1	1.383	5.561	.012
3-Way Interactions.					
Sex X SES X Type of school	0.278	1	0.278	1.134	.287
Explained	5.271	7	0.753	3.069	.003
Residual	189.902	774	0.245		
Total	195.173	781	0.250		

The study failed to recognize any statistically significant sex differences in the problem solving ability of the students. However, the problem solving ability of the students differed significantly on variables socio-economic status ( $F=5.053$   $p < .05$ ) and type of school ( $F=13.544$   $p < .01$ ). The two-way interactions taking socio-economic status and type of school also yielded F values statistically significant at .05 level. All other interaction effects of variables sex, SES and type of school on the problem solving ability in two-way and three-way analysis failed to show any significant results.

#### Sex difference in Science Achievement

The science achievement scores of the male and female students were taken separately for analysis. The mean science achievement scores of the two groups were compared. The results are shown in Table 10.

TABLE - 10

#### Mean Science Achievement Scores by sex

Sex group	N	M	SD	SE	t	p
Male	352	24.7443	6.755	.360	2.05	.05
Female	460	23.8152	5.907	.275		

The results revealed that male and female students differed significantly in their science achievement scores. The male students as a group obtained a higher mean score than the female students and the mean difference was found statistically significant at .05 level. The results of a study conducted by George and Abraham (1967) among high school pupils in Kerala and another study by Hansen and Newjar among students enrolled in Science Honours Programme of Columbia University (1974) also showed similar results. In yet another study by Jordan (1956) on North Carolina high school seniors, significant sex difference in science achievement was observed in favour of boys.

#### Sex difference in Science Attitude

The science attitude scores of the male and female students were compared. The results are presented in Table 11.

TABLE - 11  
Mean Science Attitude scores by sex

Sex group	N	M	SD	SE	t	p
Male	352	50.7642	7.275	.388		
					.51	NS
Female	460	51.0196	6.903	.322		

The science attitude scores of the male and female students did not show much difference and 't' value obtained for the mean difference between the two groups was found statistically non-significant. This indicates that sex is not a factor related to attitude towards science of secondary school students whereas significant sex difference was noticed in science achievement. The result of this study contradicts the findings of a study conducted by Neale, Noel and Tismer (1970) where significant positive correlations (at .01 level) were observed for boys in science and their attitude towards science. Similar trend was noted in a study by Lewis (1969) of the fifth grade boys and girls through projective technique which revealed significant attitudinal differences among boys and girls towards science subjects.

#### Sex difference in Problem-solving Ability.

The scores obtained by the male and female students on Problem-solving ability were taken up separately and the mean Problem-solving Ability scores of the two groups were compared. The details are given in Table 12.

TABLE - 12Mean Problem-solving Ability scores by sex.

Sex group	N	M	SE	SE	t	p
Male	352	23.1903	6.035	.322		
					.37	N
Female	460	23.3435	5.679	.365		

The results presented in Table 12 revealed that there was no significant sex difference in the problem solving ability scores of the secondary school students in Aizawl. A study conducted by Sweeney (1953) on problem-solving ability of college students showed the male superiority in problem-solving ability and Guetzkov's (1951) study revealed male superiority over female in set-breaking capacity. However, in Mizoram study the male and female students failed to differentiate in their problem-solving ability.

Science Achievement by Socio-economic Status

The students were divided into two groups based on their socio-economic status. The mean science achievement scores of the low and high SES groups were compared. The details are presented in Table 13.

TABLE - 13

Mean Science Achievement Scores by Socio-economic Status

Socio-economic Status	N	M	SD	SE	t	p
Low	509	23.8527	6.249	.277		
					2.14	.05
High	303	24.8317	6.350	.365		

The results presented in Table 13 showed statistically significant difference in the mean science achievement scores of the low and high SES groups. The superiority of students in the high SES group over those with low SES in their science attitude was evident and the mean scores showed statistically significant difference at .05 level. This signifies that socio-economic status is a factor influencing science achievement of high school students and the students from high socio-economic backgrounds are at an advantageous position compared to their low socio-economic counterparts. Studies conducted by Curry (1962) and Anand (1973) also 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.

Science Attitude by Socio-economic Status (SES)

The science attitude scores of students belonging to low and high SES groups were compared. The results are given in Table 14.

TABLE - 14

Mean Science Attitude Scores by Socio-economic Status

Socio-economic Status	N	M	SE	SE	t	p
Low	509	50.9277	7.050	.312		
					2.01	.05
High	303	52.0113	7.083	.407		

It was recorded from Table 14 that the low and high SES groups showed significant difference in their science attitude scores ( $t=2.01$   $p < .05$ ). Socio-economic Status is found as a factor favouring positive association in the science attitudes. The high SES group obtained a statistically significant higher mean score than the low SES group in the student attitude towards science.

Problem-Solving Ability by Socio-economic Status

Comparison of the problem-solving ability scores was done after classifying the students into two groups on

SES. The details of the analysis appear in Table 15.

TABLE - 15

Mean Problem-solving Ability Scores by Socio-economic Status

Socio-economic Status	N	M	SD	SE	t	p
Low	509	22.6929	5.491	.243		
					2.006	0.05
High	303	24.1624	6.092	.350		

The comparison of the mean problem-solving ability scores of the two SES groups revealed that the mean score of high SES group is significantly higher than that of the low SES group in problem-solving ability. The mean difference between the two groups was found statistically significant at .05 level. The results indicate that students belonging to high SES group were better in problem-solving ability than those in low SES group. The results of the present study demonstrate socio-economic status as a positive factor facilitating the students achievement in science, attitude towards science and problem solving ability.

Science Achievement by Parental Education

The students were classified on the basis of their parental education into two groups: Low and High. The

mean science achievement scores of the two groups were compared. The results are presented in Table 16.

TABLE - 16  
Mean Science Achievement Scores by Parental Education

Group Parental Education	N	Mean	SD	SE	t	p
(Illiterate and Elementary school educated) Low	520	23.900	6.239	.274		
					2.36	.01
(High School and College educated) High	262	25.0305	6.384	.394		

As seen from Table 16 the mean Science achievement scores of students with high parental education was found significantly higher (25.0305) than that of students with low parental education. The mean difference was found statistically significant at .01 level. This signifies that students with high parental education were better in science subjects than those with low parental education. A study by the same investigator on science achievement of college students in Mizoram revealed a contradictory finding. In that study, mean score of student with low parental education was found to be higher than that of student with high parental education. These findings reveal that while parental education is a factor faci-

litating science achievement at the secondary stage, at the college level when the students are grown up and are independent, its influence is limited. Singh (1965) also found scholastic performance to be positively correlated with father's education. A study by Contractor (1984) also revealed positive correlation between mother's education and scholastic performance of her children.

#### Science Attitude by Parental Education

The science attitude scores of the students belonging to low and high groups on parental education were compared. The details are shown in Table 17.

TABLE - 17  
Mean Science Attitude Scores by Parental Education

Group Parental Education	N	M	SD	SE	t	p
Low (Illiterate and Elementary School educated)	520	50.2827	7.027	.308	1.96	.05
High (High School and College educated)	262	51.2901	6.814	.421		

The students of low and high groups on parental education showed statistical difference in their mean science attitude scores at .05 level (Table 17). Students with high parental education obtained a higher mean score when compared to their counterparts in low parental education group. The result gives us room to accept parental education as a factor facilitating favourable attitude towards science.

Similar results were observed in a previous research on science attitude conducted among the college students in Mzoram (Dar-chhingpuii, 1982)

Problem-Solving Ability by Parental Education

The problem-solving ability scores of the two groups of students with low parental education and high parental education were compared. The results appear in Table 18.

TABLE - 18

Mean Problem-solving Ability Scores by Parental Education

Group Parental Education	N	M	SD	SE	t	P
Low (Illiterate and Elementary School educated)	520	22.8769	5.320	.233		
High (High School and College educated)	262	24.4542	6.359	.393	3.45	.001

As shown in Table 18 the mean Problem-solving ability score favours students with high parental education. The mean difference was found significant at .001 level. This confirms superiority of students with high parental education over students with low parental education. The finding reveals that parental education is a positive factor affecting problem-solving ability among the high school students.

Science achievement by parental occupation

The sample was divided into groups based on the profession of the parents. Parents who are of gazetted officers, professionals, teachers, clerical assistants, businessmen and contractors were included in the high group on parental occupation whereas the cultivators, labourers, skilled workers constituted the low group. The mean science achievement scores of the students belonging to the two groups were compared. The results appear in Table 19.

TABLE - 19

Mean Science Achievement Scores by Parental Occupation

Parental Occupation	N	M	SD	SE	t	p
Low	420	23.6227	6.211	.419		
					3.86	.01
High	372	26.2017	5.668	.520		

It is seen from the results of the analysis mentioned in Table 19 that students belonging to low and high parental occupation groups differed significantly in their mean scores on Science Achievement Test. The group classified high on parental occupation surpassed the low parental occupation group in their science achievement and the mean difference was statistically significant at .01 level. The study thereby

suggests that parental occupation is a factor related to the achievement in science and supports the findings of a number of researches conducted in India and abroad (Fram, 1946, Murali 1985, Havighurst, 1944).

#### Science Attitude by Parental Occupation

The scores on the Science Attitude Scale of the students divided into low and high parental occupation groups were compared. The details are given in Table 20.

TABLE - 20

#### Mean science attitude scores by Parental Occupation

Parental Occupation	N	M	SD	SE	t	p
Low	420	49.950	6.790	.453		
					2.39	.05
High	372	51.932	7.588	.696		

It is revealed that the students with low and high parental occupation differed significantly in their mean science attitude scores. The mean difference of 1.982 between the two groups was found to be statistically significant at .05 level and the group high on parental occupation possessed a higher mean score (51.9328) than the low parental occupation

group (49.950). The results indicate that children of officials, professionals, teachers, businessmen and contractors appear to have more favourable attitude towards science than those of cultivators, labourers and skilled workers.

Problem Solving Ability by Parental Occupation

The scores on the PSAT of students belonging to low and high parental occupation groups were taken separately. The mean problem solving ability scores of the two groups were compared and the results are presented in Table 21.

TABLE - 21

Mean Problem Solving Ability Scores by Parental Occupation

Parental Occupation	N	M	SD	SE	t	p
Low	420	22.595	6.203	.418		
					4.93	.01
High	372	25.798	5.430	.498		

The results of the analysis reveal that the high and low groups on parental occupation differed in their problem solving ability scores. The high parental occupation group achieved a significantly higher mean score (25.798) when compared to the low group (22.595) on parental occupation. The

study proves that students from better occupational groups are at an advantage in developing problem solving ability.

Science Achievement by Family Facility

The students were divided on the basis of their family facility scores. The procedure for classification has been explained in Chapter IV. Two groups were thus formed - Low and High. The mean science achievement scores of the two groups were compared. The details are shown in Table 22.

TABLE - 22

Mean Science Achievement Scores by Family Facility

Family Facility	N	M	SD	SE	t	p
High	382	25.261	6.056	.315		
					3.47	.01
Low	430	23.054	6.241	.306		

The science achievement scores of students in High group on family facility was found to be higher than that of the students having low scores on family facility. The difference between mean scores of the two groups was statistically significant at .01 level. This indicates that students from families with better facilities such as T.V, Radio, News-

papers etc. are better on science achievement test compared to those with poor family facility.

#### Science Attitude by Family Facility

The science attitude scores of the high school students were compared after dividing them into two groups based on their family facility scores. The results are given in Table 23.

TABLE - 23.

#### Mean Science Attitude Scores by Family Facility

Family Facility	N	M	SD	SE	t	p
High	382	51.1094	6.158	.362		
					1.990	.05
Low	430	49.9083	6.349	.340		

As shown in Table 23 there is a statistically significant difference between low and high groups in their attitude towards science at .05 level. This indicates that students' attitude towards science is influenced by the facilities available at home.

Problem Solving Ability by Family Facility

The problem-solving ability scores of the students belonging to low and high groups on family facility were compared and the details are shown in Table 24.

TABLE - 24Mean Problem Solving Ability Scores by Family Facility

Family Facility	N	M	SD	SE	t	p
High	382	24.3089	5.827	.298		
					1.968	.05
Low	430	22.3605	5.690	.274		

The comparison in Table 24 shows that the mean scores of students belonging to homes with better facility was higher (24.3089) than that of the students with poor facility background (22.3605). The mean difference of 1.9484 was found statistically significant at .05 level. This proves that family facility differentiates students on the problem solving ability and students with better home facilities are at an advantage.

Science Achievement by Type of School

Students belonging to two types of schools, Government and Deficit Schools were considered separately for the purpose of analysis. The science achievement scores of the two groups were compared and the results are shown in Table 25.

TABLE - 25

Mean science achievement scores by type of schools

Type of School	N	M	SD	SE	t	p
Government	120	24.4500	6.474	.591		
Deficit	692	24.1777	6.275	.239	.43	NS

As per the results shown in Table 25 there is no statistically significant difference in science achievement scores of students belonging to government and deficit schools in Mizoram.

Science Attitude by Type of School

The mean science attitude scores of students from the two types of schools were compared. The results are presented in Table 26.

TABLE - 26

Mean Science Attitude Scores by Type of Schools

Types of School	N	M	SD	SE	t	p
Government	120	50.8917	6.594	.602		
Deficit	692	50.9118	7.146	.272		
					.03	NS

The science attitude scores of the students from two types of schools did not show any statistically significant difference in their mean scores.

Problem-Solving Ability by Type of School

The problem-solving ability scores of students from two types of School were compared. The results are shown in Table 27.

TABLE - 27

Mean Problem-Solving Ability Scores by Types of Schools.

Types of School	N	M	SD	SE	t	p
Government	120	19.2583	6.232	.569		
					7.79	.01
Deficit	692	23.3740	5.473	.208		

Significant difference in problem-solving ability was noticed among students from Government and Deficit High Schools (Table 27). The mean difference in problem-solving ability was found in favour of Deficit High School students and the level of significance was beyond .01. Whereas in the case of science achievement and science attitude the students of the two types of school failed to differentiate, their problem solving ability showed a significant difference in favour of students belonging to deficit schools.

Relationship of Science Achievement, Science Attitude and  
Problem Solving Ability

Analysis of Scores of Male Students

The scores of the male students (N=352) on the science achievement test, science attitude scale and the problem solving ability test were analysed. The mean and standard deviation of the scores on the three variables for the male students are given in Table 28.

TABLE - 28

Mean and standard deviation of scores

Variable	Case	Mean	Standard Deviation
Science Achievement	352	24.7443	6.7548
Science Attitude	352	50.7642	7.2751
Problem Solving Ability	352	23.1903	6.0351

Inter-correlations of the scores on the three variables were obtained by product-moment method. The values are given in Table 29. The partial correlation between the problem solving ability and achievement eliminating the effect of attitude, between attitude and achievement eliminating the effect of

problem solving ability and between problem solving ability and attitude eliminating the effect of achievement were calculated. The results are given in Table 30.

TABLE - 29

Correlation Matrix of Scores on Science Achievement, Science Attitude and Problem Solving Ability among male students

Correlation	Science Achievement	Science Attitude	Problem Solving Ability
Science Achievement	1,0000	.1291 *	.3217 **
Science Attitude	.1291	1.0000	.0301
Problem Solving	.3217 **	.0301	1.000

\* Significant at .05 level

\*\* Significant at .01 level

The correlation of science achievement with science attitude and problem solving ability is 0.1291 and 0.3217 respectively and the correlation between science attitude and problem solving ability is 0.0301 (Table 29). All these correlations are positive but significant only in the case of the first two i.e between achievement and science attitude ( $p < .05$ ), and science achievement and problem solving ability ( $p < .01$ ). The correlation between science attitude and problem

solving ability was not found statistically significant. The results, thus, revealed significant positive relationship of the science achievement with attitude towards science and problem solving ability among the male secondary school students. Although positive and significant, the coefficient of correlation was not so high in both the cases. The variables-science achievement and problem solving ability, showed substantial correlation significant at .01 level whereas the relationship between achievement and the problem solving ability may be described as marked in comparison with attitudes.

It is seen from Table 30 that on eliminating the effect of attitude, the correlation ( $r=0.3094$ ) between the science achievement and problem solving ability still remained substantial and significant. This gives credence to infer that the problem solving ability of the male students is positively and significantly related with their achievement in science. Removing the effect of the variable problem solving ability the correlation between achievement and attitude is .1185 which is less than the original correlation, but still significant at .05 level thereby indicating that these two factors are correlated with each other.

The correlation between science attitude and problem solving ability is .0127 after partialling out the effect

of achievement. This correlation is not significant and, thereby, suggests the lack of relationship between the two variables under study.

TABLE - 30

Original correlations and partial correlations for the scores of male students on science achievement, science attitude scale and problem solving ability.

Original Correlation Coefficients	Partial Correlation Coefficients
$r_{12} = 0.1291$	$r_{12.3} = 0.1185$
$r_{13} = 0.3217$	$r_{13.2} = 0.3094$
$r_{23} = 0.0301$	$r_{23.1} = 0.0127$

Note 1 = Science Achievement,  
 2 = Science Attitude and  
 3 = Problem Solving Ability

The joint effect of attitude and problem solving ability on science achievement is investigated by computing the multiple coefficient of correlation. Problem solving ability and attitude towards science are measured as independent variables whereas the achievement in science is considered as the dependent variable. The computed value of multiple correlation  $R_{1(23)} = .3588$  is significant at .01 and .05 levels

of significance. It is not a considerable improvement over the original correlation ( $r = 0.3217$   $p < .01$ ) between the problem solving ability and the achievement in science. The results probably explains the fact that attitude has a very little effect on the achievement as compared to problem solving ability, which can also be deduced from the corresponding partial correlations.

#### Analysis of Scores of the Female Secondary School Students

The scores obtained by the female students (N=460) on the Science Achievement Test, Science Attitude Scale and Problem Solving Ability Test were taken up separately for analysis. The mean and standard deviation of the three experimental variables are presented in Table 31.

TABLE - 31

Mean and Standard Deviations of scores on Science Achievement, Science Attitude and Problem Solving Ability of  
Secondary School Students.

Variables	Cases	Mean	Standard Deviation
Science Achievement	460	23.8152	5.9066
Science Attitude	460	51.0196	6.9031
Problem Solving Ability	460	23.3435	5.6791

Intercorrelations for the science achievement, science attitude and problem solving ability scores of the female students (N=460) were calculated. The results appear in Table 32. The partial correlation between the achievement scores and attitude scores eliminating the effect of problem solving ability, and between achievement and problem solving ability eliminating the effect of attitude, and that between attitude and problem solving ability eliminating the effect of achievement are given in Table 33.

TABLE - 32

Correlation Matrix of scores on Science Achievement, Science Attitude and Problem Solving Ability among the female students

Correlations	Science Achievement	Science Attitude	Problem Solving Ability
Science Achievement	1.000	.0786	.3027 <sup>**</sup>
Science Attitude	.0786	1.00	.1358 <sup>*</sup>
Problem Solving Ability	.3027 <sup>**</sup>	.1358 <sup>*</sup>	1.000

\* Significant at .05 level

\*\* Significant at .01 level

The science achievement of female students correlated with their attitude towards science ( $r=0.0786$ ) and problem

solving ability ( $r=0.3027$ ) positively, the correlation being significant at .01 level in the case between achievement and problem solving ability. The correlation between science attitude and problem solving ability is 0.1358 which is statistically significant at .05 level. Hence, the hypotheses advanced for female students relating in three experimental variables science achievement and problem solving ability (.01) and science attitude and problem solving ability (.05) were retained but the prediction between science achievement and science attitude was not found valid at any level of confidence. The results of this research recognizes significant and substantial correlation between the science achievement and problem solving ability among the female secondary school students whereas the relationship between attitude towards science and their problem solving ability remained marked in comparison with achievement. However, the study failed to prove any significant relationship between the achievement in science of the female students and their attitude towards science.

TABLE - 33

Original correlations and partial correlations for the scores of female students on science achievement test, science attitude scale and problem solving ability test.

Original Correlation Coefficients	Partial Correlation Coefficients.
$r_{12} = 0.0786$	$r_{12.3} = 0.0592$
$r_{13} = 0.3027$	$r_{13.2} = 0.2886$
$r_{23} = 0.1358$	$r_{23.1} = 0.1255$

1 = Science Achievement

2 = Science Attitude

3 = Problem Solving Ability.

Eliminating the effect of variable attitude, the correlation ( $r=0.2886$ ) between the science achievement and problem solving ability is still significant. Thus, the problem solving ability appears to be positively and significantly correlated with the achievement even among the female students. The correlation between female students' attitude towards science and their problem solving ability 0.1255 adjudged to be significant at .05 level even after partialling out of the effect of achievement. Although the value is less than the original

correlation, but being positive and significant suggests that these two variables are correlated with each other.

The combined effect of problem solving ability and attitude towards science of the female students on their achievement in science was investigated by computing the multiple coefficient of correlation. The resultant value of multiple correlation is  $R_{1(23)} = 0.3301$ . Even though the value is not showing appreciable improvement over the original correlation of  $r=0.3027$  between the variables of science achievement and problem solving ability, the results reiterate the substantially significant positive relationship between the problem solving ability and achievement.

## RESULTS

Hypothesis 1 predicted significant sex difference in the science achievement of the students. The results presented for the analysis of scores on the Science Achievement Test (SAT) in Table 7 showed F value of 8.297 confirmed the hypothesis at .01 level of significance.

Hypothesis 2 stated that significant sex difference exists in the science attitudes of the students. The F ratio for the analysis of scores on the science Attitude scale (SAS) was not found significant at any level, and as

such the assumption in the hypothesis was rejected for want of statistical evidence.

Hypothesis 3 stated that significant sex differences exist in the problem solving ability among the students. As the derived F value of 0.039 (Table 9) for the analysis of scores on the Problem Solving Ability Test (PSAT) was not statistically significant, the prediction in the above hypothesis failed to find acceptance at any level of significance.

Hypothesis 4 predicted that significant differences exist in the science achievement of students from different socio-economic groups. The derived F value of 4.653 from the analysis of scores on the Science Achievement Test (SAT) reported in Table 7 being significant at .05 level supported the hypothesis.

Hypothesis 5 stated that significant differences exist in the science attitudes of students from different socio-economic groups. The F value of 5.025 derived from the analysis of scores on the Science Attitude Scale (SAS) found significant at .05 level confirmed the prediction in this hypothesis (Table 8).

Hypothesis 6 assumed that significant differences exist in the problem solving ability of students from different

socio-economic groups. An F ratio of 5.053 obtained for analysis of scores on the Problem Solving Ability Test (PSAT) as reported in Table 9 found significant at .05 level suggested clearly that the hypothesis could be accepted.

Hypothesis 7 predicted that significant differences exist in science achievement of students studying in Government and Deficit schools. The analysis of variance data in Table 7 show that the derived F value of 1.235 was not statistically significant at any level, thereby rejecting the assumption of this hypothesis.

Hypothesis 8 was formulated to test that significant differences exist in the science attitudes of students studying in Government and Deficit schools. The analysis of scores on the Science Attitude Scale returned F value of 0.530 statistically not significant at any level failed to support the prediction of this hypothesis.

Hypothesis 9 stated that significant differences exist in the problem solving ability of students studying in the Government and Deficit high schools. The derived F value of 13.544 on the basis of analysis of scores on the Problem Solving Ability Test (PSAT) reported in Table 9 established the tenability of hypothesis at .01 level of significance.

Hypothesis 10 stated that positive and significant correlation exist between science achievement and science attitude of male secondary school students. The assumption in this hypothesis found acceptance as the correlation between the scores on the Science Achievement Test (SAT) and Science Attitude Scale (SAS) returned  $r$  of .1291 significant at .01 level. Eliminating the effect of the variable problem solving ability the correlation between the two variables remained positive and significant,  $r_{12.3} = 0.1185$  (Table 30) confirming the prediction in the hypothesis.

Hypothesis 11 suggested that positive and significant correlation exist between the science achievement and the problem solving ability among the male secondary school students. The prediction in this hypothesis was upheld as the derived  $r$  of .3217 between the scores on Science Achievement Test (SAT) and the Problem Solving Ability Test was found positive and statistically significant at .01 level. This was further substantiated when the effect of attitude was partialled out and the obtained  $r_{13.2} = 0.3094$  proved positive and significant (Table 33).

Hypothesis 12 predicted that positive and significant correlation exist between the science attitude and the problem solving ability among the male secondary school stu-

dents. The analysis of scores on the SAS and the PSAT obtained a correlation co-efficient ( $r=0.0127$ ) which being not significant at any level of significance failed to support the prediction in this hypothesis. The partial correlation between the variable eliminating the effect of achievement also did not yield significant results.

Hypothesis 13 stated that positive and significant correlation exist between the science achievement and science attitude among the female secondary school students. The prediction in this hypothesis did not find acceptance as the derived  $r$  of 0.0786 for correlation between the scores on SAT and SAS was not significant at any level.

Hypothesis 14 assumed that positive and significant association exist between the science achievement and the problem solving ability among the female secondary school students. The hypothesis was accepted at .01 level of significance as the  $r = 0.3027$  obtained for scores of SAT and PSAT was positive and statistically significant. The prediction was confirmed further on eliminating the effect of the variable science attitude ( $r_{12.3} = 0.0592$ ).

Hypothesis 15 stated that positive and significant correlation exist between the science attitude and the problem solving ability among the female secondary school students.

The analysis of scores on SAS and PSAT returned r value of 0.1358 significant at .05 level suggested that the hypothesis could be accepted. Partial correlation between the two variables removing the effect of achievement also returned significant correlation which further supported the assumption advanced in this hypothesis.

#### DISCUSSION

##### Sex Differences in Science Achievement, Science Attitudes and Problem Solving Ability

Data presented in Table 7 upholds the significant sex difference in science achievement as the F value was significant at .05 level. Further, it was observed in Table 10 that male students scored higher mean achievement score than the female students. The mean difference being significant recognised the superiority of boys in science achievement when compared to girls. The two way and three way interactions involving sex, SES and type of school also showed significant results highlighting the sex differences in science achievement.

The test of ANOVA failed to recognise any significant sex differences in attitude towards science and the problem solving ability (Table 8 and 9). The interaction effects of SES and type of school with the variable Sex also did not yield any significant results.

The study recognised significant sex difference, and the superiority of the male students over female in science achievement. In a previous study of College students in Mizoram also the same result was observed (Sudhir and Darchhingpuii, 1987). Sex differences have also been reported by a number of researchers from studies on high school and College students (Jordan 1934, Learned and Wood, 1958, Edgerton and Britt 1947). Tylor (1956) Anastasi (1958) and Maccoby (1966) reported that boys generally show stronger numerical reasoning and spatial aptitudes and perform better on tests on science and mathematics while the girls usually excel in verbal and linguistic tests. Keeves (1973) however, mentioned that while the general pattern of results was one of superior performance by male students in science and mathematics, there had been considerable variation between countries in the extent to which boys exceeded girls in performance. Further, it was found that the differences between the sexes in achievement in science increased markedly from primary to secondary schooling. Flanagan and Davis (1964) also found that boys were generally superior to girls in mathematics and science by the time they reached high school.

Developmental studies indicate that marked differences in abilities emerge at adolescence. During adolescence boys are more aggressive, less anxious, better in mathematical reasoning and more analytic in cognitive functioning. Girls, on the other hand, seem to be more affiliative, poorer in reasoning, more field dependent and less analytic in cognitive functioning. The observed sex differences in the present study appear to be the outcome of both developmental and environmental influences. Even though the girls are given equal attention and opportunity for their education, the male dominated patrilineal culture of Mizos encourage the boys to compete, succeed and excel. This difference in performance also seems to arise from differential programming. As the area is still backward in science and technology, girls are not encouraged in their studies in science and mathematics. This may be the reason that girls were found to be weaker in science achievement when compared to boys.

Studies on sex differences in problem solving ability conducted among school and college students have expressed contradictory results. While some studies show the superiority of male over female a number of researches failed to reveal

any significant sex differences in problem <sup>solving</sup> ability (Raaheim 1963, Hoffman and Maier 1966, Mendelsohn, Griswold and Anderson 1966, Davis 1966, Maier and Casselman 1970, Strzyzewski 1973, Singer 1975, Westmoreland 1975, Kumar 1980, Kumar and Kapila 1981).

Researchers have demonstrated the vital role played by environmental factors on sex difference in problem solving. Society and culture are believed to play a significant role on both males and females in problem solving. Arbuthnot (1975) has stressed the need for a systematic exploration of the influence of varied types of socialization practices on problem solving skills. Some studies have recognized that attitude towards problem solving is the main factor (Taylor 1954, Nance and Sinnott 1964, Loupe 1970, Deaux and Emsueller 1975). Research findings have also revealed that men and women use set problem-solving strategies (Maier and Casselman 1970). The influence of society's concepts about sex-roles on the performance of the female has been explicitly stated by Tyler (1965). "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, sociological and cultural emphasis on sex-roles led many investigators to show that sex-role identification does not affect the performance of females. French (1956) and Walker and Heyns (1962) held the view that under suppressive and unfavourable female facilitating male-dominated conditions, female performance was lowered. Milton (1959) hypothesized that problem solving ability is directly related with masculine role-identification. Arbuthnot (1975) Miles and Hulfish (1977) have shown that masculinity and femininity affect the performance of the subjects. Girls with higher feminine scores were poor problem solvers than girls with more masculine force. On the other hand, studies by Yonge (1961), Behrens (1974) and Suter and Domino (1975) proved that girls with high masculine force are better problem solvers than those boys and girls with high feminine scores.

While the above studies give us room to believe that girls can become equally good problem solvers as boys under favourable conditions, the findings of the present research

reinforce the assumption. However, the finding seen in the tribal cultural perspective will pave way for the significance of such a finding. Although a male dominated patrilineal society, the status of woman in contemporary Mizo Society is quite high. There is equal opportunity for both boys and girls for education and employment. The education of girls is considered equally important and parents pay maximum attention to the education of girls as for boys. Also, the women are occupying positions in all fronts of life right from the traffic controller to a village elder. They enjoy freedom and get respect and attention, and their opinion is sought while decision making in<sup>(3)</sup> family and societal spheres. The Mizo women are very hard working and bear the brunt of the work right from child rearing to 'jhum' cultivation. In most of the Mizo families, women are joint breadwinners along with men and are not confined to their family abode. They are very shrewed, active, agile, particular and overwhelm men in a closely-knit communal configuration. This positive, egalitarian, and masculine orientation must have made them to maintain an equally high problem solving ability as men.

#### Socio-Economic Status and Science Achievement

The analysis of variance of the science achievement

scores showed a statistically significant F value (Table 7). Further, the data in Table 13 show that pupils in the high SES group achieved higher mean score (24.8317) on the science achievement test than pupils in the low SES group (23.8527) and the mean difference was significant ( $t=2.4$   $p<.05$ ).

The data reveal that the achievement in science of pupils coming from high socio-economic environment was higher than pupils from low socio-economic group. In other words, the pupils from high socio-economic group showed a definite gain in science achievement over their counter-parts in low SES group. The interaction effects taking sex and type of school in two way and three way interactions also recognized the superiority of students belonging to high SES group. The present findings are quite revealing for the data may be interpreted to mean that socio-economic environment shows a positive and significant relationship with the science achievement. In general, the results are in line with studies both western and Indian, although there are certain exceptions. Naidu and Aaron's (1969) have raised doubts about the influence of socio-economic environment on the academic achievement but this finding again emphasises the significant effect of SES on the achievement in science. The study also supports the results

of a number of studies with respect to the relationship between academic achievement and socio-economic studies of pupils in which a positive and significant relationship has been evidenced (Anand (1970) Sudame, (1973) Lalithama, (1975) Prakash Chandra, (1975), Jasdanwalla (1981), Murali (1985).

#### Socio-economic status and Science Attitude.

The test of ANOVA of the scores on Science Attitude Scale (SAS) in respect of the variable socio-economic status reported in Table 8 returned a F value significant at .05 level. Further, the data in Table 14 show that students in high SES group achieved higher mean score (52.0113) than students in low SES group (50.9277). The difference in mean science attitude scores of the two SES groups being significant ( $t=2.01$   $p < .05$ ), confirmed the positive and significant influence of SES on the students attitude towards science. The data indicate that favourable socio-economic environment is certainly conducive to the development of more positive and favourable attitude towards the science subject. In other words, children coming from homes with higher income, better occupation, higher education and better family facility seem to have an edge over the socio-economically deprived group in forming favourable attitude towards science. It is quite possible that substantial economic help and ample educational opportunities provided

to backward tribal people by the government will improve their socio-economic conditions and definitely bring about changes in their outlooks towards science and technology. A number of other studies have also brought out similar findings (Grewal, 1980, Pillai 1982, Darchhingpuii, 1982).

#### Socio-Economic Status and Problem Solving Ability

The analysis of variance of the PSAT scores on socio-economic status was proved to be significant ( $F= 5.053$   $p < .05$ ). Further, the data in Table 15 expressed that the high SES group secured higher mean score (24.1624) than the low SES group (22.6924) and the groups showed statistically significant difference in mean scores ( $t=2.006$   $p < .05$ ). The results reveal that the problem solving ability of students coming from high socio-economic environment was higher than students from low SES group. The study conclusively proves that socio-economic status is a significant positive factor which influences the students achievement in science, attitude towards science and problem solving ability. In other words, the students from high socio-economic environment, i.e. children coming from families with high income, better occupation, higher education and family facility have a definite gain over the low SES groups. The findings suggest that favourable socio-

economic conditions is certainly conducive and plays a very important role in shaping the favourable attitude towards science, sharpening the problem solving skills and maintaining a higher level of performance. The differential pattern of attitudes and abilities may be further explained as follows. Membership in a high socio-economic group generally provides the kind of environment for the child that is most beneficial to maximum development. This argument holds, for example, that the high SES child, by and large, comes from a family unit in which the parents intellectually interact more with children, and the child-rearing process is presumably less harsh and more verbal in nature. Even the environment at home and outside the immediate family will be stimulating in that men and material are accessible for intellectual interaction and the child enjoys the freedom to make use of these resources. This argument holds further in that the lower strata provides home environment which provides a more restricted range of experiences and material resources which is not conducive to develop the proper attitudes and skills to enhance the performance in science.

The analysis was further extended to examine the effect of factors ~~parental~~ parental education, parental occupation and family facility, the molecular components of the varia-

ble, socio-economic status. The results conclusively proved that children with higher parental education, better occupation and better family facility possessed a significantly higher score on science achievement, science attitude and problem solving ability.

The data presented in Table 16 show that children with high parental education (high school and college educated parents) achieved a higher mean score in science achievement, science attitude and problem solving ability than the low group on parental education (illiterate and elementary school educated parents). While the difference in mean scores was significant at .01 level for science achievement and problem solving ability, it was significant at .05 level in science attitude scores. The results recognize parental education as a positive and significant factor related to science achievement, science attitude and problem solving ability among the secondary school students.

Parental occupation was also proved to be a factor related to the achievement, attitude and problem solving ability. Students with better parental occupational backgrounds achieved significantly higher mean scores in science achievement at .01 level (Table 19), science attitude at .05 level (Table 20) and problem solving ability at .01 level (Table 21). In

other words, children of officials, professionals, teachers, office assistants, contractors and businessmen were found to be superior to those of labourers, skilled workers and cultivators.

Family facility was found to be a factor positively and significantly related to students achievement in science, attitude towards science and their problem solving ability. The high group on family facility figured a significantly higher mean score~~s~~ than low group in science achievement at .01 level (Table 22), science attitude at .05 level (Table 23) and problem solving ability at .05 level (Table 24). The study recognizes that better home facilities such as T.V., Radio, Newspaper facilitate higher achievement, more favourable attitude and better problem solving ability among the students, while deprived home conditions may become constraints of students' achievement in science, attitudes towards science and their problem solving ability.

Type of School and Science Achievement, Science Attitude and Problem Solving Ability.

The analysis of variance data reported in Table 9 show that students studying in different type of schools differed significantly in their problem solving ability. Further,

the data in Table 25 indicate that Deficit (Aided) school students achieved 23.3740 mean score on the PSAT as against the mean score of 19.2583 obtained by the government school students and mean scores differed significantly at .01 level. The study gives us room to believe that the Deficit school students tend to have higher problem solving ability than the students reading in Government schools. Student sex was not found a factor interacting with type of school, but SES was found to interact significantly with the type of school in which they study in developing their problem solving abilities. Students' achievement in science and attitude towards science were not found influenced by the type of school in which they study. The results of the analysis of variance did not yield any significant F values in both the cases.

Varying levels of problem solving ability among the different type of schools is a significant finding of the present investigation. It can be stated that factors like school climate, facilities available in the schools, the efficiency, dedication and interest and the individual attention offered by the teachers may influence in facilitating and enhancing the problem solving ability among the students. The superiority of the Deficit school students in problem solving ability

has to be noted with care and studied from the school situation in Mizoram. The schools in Mizoram do not have adequate facilities like equipments, teaching aids, library and laboratory which are significant factors for developing the problem solving skills. Norton and Butts (1973) report that the way students function in problem situations is related to their knowledge of that context and perception of the problem. Neisser (1976) and Gagne (1965) noted students' perception as the initial and most significant step in complex learning and problem solving while Winnie and Mark (1977) and Anderson and Smith (1981) observed that in perception of the task, students extract information and meaning from the environment. Once a problem is perceived, a skilled and highly motivated student will tend to connect the unknown facts, concepts or principles systematically and will resort to empirical reasoning based on their knowledge realm. Better insights into the problems and their solutions are developed through the reflective deductive - inductive logic. From the above discussion, it is evident that the teaching-learning process in the schools has a great say in fostering problem solving ability among the students. The deficit schools by virtue of their adhocism and autonomy may prove to pool the resources of its personnels and facilities

in a constructive way. The students may enjoy greater freedom, care, attention and guidance from their teachers. In the absence of adequate facilities and deficient conditions, the students must be working in close harmony with teachers in analysing the lessons and applying the knowledge to resolve them. It is a well-known fact that teachers put in greater effort and place more individual attention and care in private institutions. The achievement motivation among the deficit school students in Aizawl was found to be higher than the government schools in a previous study (Sailo, 1982). This may be the reason why the deficit schools, even though inadequate in facilities, equipment and financial resources, were able to help the students to surpass government school students in problem solving ability.

C H A P T E R      V I      :      S U M M A R Y   A N D   C O N C L U S I O N

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CHAPTER - VISUMMARY AND CONCLUSIONS

Modern societies are characterised by scientific and technological revolutions. The Science Policy Resolution of the Government of India illuminates clearly and concisely the relationship of science to national goals and development. The key to national prosperity, apart from the spirit of people, lies in modern age, in the effective combination of science and technology with manpower and material resource. Therefore, promotion of science education is an important factor in the progress, welfare and security of the nation. The Education Commission (1964-66) was of the opinion that science education must become an integral part of school education. A scientific outlook must be developed among the students so that it becomes part of their way of life and culture. The Commission felt that the quality of science teaching at all levels in the country has to be raised considerably so as to achieve its proper objectives and purposes such as, to promote an ever deepening understanding of basic principles; to develop problem solving and analytical skills and the ability to apply the skills to the problems of the material environment and social living; to promote the spirit of enquiry and experimentation.

Science education in Mizoram when compared to that of other states of India, suffers from serious drawbacks. Though the State is having very high literacy rate (59.88%) the quality of science education is very poor. As such, at the tertiary level most of the students opt for arts subject and those who join usually wind up the science course at the pre-university level. There may be many reasons for this, and these may be of varied nature. It may be due to lack of encouragement on the part of the parents, or lack of positive attitude, interest and motivation in science subjects. There is a feeling that method of teaching science employed in the secondary schools stage is not appropriate for an effective learning and the secondary science curriculum is not directly related with that of the pre-university stage. Needless to mention that in an economically backward and hilly tribal region, there is a paucity of competent science teachers at the school and college levels. Lack of facilities, such as science laboratory, equipment, teaching aids and reading materials are also the factors for the deterioration of standards in science. The matriculation results of the Mizoram Board of Secondary Education also indicates that there is a large incidence of failure in the science subjects in the state. Another interesting

observation is that very few girls go for higher studies in science subjects in Mizoram. Therefore it is imperative to study the sex differences in attitude towards science and achievement in science. Socio-economic environment as a factor affecting science achievement and attitude has not been examined in the researches conducted in Mizoram although there are a few studies analysing the organizational factors related to achievement in science (Lalduhsanga 1983<sup>1</sup>). Zochhingpuii, 1983, Thanhawla 1983). The present study assumes significance as it examines the attitudes towards science, science achievement and problem solving ability among the secondary school students in Aizawl. The investigation is further directed to analyse sex, socio-economic status (parental education, parental occupation and family facility) and type of school as factors related to student achievement in science, attitude towards science, and problem solving ability and is entitled : **A STUDY OF SCIENCE ACHIEVEMENT, ATTITUDE TOWARD SCIENCE AND PROBLEM SOLVING ABILITY AMONG THE SECONDARY SCHOOL STUDENTS IN AIZAWL.**

Objectives of the Study:

The major objectives of the study were the following:

1. To study the science achievement, attitude toward science and problem solving ability of the secondary school students in Aizawl.
2. To find the interrelationships of science achievement, attitude towards science vis-a-vis the problem solving ability.
3. To examine the relative effect of sex, socio-economic status, parental education, parental occupation, family facility, and type of school on science achievement, science attitude and problem solving ability.

Hypotheses:

The following hypotheses were 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.

#### TERMINOLOGY

1. Science achievement: Science Achievement in the study has been taken as the accomplishment in science by the scores obtained by the students on an objective test in science.
2. Science Attitude: Science attitude has been defined as the opinion or position taken with respect to psychological object in the fields of science (Moore, 1970) and has been taken as a generalised attitude toward the universe of science content being measured in terms of favourableness or unfavourableness on items on an attitude scale.
3. Problem Solving Ability (PSA): The skill of the students in understanding and analysing a problem and applying the scientific knowledge and method to solve them is designated as the problem solving ability in the present research and is being measured by a Problem Solving Ability Test (PSAT) specially developed for the study.

Sample:

The sample of the study consisted of 812 students (352 boys and 460 girls) selected at random from class IX of 17 secondary schools of Aizawl. The selection of the sample was done after giving proper weightage for the type of school, locale of the school and sex of the students.

The Tools Employed:

- (i) Science Achievement Test (SAT) developed in the Department of Education, Aizawl (Lalduhsanga 1983) has been used and the test included fifty multiple choice questions on science subjects Physics, Chemistry, Botany and Zoology for the secondary school classes. The test has been standardized on a sample of 300 high school students in Mizoram and norms are available. The test retest and split-half reliability coefficients were .83 and .9 respectively and test validated against the teachers rating and school terminal exam marks was quite satisfactory.
- (ii) Science Attitude Scale (Grewal, 1977). A five-point 20 item Likert type attitude scale adopted to Mizoram in an earlier study was used. The split-half reliability coefficient is .84 and norms are available for male and female; and class IX and X students separately.
- (iii) Problem solving Ability Test (PSAT). The test is speci-

fically developed by the investigator for the present study. The test contains problems with respect to health and hygiene, first aid, environmental science, applied nutrition, applied physics, applied chemistry and the social evil of drugs. The initial draft of 40 item test was sent to experts for their comments and on that basis the test items were modified and some were dropped. For item analysis, the test was administered on a sample of 100 secondary school students in Aizawl and only those items which yielded statistically significant correlation coefficient (with the total scores) were retained for the final test. The final test contained 18 items on multiple choice questions carrying a weightage of one mark each for the correct response. A 'crossword puzzle' with a weightage of 12 marks and 'jumbled word puzzle' with 10 marks were the other items on the 20 items problem solving ability test. The reliability of the test worked out by the test retest method ( $r = .602$ ) and the split-half method ( $r = .64$ ) were quite satisfactory and the test was found to be highly valid against the teacher ratings ( $r = .75$ ) and Dube's mathematical problem solving ability test scores ( $r = .816$ ).

#### Collection of Data

The investigator personally visited the schools selec-

ted for the study and administered the tests with the help of science teachers in those schools. A set of type-written instructions were given to each testee and the tests in science achievement, science attitude and problem solving ability were administered in that sequence. The data collection was carried out during the months of October and November, 1987.

#### Statistical Technique of Analysis

Data collected for the study on the problem solving ability, science attitude and achievement in science were scored and tabulated. Descriptive statistics were worked out for scores on science achievement, science attitude and problem solving ability tests. Correlations coefficients were computed applying the Pearson product moment method between the test scores on problem solving ability, and that of science achievement and science attitude. Comparison of the mean scores of the sub-groups based on sex, socio-economic status, parental education parental occupation, family facility and type of school was done by applying 't' test, and analysis of variance (ANOVA) was applied to know the interaction effects of variables sex, socio-economic status and type of school. The analysis of the data has been done with the computer assistance at International Institute of Population Sciences (IIPS), Bombay.

Findings:

1. The results revealed that the science achievement of the boys was positively correlated with the science attitude ( $r=1291$   $p < .05$ ) and problem solving ability ( $r= .3217$   $p < .01$ ) while their problem solving ability and attitude towards science did not show any significant relationship.
2. For female students, it was observed that the science achievement was not correlated with science attitude, while their problem solving ability was found positively correlated with science achievement ( $r= .3027$   $p < .01$ ) and science attitude ( $r= .1358$   $p < .05$ ).
3. Comparison of the science achievement scores of the male and female students showed statistically significant mean difference ( $t=2.05$   $p < .05$ ) and male students were found superior in their science achievement to female students. There were no significant sex differences in the science attitude and problem solving ability of the secondary school students as the male and female students failed to differentiate in their mean scores.
4. Socio-economic status was found to be significant factor related with the science achievement, science attitude and the problem solving ability of the secondary school

- students. Students of high SES group secured statistically significant mean scores than the low SES group on science achievement ( $t=2.14$   $p < .05$ ), science attitude ( $t=2.01$   $p < .05$ ) and problem solving ability ( $t=2.006$   $p < .05$ ).
5. Significant difference was observed in science achievement ( $t=3.86$   $p < .01$ ), science attitude ( $t=2.39$   $p < .05$ ) and problem solving ability ( $t=4.93$   $p < .01$ ) of students belonging to high and low on parental occupation. Children of officials, professionals, teachers, office assistants were found to be better than those of labourers, skilled workers and cultivators.
  6. Students with high parental education were found to be better than those with low parental education in their science achievement ( $t=2.36$   $p < .01$ ). Parental education was also found related to the science attitude, students with high parental education group having more favourable attitude than the low group ( $t=1.96$   $p < .05$ ). Students with high parental education obtained higher mean score than students with low parental education and showed statistically significant difference in their mean problem-solving ability score ( $t=3.45$   $p < .01$ ).
  7. High school students with better family facility showed statistically significant higher mean scores in their science

achievement ( $t=3.47$   $p < .01$ ), science attitude ( $t=1.99$   $p < .05$ ) and problem solving ability ( $t=1.968$   $p < .05$ ) tests than those with less family facility.

8. Analysis of problem-solving ability scores of Government and Deficit school students showed statistically significant difference in favour of the Deficit School students ( $t=7.79$   $p < .01$ ). However, the students from the two types of schools did not differ in science achievement and science attitude scores.
9. The two way interaction analysis of science achievement scores revealed that sex and socio-economic status ( $F=4.818$   $p < .05$ ) and socio-economic status and type of school ( $F=4.582$   $p < .05$ ) were having significant effects, whereas sex and SES failed to yield any statistically significant results. The three way interaction analysis taking sex, SES and type of schools also showed statistically significant results ( $F=4.154$   $p < .05$ ) the male students with high SES and from Deficit schools favouring higher mean scores than female students with low SES and government schools.
10. For science attitude scores, the two way and three way interaction taking sex, SES and type of school did not reveal any statistically significant results. It was found

that SES is the only variable related to science attitude scores, students with high SES showing more favourable science attitude than those from low socio-economic backgrounds.

11. The two<sup>way</sup> interaction analysis with respect to problem solving ability test scores revealed statistically significant result for SES and type of school ( $F=5.561$   $p < .01$ ). The three way interaction analysis taking sex, SES and type of school failed to yield positive results. SES and type of school were found to be the factors related to problem solving ability in the present study.

#### Educational Implications

The present research has brought out certain salient findings which, if proper attention is given will help in the promotion of science education in Mizoram. The science achievement of the student were found positively related to their problem solving ability both among the male and the female students. However, among the female, science attitude was a positive factor in enhancing problem solving ability. Science as a subject consists of a body of facts, principles, theories and laws clubbed together with logic and reason. Specific abilities of

comprehension, recalling information, skill in experimentation, skill in solving problems, skill in handling and classifying given information, analysis, synthesis and evaluation are required for successful performance in science subjects. Problem solving ability has also the same scientific basis and this may be the reason that the science achievement and problem solving ability were positively related. This calls for proper development of problem solving skills to improve their specific abilities. The science teachers should be oriented with the skill in understanding and analysing the problems through scientific method to solve them and impart these skills among the students through their science lessons. Cultivation of proper attitude in science is also a necessary pre-requisite to improve the problem solving ability at the secondary stage especially for the girls. Sex differences in science achievement and problem solving ability have been reported in a number of studies conducted among schools and college students. (Sweeney, 1953; Terman and Tyler, 1954; McNamar 1955; Felen 1975; Maxwell 1975; Macway 1975; Singer 1975 and Hayes 1978). Analysing the reason for the poor performance of females, researches' have demonstrated the vital role played by environmental factors on sex differences in problem solving and science achievement. It has been re-

vealed that attitude towards problem solving is a main factor which bring about sex differences in ability and achievement, and society and culture play a prominent role in forming proper attitude especially among the females. The present study also recognises the importance of attitude in problem solving ability among the female students. It has also been noticed that female group is susceptible to training and practices to change their attitude towards problem solving in a positive manner and enhance their performance in scientific fields (Carry, 1955; Hoffman and Maier, 1961; Singer, 1975; Miles, 1976; Kumar, 1980). The results of these researches guide us to evolve programmes and strategies for attitudinal change especially for the female students at secondary stage. The role of parental education in promoting science attitude has been highlighted in the present study. This gives us credence to believe that the non-formal science education through package programme, contact methods and short term courses in science can inculcate interest and positive attitude towards sciences. It has been noticed that the type of school in which the children study and the facility at home are factors related to science achievement and problem-solving ability. These findings have real educational significance. Students having better

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family facility are at an advantage as they are open to multi-media for acquiring scientific information. This is especially true in a remote area like Mizoram where the resources are limited. The schools in Mizoram do not have adequate facilities like science equipment, teaching aids, library, and laboratory which are significant factors for the promotion of the science education. It is observed that the Deficit schools in the state, of late, have taken special steps in conducting science exhibition, science workshops and even the production of teaching aids from local resources. This may be the reason why the students from the Deficit stream of schools showed superior ability in problem solving.

#### Suggestions for Further Studies.

Beyond the problem of incorporating the findings of the present research into policies and programmes for the promotion of science education in the state of Mizoram, certain other related issues seem to be significant and as such are recommended for further investigations:

1. Studies related to the development of concept formation and problem solving skills among the rural and urban secondary school students.

2. Experimental studies to investigate the effect of passive and active educational environment on problem solving ability, intellectual development and science achievement.
3. A comparative study of the personality factor patterns and problem solving ability among the gifted and backward children.
4. Problem solving behaviour in relation to personality, intelligence and age : A study of college students in Mizoram.
5. Achievement motivation, adjustment and self-concept as related to the academic achievement of secondary school students.
6. A study of the effect of socio-economic environment and school stream on the mental abilities and the academic achievement of high school students in Mizoram.
7. Effect of classroom learning situations on the attainment of objectives of science education in elementary school.

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NORTH-EASTERN HILL UNIVERSITY  
DEPARTMENT OF EDUCATION  
MIZORAM CAMPUS : AIZAWL

ACHIEVEMENT TEST IN SCIENCE

Instructions

There are 50 questions in the test. Three answers are given for each question marked by letters - a, b, and c where only one answer is correct. Encircle the letter corresponding to correct answer against the corresponding question number in the answer sheet provided for marking answer.

Example : Q - The valency of Hydrogen is

(a) 1      (b) 2      (c) 3

A - (a)      b      c

Do not write anything in the question paper. Extra sheet for calculation if necessary will be provided. Time given is one hour.

1.  $\text{Zn} + \dots\dots\dots = \text{Zn SO}_4 + \text{H}_2$   
(a) h HCL      (b)  $\text{H}_2 \text{ SO}_4$       (c)  $\text{HNO}_3$
2. We (a) can      (b) cannot      (c) sometimes can  
hear ultrasonic sound.
3. Which of the followings is a flightless bird?  
(a) Ostrich      (b) Vulture      (c) Babbler

4. Phosphorous combines with oxygen forming  
(a) Phosphoric acid (b) Water (c) Phosphorous Pentoxide
5. Galileo Galilei is famous for his  
(a) Lens (b) Microscope (c) Telescope
6. The word 'amphibian' refers to those animals that can  
lead their life on  
(a) Land (b) Water (c) both Land and Water
7. Each cell of a plant is surrounded by  
(a) Protoplasm (b) Cytoplasm (c) Cell wall
8. Three balloons of same size are filled with  
(a) Hydrogen (b) Oxygen (c) Air  
respectively. If they are let go, which will go up fastest?
9. What soil is best for the growth of plant?  
(a) Clayey soil (b) Sandy soil (c) Loamy soil
10. Conduction is the transference of heat in which molecules  
of a substance  
(a) do (b) do not (c) sometimes do  
move bodily.
11. Speed of sound is  
(a) more than (b) less than (c) equal to  
the speed of light.
12. In how many ways is a frog able to take in oxygen?  
(a) 1 (b) 2 (c) 3

- 13 & Draw a labelled diagram of solar eclipse showing the  
14 sun, the moon the earth and the rays of sunlight.
15. Iodine is used to test the presence of  
(a) sugar (b) starch (c) minerals  
in the seed.
16. Sound (a) can (b) cannot (c) sometimes can  
propagate in vacuum.
17. One method used to prevent rusting of iron is  
(a) by dipping iron in water  
(b) by dipping iron into molten zinc  
(c) by magnetising.
18. How many calories does an egg contain?  
(a) 100 (b) 75 (c) 50
19. All acids contain replaceable  
(a) oxygen (b) hydrogen (c) nitrogen
20. The lightest gaseous element known is  
(a) oxygen (b) hydrogen (c) nitrogen
- 21& Draw a labelled diagram of respiratory organs showing  
22. lungs, trachea larynx and nose.
23. Concave mirror is used in  
(a) camera (b) telescope (c) slide projector
24. Water cycle in nature influences  
(a) climatic conditions (b) oxygen (c) neutralization

25. Heat reaches us from the sun by  
(a) Conduction (b) Convection (c) Radiation
26. Fishes are flattened at sides and tapered at the ends which help them to move quicker and this is called  
(a) steam lined body (b) fins (c) tail
27. Wall lizard can stay in the ceiling upside down because its limb has  
(a) sucker (b) claws (c) fingers
28. Draw a labelled diagram of the preparation of Oxygen by heating potassium permanganate showing Oxygen gas, potassium permanganate, gas jar and source of heat.
29. Black surfaces are (a) worse (b) better (c) same absorbers and radiators of heat than polished surface.
30. Oxygen is a good supporter of  
(a) combustion (b) reduction (c) composition
31. Virtual image (a) can (b) cannot (c) sometimes can be reflected just like light rays.
32. What part of a stem conduct water and mineral salts upwards from soil?  
(a) Xylem (b) Phloem (c) Epidermis
33. Climbing plants stand with the help of some support by  
(a) coiling round the support  
(b) leaning against the support  
(c) tendrils

35. Pure water can be obtained from sea water by the process of  
(a) Evaporation (b) Condensation (c) Distillation
36. The pitch of a sound depends upon the frequency of the sound while the loudness of a sound depends on  
(a) the magnitude of the frequency  
(b) the magnitude of its vibration  
(c) the size of the body
37. Coca Cola contains  
(a) acid gas (b) carbon dioxide gas (c) salt gas
38. Seed requires air, suitable temperature and  
(a) soil (b) water (c) hydrogen  
for germination.
39. Which of the following gas is necessary for photosynthesis:  
(a) oxygen (b) nitrogen (c) carbon dioxide
40. Jagdish Chandra Bose applied method of  
(a) physics (b) chemistry (c) biology  
to study with a quantitative precisions, various phenomena  
in biology.
41. The valency of Al and Br are 3 and 1 respectively in  
Aluminium Bromide. Its formula is  
(a) Al Br (b) Al<sub>3</sub> Br (c) Al Br<sub>3</sub>
42. Ray of light after passing through a prism  
(a) bends away from (b) bends towards to  
(c) does not bend to the base of the prism.

43. The part of plant that prepares food is  
(a) root (b) stem (c) leaf
44. Which of the following is vertebrate?  
(a) worm (b) insect (c) snake
- 45., How does fish take in oxygen?  
(a) through the lungs  
(b) through the gill filaments  
(c) through the air bladder
46. How much heat is given out when 500 gm of water steams at 100 C? Heat of vapourization = 540 Kcal/Kg  
(a) 0  
(b) 2,70,000 kilocalories  
(c) 27,00,000 kilocalories
47. Birds have (a) feather (b) wing (c) hollow bones to lessen their weights.
48. One characteristics of a reptile is that they have  
(a) eyes (b) car (c) egg
49. Which of the following is a base?  
(a)  $H_2SO_4$  (b) KOH (c)  $H_2O$
50. The process of hydrogenation of oils is used for preparing  
(a) Dalda (b) Preserved fruit (c) acid.



3.	Study of science subjects is rather a dull affair.	SA	A	U	D	SD
4.	Other subjects cannot be properly understood without the knowledge of science.	SA	A	U	D	SD
5.	Science subjects are very difficult to study	SA	A	U	D	SD
6.	Science subjects are more exact than others.	SA	A	U	D	SD
7.	Science is bound to lead our society into godlessness.	SA	A	U	D	SD
8.	Science subjects provide more recreation than other subjects	SA	A	U	D	SD
9.	Scientific knowledge alone cannot improve a man's life.	SA	A	U	D	SD
10.	Science sharpens our reasoning power and logical thinking.	SA	A	U	D	SD
11.	Science fails to solve all of our problems.	SA	A	U	D	SD
12.	Science subjects are useful for getting a success in the competitive examinations.	SA	A	U	D	SD
13.	Too much emphasis on science would bring down our moral standards.	SA	A	U	D	SD
14.	Science alone is responsible for our technical and industrial progress.	SA	A	U	D	SD
15.	A student gets discouraged when he fails to answer certain questions in science.	SA	A	U	D	SD

- |     |  |    |   |   |   |    |
|-----|--|----|---|---|---|----|
| 16. | Working in a scientific field brings more fame.            | SA | A | U | D | SD |
| 17. | Science can be studied by males only.                      | SA | A | U | D | SD |
| 18. | Science subjects open up many avenues of employment.       | SA | A | U | D | SD |
| 19. | Science has made us to depend entirely on machines.        | SA | A | U | D | SD |
| 20. | Science has turned the impossibilities into possibilities. | SA | A | U | D | SD |

NORTH-EASTERN HILL UNIVERSITY  
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SCIENCE ATTITUDE SCALE  
(Mrs. Avinash Grewal)

KAIHHRUAINA

Heng a hnuaiia ziak hi science chungchang thil thenkhat ani a. A thente hi chuan science chungchang a i ngaihndan an phawk mai thei. Science zirna chung changa i ngaihndan dik tak hriat kan duh hle a. Heta inziak thenkhat hi i ngaihndan nena inzul a awm mai thei; a thente chu i ngaihndan nen a inanglo mai thei bawk. Ngun tak a ngaihtuah chung a i chhiar hnuah i ngaihndan nen a inan leh an loh chiang ang che.

I pawm zawng tak mai anih chuan a thu inziak zawna (SA) Strongly Agree tih kha thai bial hnan la; i ngaihndan a ni ve a nih chuan A (Agree) kha thai bial hnan ang che. A thu inziak chung changah ngaihndan fumfe i nei lo anih chuan U (Undecided) kha thai bial hnan la, i ngaihndan nen a inang lo a nih chuan D (Disagree) kha thai bial hnan la, tin, i ngaihndan nen a in per-san hle chuan SD (Strongly Disagree) kha i thai bial hnan dawn nia.

I ngaihndan dik tak-tlang takin tilang hram ang che.

STATEMENTS

1.	Scientist-te hi midangte ngaihtuahlo mi an ni.	SA	A	U	D	SD
2.	Science thiamna hmanga ei zawнна hi eizawнна dang zawng aiin khaw- tlang tan a chhenfakawm zawk.	SA	A	U	D	SD
3.	Science zir hi thil ninawm tak a ni.	SA	A	U	D	SD
4.	Science thiam loh chuan subject dang a thiam tak tak theih loh.	SA	A	U	D	SD
5.	Science subjects hi a harsa em em hlawm.	SA	A	U	D	SD
6.	Science hi subject dang zawng zawng aiin a dik chiah chiah bik.	SA	A	U	D	SD
7.	Science hian Pathian awm ring lo mi-ah mi a siam vek ang.	SA	A	U	D	SD
8.	Science subject hian subject dang zawng aiin rilru leh taksa in- tihharhna (recreation) a pe tam.	SA	A	U	D	SD
9.	Science thiamna ringawt hian mihring nun a siam thei lo.	SA	A	U	D	SD
10.	Science hiam awmze nei tak leh fing taka thil chhutna-ah mi a tanpui.	SA	A	U	D	SD
11.	Science hian kan harsatna zawng zawng a su kiang vek thei lo.	SA	A	U	D	SD
12.	Hna zawнна-a Exam na-ah Science subjects atangin hlawhtlin a awl bik.	SA	A	U	D	SD

- |     |  |    |   |   |   |    |
|-----|--|----|---|---|---|----|
| 13. | Science lam zirna uar lutuk<br>hian kan chhunglam nun a<br>tichhe thei ang.                          | SA | A | U | D | SD |
| 14. | Thilsiamna lam leh technical lam<br>a hmasawna hi science vang liau<br>liau a ni.                    | SA | A | U | D | SD |
| 15. | Science subject-a zawhna then-<br>khat chhan theihloh a neihs<br>zirlai chu a hnual thin.            | SA | A | U | D | SD |
| 16. | Science lam thiamna hmanga ei-<br>zawna kawngah hian hmingthan<br>a awl bik.                         | SA | A | U | D | SD |
| 17. | Science chu mipa zir chi chauh<br>a ni.  | SA | A | U | D | SD |
| 18. | Science subject hian eizawna-<br>atan hnathawktu tamtak a siam<br>belh.                              | SA | A | U | D | SD |
| 19. | Science hian kut ke berah khawl<br>(machine) min hman tirin, an tel<br>lova awm thei lovah min siam. | SA | A | U | D | SD |
| 20. | Science thiamna hian thiltih<br>theih lova ngaihte tih theih dan<br>kawng a hawng.                   | SA | A | U | D | SD |

NORTH-EASTERN HILL UNIVERSITY  
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PROBLEM SOLVING ABILITY TEST (PSAT)  
KAIHHRUAINA

He test-ah hiam item 20 a awm a. I nitin nunah harsatna eng eng emaw i tawk thei. Harsatna engemaw i tawh a, chu harsatna sutkianna atana tangkai ni-a i hriat leh i tih ngei tur ni bawk a i hriat te lo hriat hi heng item te hian an tum ber a ni.

Item tin hi ngun takin chhiar la, harsatna sukiang tura i tih tur ber, pakhat chauh zel thai bial hnan ang che. A hnuaia entirna pek hi chhiar phawt la.

ENTIRNA: Tunlai hian kan ramah sikserh natna (Malaria) a tam hle-in mi tam takin he natna avang hian nunna an chan a ni. Nang leh i chhungte he natna lakah hian in him theih nan, he natna rawn thlentu hi suat tul i tiin, i tum hle bawk a. A hnuaia rannung (insect) eng ber hi nge i suat ang?

- a. Tho (house-fly)
  - b. Thosi pa (Male anopheles)
  - (c.) Thosi nu (Female anopheles)
  - d. Khumfa (bed bug)
-

1. In school field a in pawlin games in neih laiin field ah chuan ui pakhat a lokal a, in thian pakhat a rawn seh ta mai a. Hemi chungchangah hian engnge i tih hmasak ber ang le?
  - a. Ui chu ka um vat ang
  - b. Doctor ka ko ang.
  - c. Damdawiin-a dah ka rawt ang.
  - d. A sehna laia thi chhuak tihtawp ka tum phawt ang.
  
2. Lakhuihthei i vel dawn a, i chemte hman thin chu a lo tui ek reng mai a, chemte pakhat zawk erawh chu a lo la tui ek ve lo. Chu chemte chu a tui ek ve mai loh nan, hman rih loh a, dah that i duh ta a. A tui ek ve loh nan engtiangin nge i tih ang?
  - a. Tuiin fai takin ka sil phawt ang.
  - b. Tel mawm ka chulh ang a, ka dang ang.
  - c. Rawng ka hnawih (paint) ang.
  - d. A khat tawkin tui sa-in ka sil thin ang.
  
3. Nikhat chu i nauvin saidawium-a tui chu filter tui emaw tiin a in ta pawp mai a, Khawnvartui a lo ni reng mai si a. Engtiangin nge i tanpui ang?
  - a. Tui thianghlim ka intir teuh ang.
  - b. Daikal (dai leng) vat turin ka ti ang.
  - c. A luak theih nan luak tichhuak thei intur ka pe vat ang.
  - d. Mut hilhna damdawi ka eitir ang.

4. Exercise hahthlak tak mai, tha sen tam ngaihna chi ber lak i duh a, heng a hnuaia mite hi a eng ber hi nge i thlan ang?
- Tui hleuh
  - Sakawr chung chuan
  - Ke-a thui tak kal
  - Thirsakawr chuan (cycling)
5. Inah i nau nen rawng inbawl laiin i nau kawr hak lai chu a lo kang palhin a alh ta mai a, engtinngge i tih ang?
- Min pui turin thenawm te ka au ang.
  - A kang chu tihmih ka tum ang
  - Doctor ka ko ang.
  - Ka kan ve loh nan ka tlan sawn phawt ang.
6. Artui i kang dawn a, artui chu a chhe lova, a eitlak ngei a ni tih tikeh lovin engtinngge i hriat theih ang?
- Ka hnim ang
  - Ka thing ang
  - Tuih ka chiah ang.
  - A hmel landanah ka hre mai ang.
7. Nipui lai a tui a hal hian, tui vawit in kan chak bik thin a, tui dahvawhna (vur bawm) nei te silo ula, in chhungkua-in tui vawt in in thin theih nan engah hian nge tui chu i dang ang?
- Hlum belah
  - Stainless Steel belah
  - Alluminium belah
  - Tui um (Mau bur) ah

8. Work Experience in neih lain in pawla mi pakhat hnar a lo thi ta a, a nasa viau mai a, chumi tanpui tur chuan engnge i tih hmasak ber ang?
- A nu leh pa ka ko ang.
  - Doctor ka ko ang.
  - Hlau-in ka khur ang.
  - Thichhuak tihreh ka tum ang.
9. In leng hmanhmawh tak mai i nei a, thingpui i lum a, i no hmantur chu glass no (rial no) a ni. No pakhata i han thlit chuan a khi ta mai a, a dangte chu an khi ve ang tih i hlau ta hle mai a, i hmanhmawh tawh si, engtingge he harsatna hi i sutkian ang?
- No dangte chu ka chhum so zet ang.
  - No chu tui lumin ka sil phawt ang.
  - Thingpui chu thlit hma-in ka nghak dai phawt ang.
  - An khik ve kher tawh loh ringin, ka thli pawp pawp ang.
10. Needle and Thread race (Hriau thil chak leh tlan chak inkawp a intihsiak)-ah i tel ve a. I thil ran theih nan engtiang hian nge i thil ang?
- Mit siai-in ka thil ang.
  - Mit pahnih mengin ka thil ang.
  - Hriau kua (a beng) chu hriau sin zawkin ka vit phawt ang.
  - Ni thlar zawnga enin ka thil ang.

11. In vengah, Cholera a leng a, in chhungkua-in in kai ve loh nan engtianga inven hi nge thaber a i hriat?
- Kan in chu natna hrik that thei damdawi-in ka sil emaw theh emaw ang.
  - Nitin kan inbual thin ang.
  - Tui chhuan so kan in thin ang.
  - Cholera vei kan hmuh apiangin hnar kan hup ang.
12. Thla sik lai hian zanah pheii chuan a vawt kan ti thei hle thin a. Zan mut laia i pindan tihlum i duh a, a hnuaia mite hi a eng ber nge i pindan tihlum nan i thlan ang?
- Gas stove
  - Electric Heater
  - Mei ling
  - Lungalh thei (coal).
13. Chemistry laboratory a experiment i tih lain vanduai thlak takin Caustic Soda ( $\text{NaOH}$ ) i mitah i tilut hlah mai a, engtinge i tih ang?
- Ammonium Hydroxide ( $\text{NH}_4\text{OH}$ ) in ka sil vang ang.
  - Tui lumin ka sil vat ang.
  - Boric acid in ka sil vat ang.
  - Sulphuric acid ( $\text{H}_2\text{SO}_4$ ) in ka sil vat ang.
14. In Sitting room thar chu a zau bawk a, a nuam hle dawn a. Mahse tawng hian 'aw thangkawk' a awm thin a, i ngaimawh hle mai a, engtia tihreh nge i tum ang?
- Carpet ka phah ang.
  - Thutthleng leh dawhkan tam tawk ka dang ang.
  - Bang chu rawng ka hnawih (paint) ang.
  - Room chu ngun takin ka sil ang.

15. Khaw lum lai hian thlai chhum leh bawngnute te hi a hingin a chhe awl hle mai a. Bawngnute chu a chhiat loh nan engtingge i tih ang?
- Germs (natna hrik) tihlum turin minute 5 (nga) ka chhuang so ang.
  - Ngun takin ka chhuang so ang a, chumi zawh chuan ka chhin tha ang.
  - Tho bawm theihloh turin ka siam ang a, ka chhuang lum bawk thin ang.
  - Ka chhuang so ang a, chumi zawhah hmun daiah chhin lohvin ka dah ang.
16. In inchhunga electric current kal danah him tawklo a awm
- Tuidawt-a tui i herhchhuah lai chuan current-in a man thei che a. Hemi chungchanga tih tur tul hmasa ber chu engnge ni a i hriat?
  - Electric lam thiam mi ka ko ang.
  - Keimahin siam that ka tum ang.
  - A Main Switch ah ka Off ang.
  - Rubber slipper bunin tui chu ka herh haw mai ang.
17. I chhungte dang awm loh hlanin i naute awm chu a khua a lo sik thutin a lo kaih ta mai a. Hemi chungchangah hian engnge i tih hmasak ber ang le?
- Doctor ka ko vat ang.
  - A lu/tukkhum chu tuivawt-in ka leih vak ang.
  - Lum takin ka tuam ang.
  - Midang ka pun vat ang.

18. Kan ram sik leh sa hi, tunhma kum sawm (10) vek kal ta nena kan khaikhin chuan a lo danglam ta hle mai a. Tlang ram ni siin a lum ve ta hle ani. A lum zual chang phei chuan hrehawm kan ti hle a. He boruak lo lum hrehawm ta hle mai hi, a tihnep dan kawng tha ber ni- a i hriat chu eng hi nge le?

- a. Mitin-in Air Condition hman.
- b. In tina Fan (Ceiling Fan) neih.
- c. In bul vela thing phun uar theuh.
- d. Cold drinks leh ice cream man tlawm zawk a zuar tu tam tawk Aizawl a neih.

19. A hnuaia thu te hi tunlaia khawtlangin kan buaipui em em, sual (social evils) kan tihte an ni hlawm a. Thumal tin hi awmze nei turin kan rem dik teh. Saptawng (English words) an ni hlawm.

- (i) P O U M I
- (ii) N E R H I O
- (iii) R R O T P N O I C U
- (iv) D R M X A N A
- (v) Q O R U I L
- (vi) B N G I L M A G
- (vii) G G M S N G U I L
- (viii) C D E I I S U
- (ix) P A E R
- (x) F T H E T

20. Puzzle-ah hian Science lama mi hmingthangte paruk, an thil hmuhchhuah pakhat theuh nen zeh a ni a, thai-in han zawng chhuak teh le.

R	M	Q	T	T	A	W	S	E	M	A	J
O	H	V	U	O	P	N	E	S	R	N	E
N	Z	D	V	I	X	K	L	H	O	V	N
A	E	S	I	V	N	Z	B	I	E	K	I
L	E	W	W	U	D	I	T	I	N	P	G
D	L	T	T	B	M	A	N	S	T	M	N
R	A	D	I	O	T	S	X	E	G	Q	E
O	X	M	C	I	N	H	J	P	E	S	M
S	P	K	V	D	Y	D	F	E	N	R	A
S	M	A	D	A	M	E	C	U	R	I	E
O	R	H	R	Z	P	M	K	B	A	C	T
G	V	X	T	I	N	O	C	R	A	M	S

NORTH-EASTERN HILL UNIVERSITY  
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PROBLEM SOLVING ABILITY TEST (PSAT)

Directions

This test consists of 20 items. In your daily life you may come across certain problems of varied nature. This test aims at knowing your reactions toward various activities useful in finding solutions to such problems. Each problem in the test is provided with four possible solutions, marked by letter a, b, c and d. You are required to read each item carefully and then decide what your first reaction to it is. Encircle the letter corresponding to correct reaction against the corresponding question number in the answer sheet provided for marking answer.

Example: There is a widespread of malarial disease in our state now a days, and many people have lost their lives because of this disease. To safeguard yourself and your family from this dreadful disease, you want to eradicate the insect which is responsible for this disease. Read the list of insects below.

Which one will you eradicate?

- a. house-fly
- b. Male anopheles
- c. female anopheles
- d. bed bug

1. While playing in your school field, a dog comes and bites one of your playmates. What would be your first reaction to help him?
  - a. I will chase the dog
  - b. I will call a doctor
  - c. I will suggest taking him to the hospital
  - d. I will give him first aid.
  
2. While trying to peel pineapple, you find that your kitchen knife gets rusted. What will you do to prevent rusting of your other knives which do not yet get rusted?
  - a. I will wash them nicely with water
  - b. I will oil and then store them like that
  - c. I will paint them
  - d. I will wash them with hot water occasionally
  
3. Your younger brother drinks kerosene oil from the bottle by mistake, thinking that it is filtered water. What will you do first to help him in this situation?
  - a. I will make him drink plenty of pure water
  - b. I will make him pass stool quickly
  - c. I will give him an emetic of warm salt water.
  - d. I will give him sleeping pills.
  
4. You are interested in physical exercise. You want to take exercise which involves maximum expenditure of energy. Which of the given exercises will you choose?
  - a. swimming
  - b. horse riding
  - c. jogging
  - d. cycling

5. While cooking dinner with your sister at home, her cloth catches fire suddenly. What will be your first reaction in this problematic situation?
- I will shout for help.
  - I will try to put out the fire by covering her with blanket.
  - I will call a doctor
  - I will run away from the scene so that I am safe from fire.
6. You are going to make an omelette. How can you tell that the egg is safe for eating without breaking it first?
- I will know by shaking it
  - I will know by smelling it
  - I will know by immersing it in a bowl of water
  - I will know it from its appearance.
7. You want to have cool water for your family during summer, but you do not have a refrigerator in your home. How will you manage to have cool water all through the hot season?
- I will keep water in an earthenware pot
  - I will keep water in an alluminium vessel.
  - I will keep water in a stainless vessel
  - I will keep water in bamboo tubes.
8. While having work experience class in your school garden, one of your friends' nose bleeds profusely, what will you do first to help him?
- I will run and call his parents
  - I will tremble with fear
  - I will call a doctor
  - I will try to stop the bleeding immediately.

9. While preparing tea for visitors who are in kind, of a hurry to leave, you find that the glass in which you pour tea cracks. What will you do so that the rest of the glasses do not crack?
- I will boil the rest of the glasses first
  - I will wash the rest of the glasses with warm water before pouring tea in them
  - I will wait till the tea gets cold.
  - I will quickly pour tea hoping that they will not crack like the first one.
10. You take part in the 'needle and thread' race in your school sports. How will you thread the needle so that you win the race?
- I will close one eye and thread it
  - I will open both the eyes and thread it
  - I will poke the eye of the needle with the point of another needle and then thread it.
  - I will look through the eye of the needle against the sun and thread it.
11. Cholera breaks out in your locality. What preventive measure will you and your family take in this regard?
- I will disinfect the house.
  - We will take bath everyday
  - We will drink only boiled and colled water when we feel thirsty.
  - We will close our mouths and noses with hankerchief when we happen to see cholera patient.

12. In this hilly area of ours you feel cold, specially during winter nights. You want to keep your bed room warm throughout the night during this season. What will you choose to keep the room warm at night?
- gas stove                      gas stove
  - electric stove
  - charcoal
  - coal
13. You are working in your chemistry laboratory. Unfortunately caustic soda (NaOH) gets into your eye. What will be your reaction to this?
- I will wash my eye with ammonium Hydroxide ( $\text{NH}_4\text{OH}$ ) immediately.
  - I will wash my eye with warm water immediately.
  - I will wash my eye with boric acid immediately.
  - I will wash my eye with sulphuric acid ( $\text{H}_2\text{SO}_4$ ) immediately.
14. You have a new sitting room which is quite big and nice. But when you talk, an 'echo' is produced, and you do not like this. What will you do to stop the echo?
- I will put carpet on the floor.
  - I will put sufficient number of furniture
  - I will paint the wall
  - I will wash the room thoroughly with water everyday.

15. In warm weather, milk gets spoiled easily. How will you prevent the milk from getting spoiled?
- a. I will boil it so as to kill the germs which may be present in it to cause spoilage.
  - b. I will boil it nicely and after that I will cover it.
  - c. I will protect it from flies and warm it occasionally.
  - d. I will boil it and then keep it in a cool place uncovered.
16. There is something wrong with the electric current in your house. When you open the water tap you get a shock. How will you act in this dangerous situation?
- a. I will call an electrician
  - b. I will try my level best to make it alright.
  - c. I will put off the main switch first of all
  - d. I will open the tap wearing rubber slipper
17. While your parents are away, the baby under your care gets fever and convulses. What will you do first in this problematic situation?
- a. I will call a doctor quickly.
  - b. I will pour cold water at the back of his head.
  - c. I will keep him very warm with blanket.
  - d. I will call all the neighbours.

18. The climate of this hilly area has changed a lot and become very hot, specially during summer. In what way can you best solve this problem?

- a. I will suggest that every house has an air conditioner.
- b. I will suggest that every house has ceiling fans.
- c. I will suggest that every family plant trees in the compound of the house.
- d. I will suggest that more ice-cream be produced at cheaper price.

19. The physical, spiritual and moral lives of our present Society are in danger. Certain things are responsible for this. Below is a list of such things written in jumbled form. Re-arrange each word so that they make sense.

- (I) POUMI
- (II) NERHIO
- (III) RROTPNOICU
- (IV) DRMXANA
- (V) QORUIL
- (VI) BNGILMAG
- (VII) GGMSNGUIL
- (VIII) CDEIISU
- (IX) PAER
- (X) FTHET

20. In the puzzle below, six scientists with one invention each are given. Try and detect them.

R	M	Q	T	T	A	W	S	E	M	A	J
O	H	V	U	O	P	N	E	S	R	M	E
N	Z	D	V	I	X	K	L	H	O	V	N
A	E	S	I	V	N	Z	B	I	E	K	I
L	E	W	W	U	D	I	T	I	N	P	G
D	L	T	T	B	M	A	N	S	T	M	N
R	A	D	I	O	T	S	X	E	G	Q	E
O	X	M	C	I	N	H	J	P	E	S	M
S	P	K	V	D	Y	D	F	E	N	R	A
S	M	A	D	A	M	E	C	U	R	I	E
O	R	H	R	Z	P	M	K	B	A	C	T
G	V	X	T	I	N	O	C	R	A	M	S

NORTH-EASTERN HILL UNIVERSITY  
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PERSONAL DATA SHEET

1. Name \_\_\_\_\_ 2. Sex \_\_\_\_\_ 3. Age \_\_\_\_\_
4. Class \_\_\_\_\_ 5. School \_\_\_\_\_
- 6 Permanent Residence: \_\_\_\_\_
7. I pa emaw, i guardian emaw-in zirna lam a a thlen chin  
(Educational Qualification) \_\_\_\_\_
8. I pa emaw, i guardian emaw hnathawh hming (Occupation):  
\_\_\_\_\_
9. In chhungkaw thla tin pawisa lak luh zat (Monthly Family  
Income): \_\_\_\_\_
10. A hnuaia thil hrang hrang tarlan te hi, in in-a in neih  
ang apiang, a zawnah thai ( ) zel teh le.
- |   |   |
|---|---|
| (a) Puan thui khawl                           | (b) Gas stove   |
| (c) Pressure Cooker                           | (d) Electric Istiri   |
| (e) Electric hmang chi<br>chhang/cake ur bawm | (f) Electric hmanga room tih-<br>lumna (Room heater)                |
| (g) Electric hmanga rawng<br>bawlna (Heater)  | (h) Electric hmanga tui<br>tihlumna (Geyser)                        |
| (i) Thlalakna (Camera)                        | (j) Electric hmanga Mawsawla<br>leh thildang hersawmna<br>(Grinder) |
| (k) Sa her sawmna (Mincer)                    | (l) Refrigerator  |
| (m) Television                                | (n) Video Player  |
| (o) Puansuk Khawl<br>(Washing machine)        | (p) Fan, Ceiling/Portable   |

(q) La phiar Khawl

(r) Puan tah khawl

(s) Vacuum Cleaner

(t) Air Conditioner

(u) Radio

(v) Sana lian, banga khai  
chi (Wall clock)

(w) Tape Recorder

(x) Electric Light

(y) Motor :

(i) Car

(ii) Jeep

(iii) Taxi

(iv) Truck

(v) Bus

(vi) Van

(vii) Scooter/Bike/Bicycle.

NORTH-EASTERN HILL UNIVERSITY  
DEPARTMENT OF EDUCATION  
MIZORAM CAMPUS : AIZAWL

SCIENCE ACHIEVEMENT TEST  
(Answer Sheet)

Please encircle the letter corresponding to the correct answer.

1. a b c

2. a b c

3. a b c

4. a b c

5. a b c

6. a b c

7. a b c

8. a b c

9. a b c

10. a b c

11. a b c

12. a b c

13 & 14. Draw the diagram below and label it

15. a b c

16. a b c

17. a b c

18. a b c

19. a b c

20. a b c

21 & 22. Draw a labelled diagram of respiratory organs showing lungs, trachea, larynx and nose.

23. a b c

24. a b c

25. a b c

26. a b c

27. a b c

28 & 29 Draw a labelled diagram of the preparation of oxygen by heating Potassium Permanganate showing Oxygen gas, potassium permanganate, gas jar and source of heat.

30. a b c

33. a b c

36. a b c

39. a b c

42. a b c

45. a b c

48. a b c

31. a b c

34. a b c

37. a b c

40. a b c

43. a b c

46. a b c

49. a b c

32. a b c

35. a b c

38. a b c

41. a b c

44. a b c

47. a b c

50. a b c

---

NORTH-EASTERN HILL UNIVERSITY  
DEPARTMENT OF EDUCATION  
MIZORAM CAMPUS : AIZAWL

ACHIEVEMENT TEST IN SCIENCE : SCORING KEY

- |  |       |       |       |
|--|-------|-------|-------|
| 1. b                                       | 2. b  | 3. a  | 4. c  |
| 5. c                                       | 6. c  | 7. c  | 8. a  |
| 9. c                                       | 10. b | 11. b | 12. b |
| 13. Neat figure indicates full marks.      |       |       |       |
| 14. Correct labelling indicates full marks |       |       |       |
| 15. b                                      | 16. b | 17. b | 18. b |
| 19. b                                      | 20. b |       |       |
| 21. Neat figure indicates full marks       |       |       |       |
| 22. Correct labelling indicates full marks |       |       |       |
| 23. c                                      | 24. a | 25. c | 26. a |
| 27. a                                      |       |       |       |
| 28. Neat figure indicates full marks       |       |       |       |
| 29. Correct labelling indicates full marks |       |       |       |
| 30. b                                      | 31. a | 32. b | 33. b |
| 34. a                                      | 35. c | 36. b | 37. b |
| 38. b                                      | 39. c | 40. b | 41. c |
| 42. b                                      | 43. c | 44. c | 45. b |
| 46. b                                      | 47. c | 48. c | 49. b |
| 50. a                                      |       |       |       |

NORTH-EASTERN HILL UNIVERSITY  
DEPARTMENT OF EDUCATION  
MIZORAM CAMPUS : AIZAWL

PROBLEM SOLVING ABILITY TEST (PSAT)  
(Answer Sheet)

Ichhanna chu kual khung zel ang che.

- |             |             |             |
|-------------|-------------|-------------|
| 1. a b c d  | 2. a b c d  | 3. a b c d  |
| 4. a b c d  | 5. a b c d  | 6. a b c d  |
| 7. a b c d  | 8. a b c d  | 9. a b c d  |
| 10. a b c d | 11. a b c d | 12. a b c d |
| 13. a b c d | 14. a b c d | 15. a b c d |
| 16. a b c d | 17. a b c d | 18. a b c d |

19. A hnuaiah hian Social evils te chu, a zawhna number nena inmil turin dah rawh le.

- |       |        |
|-------|--------|
| (i)   | (ii)   |
| (iii) | (iv)   |
| (v)   | (vi)   |
| (vii) | (viii) |
| (ix)  | (x)    |

20. Science lam a mi hmingthangte, an thil hmuhchhuah pakhat theuh nen thai-in han zawng chhuak teh.

R	M	Q	T	T	A	W	S	E	M	A	J
O	H	V	U	O	P	N	E	S	R	N	E
N	Z	D	V	I	X	K	L	H	O	V	N
A	E	S	I	V	N	Z	B	I	E	K	I
L	E	W	W	U	D	I	T	I	N	P	G
D	L	T	T	B	M	A	N	S	T	M	N
R	A	D	I	O	T	S	X	E	G	Q	E
O	X	M	C	I	N	H	J	P	E	S	M
S	P	K	V	D	Y	D	F	E	N	R	A
S	M	A	D	A	M	E	C	U	R	I	E
O	R	H	R	Z	P	M	K	B	A	C	T
G	V	X	T	I	N	O	C	R	A	M	S

NORTH-EASTERN HILL UNIVERSITY  
DEPARTMENT OF EDUCATION  
MIZORAM CAMPUS : AIZAWL

PROBLEM SOLVING ABILITY TEST : SCORING KEY

1. d	7. a	13. c
2. b	8. d	14. b
3. c	9. b	15. d
4. a	10. a	16. c
5. b	11. c	17. b
6. c	12. c	18. c

19. I) OPIUM  
II) HEROIN  
III) CORRUPTION  
IV) MANDRAX  
V) LIQUOUR  
VI) GAMBLING  
VII) SMUGGLING  
VIII) SUICIDE  
IX) RAPE  
X) THEFT

20. JAMES WATT - STEAM ENGINE  
MARCONI - RADIO  
RONALD ROSS - QUININE  
MADAME CURIE - RADIUM  
ROENTGEN - XRAY  
NEWTON - GRAVITATION.

POPULATION AND LITERACY IN MIZORAM  
(1901 - 1981)

Year	Population			Literacy			Literacy percentage
	Male	Female	Total	Male	Female	Total	
1901	39004	43430	83434	736	25	761	0.93
1911	43028	48176	91204	-	-	3635	3.98
1921	46652	51754	98406	-	-	6183	6.28
1931	59186	65218	124404	-	-	13320	10.70
1941.	73855	78931	152786	-	-	29765	19.48
1951	96136	100006	196202	44375	16718	61093	31.13
1961	132465	133598	266063	70743	46351	117094	44.00
1971	170824	161566	332390	103324	75469	178793	53.79
1981	251988	235786	487774	166296	123945	290241	59.88

Source : Census of India Final Population Totals 1901-1981 (compiled)

PROGRESS OF EDUCATION IN MIZORAM

(1947 - 1986)

Year	Primary		Middle		High		College	
	No. of schools	Enrol- ment	No. of schools	Enrol- ment	No. of schools	Enrol- ment	No. of col- leges	Enrol- ment
1947	285	16037	22	2124	2	162	-	-
1952	430	21553	65	2945	5	711	-	-
1962	625	43600	113	7150	10	1940	1	N.A
1972	403	62576	190	16321	90	7244	2	867
1974	487	66839	214	20421	99	10742	4	1564
1976	510	79043	217	22691	103	12971	6	1870
1978	514	67933	234	20999	111	13459	6	3177
1980	652	74490	294	25021	128	15912	8	4584
1982	840	90428	351	24398	139	14304	12	5204
1984	927	86829	394	30299	140	15534	12	4959
1986	1025	89401	443	36550	154	16252	12	5293

Source (1947-1986) : Statistical Branch, Directorate of Education,  
Mizoram.

ADMISSION AND RESULTS OF MATRICULATION EXAMINATION  
IN THE FIRST TEN YEARS OF ESTABLISHMENT OF HIGH  
SCHOOLS IN LUSHAI HILLS.

ADMISSION.

	1944	1945	1946	1947	1948	1949	1950	1951	1952	1953
	56	35	39	77	92	166	124	195	176	176

RESULTS.

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
TEST	27	26	24	36	43	49	50	69	87	93
CANDIDATES	25	22	24	31	37	48	48	54	76	78
PASS	20	21	18	23	31	36	32	35	54	58
P.C.	80	95.45	75	69.56	83.78	75	66.66	70.37	67.11	74.36

LUNGLEI HIGH SCHOOL

ADMISSION (Including Middle Section Class I - VI)

	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
	99	95	104	148	90	136	133	148	-	-

RESULTS. MATRIC

	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
CANDIDATES	19	20	15	32	33	33	50	51	51	75
PASS	4	15	9	23	32	29	38	39	41	47
P.C.	21	73	60	71.27	96.96	87.87	77.55	76.38	80.39	62.30

YEAR-WISE BREAKUP OF ENROLMENT AND EXAMINATION RESULTS .

Year	Number of Trainees	Pass Percentage
1975-76	31	100%
1976-77	47	100%
1977-78	61	100%
1978-79	64	100%
1979-80	74	100%
1980-81	100	89%
1981-82	108	77.7%
1982-83	-	-
1983-84	-	-
1984-85	111	88.2%
1985-86	90	81.1%
1986-87	115	88.7%

Source of Information: Enrolment and Examination Records of the Mizoram Institute of Education, Aizawl.

NEHU Library  
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 Date 22/6/90  
 Class by .....  
 Sub Heading by .....  
 Catered by .....  
 Transcribed by .....

Enrolment in Science Courses since 1985-86 - 1987-88

<u>P.U. Sc.</u> <u>(1985-86)</u>	<u>Pachhunga University</u> <u>College</u>			<u>Lunglei</u> <u>Government</u> <u>College</u>		
	<u>Boys</u>	<u>Girls</u>	<u>Total</u>	<u>Boys</u>	<u>Girls</u>	<u>Total</u>
<u>I Year</u>	163	38	201	41	9	50
<u>II Year</u>	90	24	114	25	5	30
<u>B.Sc</u>						
<u>I Year</u>	59	15	74	-	-	-
<u>II Year</u>	33	6	39	-	-	-
<u>III Year</u>	3	-	3	-	-	-
<u>P.U. Sc</u> <u>1986-87</u>						
<u>I Year</u>	168	45	213	45	4	49
<u>II Year</u>	93	33	126	27	10	37
<u>B.Sc.</u>						
<u>I Year</u>	39	10	49	-	-	-
<u>II Year</u>	27	7	34	-	-	-
<u>III Year</u>	12	3	15	-	-	-
<u>P.U. Sc.</u> <u>1987-88</u>						
<u>I Year</u>	72	119	191	59	8	67
<u>II Year</u>	112	33	145	51	7	58
<u>B.Sc</u>						
<u>I Year</u>	34	16	50	-	-	-
<u>II Year</u>	<u>19</u>	<u>4</u>	<u>23</u>	-	-	-
<u>III Year</u>	7	-	7	-	-	-

Source (1985-88) : Statistical Branch, Directorate of Education, Mizoram.