CHAPTER III
REVIEW OF RESEARCH LITERATURE AND HYPOTHESES

There exists a continuum between the old theories and new research ideas. Because knowledge is dynamic and it always grows along this continuum. The past research ideas are to be discussed to view a problem in a proper perspective to streamline the researcher's efforts to solve the problem. Keeping in view the objectives of the present research, numerous studies pertaining to the development of scientific creativity in relation to various variables, such as intelligence, personality, cognitive styles, sex differences, area-wise differences and environmental factors, have been surveyed and presented systematically in this chapter.

3.1 INTELLIGENCE AND SCIENTIFIC CREATIVITY:

Intelligence is one of the important cognitive factors affecting the scientific creativity among students. Few studies have been conducted in this field to explore the relationship of intelligence and scientific creativity.

Neer and Stein (1935) conducted a study to find the relationship between intelligence and creativity in 64 scientists engaged in industrial research. Highly intelligent scientists were found to be superior in scientific creativity. Also Taylor (1964) in his research on creativity found that lower the intelligence level of students, the little the performance on scientific creativity test.
In one study, Schmadel et al. (1965) compared performance of 31 gifted 7th graders on tests of measuring various selection aspects of creativity with those of all the children in 7th grade (N=403). Gifted group with high I.Q. was found to be significantly superior, on the measures of originality, sensitivity to the problems and conceptual foresight.

Kurtzman (1967) compared three groups of adolescents with different levels of creativity in science. The results indicate that more creative science students tend to be more intelligent and vice versa. McAlpine (1972) undertook a major piece of research on the fluency and flexibility of thinking of secondary school pupils with high ability in science in New Zealand, U.S.A. and U.K. Variables included fluency, flexibility, intelligence and other personality factors. In his study, positive correlations were achieved between intelligence and fluency as well as intelligence and flexibility. Kraj Kovich (1978) also found significant relationship between scientific problem solving ability and intelligence.

Starr and Nicholl (1978) administered a test of creativity, intelligence, attitude towards science to a group of 110 pupils. Intelligence was related to scientific creativity and scientific attitude. In a study by Houtz and Denmark (1983), a Classroom Activities Questionnaire (CAQ), the Torrance Test of Creative
Thinking Verbal Forms and Several Verbal maze problem-solving tasks were administered to 207 students in grade 4-6 from 14 sub-urban middle class-rooms. Problem solving ability was related only to intelligence and ideational fluency related significantly to students' perception of emphasis on higher level thinking skills in the class-room and positive class-room climate. Similarly Jhaj (1983) studied the general intelligence and achievement in relation to scientific creativity. He compared the cognitive and non-cognitive factors of 140 scientifically creative and 140 non-creative high school students. Students were administered a test of General Mental Ability and measures of scientific creativity. Achievement scores were obtained by taking the average of annual and semiannual examination marks. Results of a Varimax factor Rotation analysis indicated significant differences between the creative and non-creative group on the various cognitive and non-cognitive factors investigated.

According to Greenbowe (1984) in solving science and mathematical problems, the content of knowledge and level of intellectual development, highly contributes. Kreshne', John and Ledger (1985) in their study of the effect of intelligence on students' creativity found that it had an effect on different dimensions of students Creativity. They further suggested that performance on each of the creativity subsets may be strongly influenced by different psychological, intellectual and social factors. Similarly, Raina (1986) found that all the three components of scientific creativity
viz., originality, fluency and flexibility are positively related to intelligence.

In contrast to the above findings, RossMan and Hasn (1972) observed that creativity can probably be regarded as independent of intelligence in case of engineering students.

Also, Sansanwal and Gurpal (1983) compared 30 scientific 9th grader students of higher and lower intelligence by administering tests of Intelligence and Creativity. ANOVA of their study also showed no significant differences in mean fluency, flexibility, originality or total creativity on the variable of intelligence.

From the above results, it is clear that different studies conducted in the field of intelligence in relation to scientific creativity are limited and are conclusive. Thus, there is a need to explore further this field of research.

3.2 PERSONALITY AND SCIENTIFIC CREATIVITY:

A variety of studies have been conducted to find out the personality traits of scientifically creative individuals. Here, attempt has been made to present the studies in a systematic manner.

Galton (1874) found that the scientists were characterized by great energy, great circumference of their heads, excellent health, steady, perseverance, practical bent of mind, high degree of memory, spirit of independence, and
innate taste for science. They have all around superior qualities special excellence of the automatic activity of mind, and have a sober will and were found mentally well-developed and fairly balanced. Kretschmer (1931) reported that the scientists are not associated with any kind of abnormality. They have often shown "Lively Originality and Vibrated with sensibility and inward tension behind the cool stream of thought there lies a glowing passionate core..... that drive their thoughts". "Spark Leaps" and old established ways are destroyed and new ones arise, scientific and inventive genius is..... under the sway of an over-valued idea". The success of such an idea depends on the favourableness of circumstances and the intellectual power of the individual". The successful are inventors... the failure, paranoics.

In one of the genetic study of the geniuses for forty years Terman (1925) found the general pattern of personality traits of the highly talented, including scientific talents. He found them to be more or less associated with stability and absence of disturbing conflicts, all-round special adjustment, well balanced temperament, freedom for excessive frustration and strength of character and moral judgement.

Cattell and Drevdahl (1955) made some interesting additions to offer to the picture of creative scientists. He found them highly intelligent, independent of mind and dominant as well as sensitive in psychological sense. But in comparison to the general population these scientists were
found to be introspective reserved and cool, and they tended to be outwardly inhibited, serious and taciturn and self sufficient to a degree. The scientists have disagreed for social pleasantries as well as conventions. Similarly study conducted by Stein (1956) on the industrial chemists selected on the basis of composite ratings on creativity by superior colleagues and subordinates, it was concluded that more creative chemists tend to be autonomous, striving for more distant goals, have more integrative attitudes, are more cautious and realistic, are more consistent in their desire for reward, have a more differentiated value hierarchy and perceive themselves as assertive and authoritative with leadership ability.

In one of the study Gough (1961) reported that eminent scientists were having similar characteristics as that of creative workers in other fields. These characteristics were: high intelligence, a strong tendency towards independent judgement and achievement in independent ways, personal dominance, responsiveness to other people's interests and motives and a marked preference for aesthetic elegance and complexity of design. Bloom (1963) studied outstanding scientists and found that these individuals had a tremendous amount of energy, had difficulty in establishing warm relationships with other people and tended to retreat from a social and personal world into a world of ideas and objects. Similar results were presented by Singh (1980) who studied scientists. Also Taylor and Barron (1963) presented the paper on scientific creativity and
personality traits of scientists. They were found to possess a high degree of autonomy, preference for mental manipulation involving things rather than people, high ego strength, emotional stability, liking for method and precision, preference for defence mechanism such as repression and isolation, a high degree of personal dominance but a dislike for personally toned controversy, high degree of impulse control, a liking for abstract thinking with considerable tolerance for cognitive ambiguity, independence of judgement, superior general intelligence, an early interest in intellectual activities, a derive towards comprehensiveness, elegance in explanation and an interest in coping with uncertain circumstances.

Chambers (1964) conducted a study to find out the differences in the personality traits of eminent creative research scientists from less creative ones. Creative scientists were found to be more dominant and had stronger initiative than the less creative ones. The creative group also appeared much more strongly motivated towards intellectual success.

After conducting a thorough research, Taylor and Holland (1964) stated that scientists rate themselves high in professional self confidence, self sufficiency, independence, emotional restraints and low in aggressiveness, assertion, social desirability, sociability and masculine vigour; they tend not to give a typical response on Multiple choice biographical questions.

Vaidya (1964) investigated the problem solving ability in science among certain groups of adolescent pupils. The major
findings of his study were that poor problem solver appears to stick to one idea at a time stubbornly and later on cease to think in disgust and they do not have imagination power. A profile of General Electric Research Fellows and NSF college science students was compared by Pearce (1968) and it was observed that they differed significantly from other high school students on Factors B+, C+, D-, H+, I+, J+, G-, Q2, Q3 ♦ and Q4♣.

Parloff and Datta (1970) conducted a study on the adults and adolescents to ascertain those personality factors which were related to creativity. Sample selected was drawn from 5000 successful male students of 22nd and 24th Annual Science Talent Search (STS). The total adult sample consisted of 200 subjects of whom 101 were classified as more creative and 99 as less creative. The sample included mathematicians, research scientists, writers and architects. Personality traits were measured by California Personality Inventory (CPI). Coefficients of congruence (Herman, 1960) were computed. The results indicated a high degree of similarity between the structure of CPI for both adolescents and adults groups. The four factors were:

Factor I : Disciplined Effectiveness
Factor II : Assertive Self Assurance
Factor III : Adaptive Autonomy
Factor IV : Humanitarian Consciousness.

More creative adolescents scored higher on factor I than low creative adolescents (Not in case of adults).
On factor II, in both samples, more creative group tended to describe themselves as more self-assured.

On factor III, both samples showed significantly more autonomy than less creatives.

Factor IV failed to differentiate more or less creative groups in both the samples.

Roy (1973) was able to identify the characteristics of unsuccessful as compared to successful problem solvers. Unsuccessful problem solvers were unable to become intensely involved in a task, were less organised in their approach, less able to explore and elaborate initial ideas and were inclined to give them up easily.

An investigation was conducted by Verma (1973) with the aim to develop a battery of tools of divergent thinking for adolescent boys and girls in different areas, to explore the patterns of growth of divergent thinking, to select the tests of divergent thinking, to study the factors of divergent thinking ability, to study the personality concomitants of divergent thinking factors and to study the dependence of personality dimensions. In all 100 students were selected for the first stage and 540 students were selected for the final stage of the study from A grade and public schools of Rajasthan. The following tools were administered: The Word Fluency Test, Controlled Association Test, The Number Rules Test, the Sentence Construction Test, The Word Grouping Test, Multiple Grouping Test, Figural Similarities Test, The Picture Drawing Test, The A-D Scale (Dependence-Autonomy), The C-Scale.
Conformity-nonconformity), The ES Scale (Strong-Weak ego) and D-Scale (closed openness of mind). The battery of tests of divergent thinking was developed on the lines of Guilford, Gatzel and Jackson, Wallach and Kogan and Torrance.

The findings of the study revealed that autonomy misconfirmity and openness of mind were functionally related to the abilities of divergent thinking, (ii) the effect of divergent thinking on ego strength was little and, (iii) autonomy, misconfirmity and openness of mind could help in understanding the divergent thinking of adolescents.

Gopal (1975) conducted a research on 'Certain Differentiating Personality Variables of Creative and Non-creative Science and Engineering Students'. The study proposed the following hypotheses:

(i) Creative science students are significantly more reserved, emotionally stable, assertive, sober, self-opinionated, imaginative, shrewd, experimenting self-sufficient and relaxed than non-creative science students.

(ii) Creative engineering students are significantly more reserved, emotionally stable, assertive, sober, self-opinionated, imaginative, shrewd, experimenting, self-sufficient and relaxed than non-creative engineering students.

(iii) Creative engineering students are significantly more outgoing, happy go lucky and tender-minded than the
creative science students.

(iv) Non-creative engineering students are significantly more outgling, happy go lucky and tender-minded than non-creative science students.

The following were the findings of the study:

(1) Creative science students were found to be more reserved, emotionally stable, assertive, sober, self opinionated, imaginative, shrewd, experimenting, self sufficient and relaxed than non-creative science students.

(2) Creative engineering students were found to be more reserved, emotionally stable, assertive, sober, self opinionated, imaginative, shrewd, experimenting self sufficient and relaxed than non-creative engineering students.

(3) Creative science students were found to be more reserved emotionally stable, assertive, sober, self opinionated, imaginative, shrewd, experimenting, self sufficient and relaxed than creative engineering students.

(4) Non-creative science students were found to be more reserved emotionally stable, assertive, sober, self opinionated, imaginative, shrewd, experimenting, self sufficient and relaxed than non-creative engineering students.
The nature and change in creativity during medical school were studied by Barath (1980) with 113 1st year, 103 IVth year, 121 Vth year medical students who were given a general socio-psychological questionnaire: the Edwards Personal Preference Schedule; the opinion, attitude, and interest survey, the California Test of Mental Maturity (Subtests 4 and 5) and a battery of single phase attitudinal scale. The results indicated that correlates of creativity do not exist in students attitudes, expectations and professional orientation. Also, there was no correlation of personality traits and creativity of medical students. The factor structure underlying self-concept, fluency, flexibility, originality, total creativity and problem solving variables in 375 randomly selected 9th, 10th and 11th grade students was investigated by Sansanwal (1982). Students were tested on measures of creativity, problem solving and personality. The correlational matrix of study variables were explained in terms of 5 factors: Positive cognitive and Adjustment self-concept, Verbal creativity, Negative Self Concept, Self Concept Aesthetic and Problem solving. Fu, Moran and Milgram (1982) examined that students differed in personality traits on the basis of creativity.

Another group of studies conducted in the field of scientific creativity was the comparative type of studies that is, the research studies comparing the personality traits of scientifically creative and non-creative individuals, the different groups of students belonging to different areas.
Such type of comparative study of personality traits of scientifically creative and non-creative students was conducted (Jhaj, 1983). He observed the constellations of personality traits and achievement in relation to scientific creativity. For this purpose, he administered a high school personality questionnaire and measures of scientific creativity on 140 creative and 140 non-creative high school students. Achievement scores were obtained by taking the average of annual and semiannual examination marks. Results of a Varimax Factor Rotation analysis indicated significant differences between the creative and non-creative group on the various Varimax personality factors investigated.

Katz (1984) conducted three studies on creative styles: Relating Tests of Creativity to the work patterns of scientists, Personality and Individual differences. In study I, 100, 17-30 years old students were administered the Torrance Test of Creative Thinking, the Remote Association Test, and measures of figural preferences and perceptual closure. Scores were subjected to a Q type factor analysis to identify homogenous response types. Results show that over 90% of students could be classified to 1 to 4 patterns. In study II, a post hoc mail questionnaire consisting of the Adjective Checklist and Individual Difference Questionnaire was sent to 85 students in study I, to test whether students who contributed to each of the 4 patterns had similar personality characteristics. Data from the 52 students who responded show that the creativity test pattern exhibited by students could be predicted from the
personality profiles along. In study III, 59 eminent Canadian scientists were administered the Adjective Checklist and a Q-sort deck of 56 descriptive items designed to reflect their activity. Results show that work habits could be predicted from the personality profiles. The four patterns of response and personality types correspond to initiator, methodologist, artificer and aestheteician. It is suggested that there is commonality between creativity test performance and actual scientific output work.

Singh and Singh (1984) compared mathematical creativity and personality characteristics among 120 students from Class 7th and 8th in rural, convent and Saraswati Shishu Mandir School, using a Mathematical Creativity Test and a Hindi adaptation of the Thorndike Dimensions of Temperament. No differences were found among students on the basis of mathematical creativity. But there were differences in the personality characteristics of students. Saraswati Shishu Mandir School students and convent students were sociable whereas rural students were solitary. None of students was tough-minded, S.S.M.S. students and convent students were active whereas rural students were lathargic. Similarly, Richardson (1985) in a study of Jamaican adolescents (202 female and 73 male) from 8 high schools were administered a test measuring 8 aspects of creativity and Minnesota Multiphasic Personality Inventory (MMPI). There were found significant relationships between scientific creativity and personality for entire sample.
Dolliver and Krauskop (1989) conducted a research on the personality pattern, problem solving style and personal problems in college students. The Personality Assessment System (PAS) which is derived from a modified Wechsler Adult Intelligence Scale (Weis) was administered to 220 university students. It was found that students who had different PAS classification rated their problem solving styles differently as measured by Heppner and Peterson's (1982) Personal Problem Solving Inventory (PSI). Low but significant correlations were found between PAS/WAIS and PSI.

Richard (1989) administered a research to identify the individual differences related to the capability to develop workable solutions for instructed problem. Students enrolled in Psychology (N=371) during spring semester of 1988 participated in this experiment. They were given a material problem and a set of verbal problems to solve. All volunteers responded to twelve individual differences measures which assessed such things as: 'Tolerance for Ambiguity' and 'Assertiveness'. The potential predictors included all the individual difference measures plus relevant demographic variables e.g. sex and year of college completed. Four predictors accounted for the sixty per cent of the variance in material criterion. These were, in order of variance accounted for 'Mental Rotation', Preference for the use of 'Intuition' in perception, preference for 'Introversion' and 'Sensation Seeking' or risk taking propensity. Only one variable was
predictive of the verbal criterion. This was the Preference for the use of 'Sensing' in perception.

3.3 COGNITIVE STYLES AND SCIENTIFIC CREATIVITY:

Creativity in science is a cognitive variable. The creativity in science is highly determined by the style in which the informations are processed by an individual. Few researches have been conducted to explore the field of relationship between cognitive styles and scientific creativity.

Field and Gropley (1969) explored the cognitive styles of high school science students and found that although quite clear differentiation could be made on this dimension, yet it was not clear that this was not simply a general ability factor in creativity among science students.

The investigation conducted by Rao (1976) was aimed to study the relation of three cognitive variables, namely category width, field independence and integrative complexity to creative abilities. The hypothesis was that there are statistically significant differences between the 'field independent' group and the 'field dependent' group on each of the creativity tests. For this study, 182 boys of class were selected from five municipal high schools of Vijaywada in Andhra Pradesh. Based on the scores on Hidden Figures Test, students who obtained above median scores were identified as field independent group and those who obtained below median
scores were identified as field dependent group. These two groups were compared as to their performance on the following creativity tests: Consequences test, which measured originality; Unusual uses test, which measured spontaneous flexibility; Match Problems Test, which measured adaptation flexibility; Words Test, which measured word fluency; Associations test, which measured associational fluency; Things Categories test which measured ideational fluency; Seeing Problems Test which measured sensitivity to problem and Object synthesis test, which measured redefinition. Main conclusions were as: Boys with field-independent traits generally did better in their performance on creativity tests by displaying more originality, more adaptive flexibility, more ideational fluency, more associational fluency, more sensitivity to problems and more redefinition; but the two groups did not differ significantly in their spontaneous flexibility, word fluency, expressional fluency and elaboration.

Lloyd (1978) conducted a study of cognitive styles in scientific creative problem solving. In this study, problems solving variables are hypothesized to explain cognitive styles. Data was obtained from a sample of twenty nine males and eighty three female college students. The Hidden Figures Test, a measure of field dependence-independence, was used and Lloyd summed up that neo-piagetion cognitive style was validated with mobile field independent formal thought considered to be the hall mark of creative problem solving.
Also Anna (1982) discusses the connection between the individual differences in creativity and properties of cognitive styles (i.e. field independence tolerance of cognitive instability, reflection Vs. impulsivity).

A survey of relevant empirical findings is presented. The finding is noted that at various phases of creative process, radically different modes of functioning play different roles. Thus, various cognitive styles are useful in creativity in science. Musil, Miroslav and Ondrusk (1982) conducted a similar type of study on the scientists. 85 scientists were administered a battery of test, including Intelligence Structure Test and Torrance Test of Creative Thinking, to measure verbal and nonverbal IQS. Verbal and figural divergent thinking, cognitive styles and creative personality. An index of scientific creativity based on publication and patent rates was established as an external objective criterion. Divergent thinking proved to be an important factor in scientific creativity. A specially conceived divergence test and the combination of qualitative and quantitative divergence scores appeared to be the best predictors of scientific creativity.

In one of the research evidence, Kumar (1984) stated that students are significantly more field-independent in science subjects. Also, in science the high creatives were found to be field independent and low creative were field-dependent (Vesasi, 1985). Similarly, in a study Boyd (1987)
suggested that cognitive styles characterize both the Masters and the followers positions. In deductive and inductive reasoning processes, these styles play important role.

But the contrasting results have been collected by Artley et al. (1980). He took the sample of 84 college students, that is nineteen male and 65 female students. No significant correlations were found among the variables of problem solving, creativity and cognitive styles. Also, Ganihar (1993) found no relationship of field independence or field dependence with achievement in science.

Review of studies related to cognitive styles and scientific creativity of the students, though indirect and very scanty, is indicative of association between students cognitive styles and creativity in science. Therefore, it appears plausible to infer relationship between cognitive style of the students and their scientific creativity. To see the direction and extent of this relationship is the aim of the present study.

3.4 SEX DIFFERENCES AND SCIENTIFIC CREATIVITY

Strauss and Strauss (1968) explained that children's creativity varies according to the degree to which the child's family role requires conformity to conventional norms. Creativity was measured by the ability of generate ideas which might solve a puzzle presented to family groups.
Data for 128 Indian and American families showed that Indian children had lower scores in both societies. Sex differences in creativity were greatest in India. Similarly, in a study Nayar (1971) found that boys scored better on numerical ability, problem solving and critical thinking than girls.

Verma, Suri and Datta (1983) found high positive correlation in males and low positive correlation in females with the scientific creativity.

Verma and Raina (1985) conducted a study on 1000 boys and girls of 10th Class from Jammu and Kashmir state. The results showed that boys scored better on Scientific Creativity Test as compared to the girls. Such type of results in spatial creativity were found by Gowan (1985). He stated that males were found to be generally superior in spatial ability as compared to female. This evidence centres on the psychological androgen testosterone. The relationship of testosterone is with lateralization of brain, which may influence the spatical creativity.

Kreshner, John and Ledger (1985) in their study of the effect of sex, intelligence and style of thinking on students' creativity they found that sex, IQ and thinking style each had an effect on different dimensions of students scientific creativity.

Shukla and Sharma (1986) found the sex differences in scientific creativity. They studied the differences in
scientific creativity in 117 males and 113 females in the middle schools of Raipur and Rajangon districts of India. The test of scientific creativity developed by Shukla (1980) which measures fluency, flexibility, originality and global scientific creativity was administered. Results indicated that males and females do not differ significantly in any of the measures of scientific creativity - The mean scores of the boys on all measures of scientific creativity as well as on global scientific creativity were consistently, but insignificantly higher than those of girls.

But in the investigations conducted by Richardson (1984) and Bhardwaj (1985) female score better on creativity in science. Also Raina (1986) girls performed better on the test of scientific creativity as compared to boys.

According to Vandersca (1986) the girls are more interested in biological concepts related to creativity than boys.

On the contrary to the above results, in the following studies, sex differences were found to be negligible in the development of scientific creativity of the students.

As Acharyaula (1978) found no sex differences in intelligence, figural creativity and general science. In another study, Acharyula and Yasodhara (1984) asked 79 male and 37 female preschoolers to draw whatever picture they liked within 40 minutes time limit to see their ability and
creative skill in drawing pictures. No sex differences were found in students in terms of creative drawing ability.

In the light of above conflicting research findings regarding the relationship between sex differences and scientific creativity, there is a need of conducting more research in this field.

3.5 AREA-WISE DIFFERENCES AND SCIENTIFIC CREATIVITY:

Cultural and geographical factors play important role in the development of scientific creativity. Also, the way in which the person has got his elementary and secondary education, type of schools, urban or rural areas, his friends, his religion, his political group, his neighbourhood all may help or hinder his creative production. According to Lancaster (1979), the extent of creativity may differ among the students belonging to the both urban and rural areas school.

Shukla and Sharma (1986) conducted 'A Cross Cultural Study of Scientific Creativity'. They administered a scientific creativity scale to 230 urban, rural, tribal and refugee students in middle school to test for fluency, flexibility. The lowest scores came from tribal pupils and that rural pupils scored higher on fluency than refugee.

A limited number of research studies have been conducted in this field and there is dearth of research studies exploring the impact of different geographical areas
on the development of scientific creativity among students. Also results of comparison of effects of urban and rural background on science creativity are not conclusive. So, there is need to conduct the further research in this field.

3.6 **ENVIRONMENTAL FACTORS AND SCIENTIFIC CREATIVITY**:

The determiners of creative production lie both within the individual and the environment—provided by his family, his school and his working milieu. Despite research done in the past and currently in progress little is known about the factors of environment which contribute to creativity in science. By organizing all the research done already attempt has been made to find out the determinants of creativity in science.

Thistlethwaite (1959) discovered some of the factors that influence later creativity and achievement of talented students. His analysis of various studies suggested that scholarly and scientific fields should be treated separately. He developed a productivity measure for the natural sciences. Pace and Stern college characteristics Index (CCI) was administered to 916 of National Merit Scholars and certificate of Merit winners at 36 colleges. Students were asked to indicate whether each of the 300 statements in CCI was probably true or probably false about their college. Correlations were obtained by correlating the college's median score on each of the CCI scale with its productivity index. He found that Natural Science Productivity is associated with students
cultures which stress scientism and aggression; outstanding achievement in natural science does not appear in colleges where students culture stress social conformity. He reports significant correlations between students press scales, viz., aggression, scientism and social conformity were .43, .59, and -.42 respectively. Faculty Press Scales viz. informality and warmth of students, faculty contacts, closeness of supervision and directiveness of teaching methods have been found to be significantly correlated with productivity in science, the values of correlation being .43, -.38 and -.42 respectively. Roe (1960) found parents of social scientists to be overprotective and firm and control, even if not overt was very evident.

Stein (1963) reported some interesting results based on the study of biographies of chemists who were engaged in industrial research. His more creative subjects say that they were more distant from either parent and from adults in general than do his less creative subjects. Parents of more creative subjects were more inconsistent in their attitudes towards them than those of less creative subjects.

MacKinnon (1965) has reported that talented architects who are having unusual freedom in making decisions and exploring their environment, they experienced neither overprotection nor rejection from their parents, but at the same time parents set definite standards of conduct and values and provide a model for identification. In a study, Haddon and Lytton (1968) found
that children of comparable intelligence scored higher on tests of divergent thinking in "permissive" than in traditional primary schools, in any subject of curriculum. Andrews and Gordon (1970) in three studies on scientists found that there is great influence of social factor, nature of organisation, interference and responsibility for initiative on the creative scientific output. One study was conducted on 115 project directors the main findings of the study was that the research innovativeness, and the correlates of creativity were increased by the feeling of "Security" being "influential", free from "interference" and "responsibility" for initiative. The change of any sort in these factors influenced the creative performance significantly. In the second study on chemists, he showed that the variations in environmental factors produced changes in job orientation. The third study indicated that the free environment of working resulted in the increase of the quality of problem solving and originality.

Fu, Moran, Sawyers and Milgram (1981) examined the relationship between preschoolers' creativity and parental creativity, child-rearing attitudes and personality. 31 preschoolers and their 27 fathers and 31 mothers were administered Parent Attitude Research Instrument and Myers Briggs Type Indicator. Results fail to indicate any significant relationship between creativity in children and specific parental variables.
There are some environmental conditions which are perceived in similar degrees by all the children. Many of them may influence the development of scientific creativity of the students. These environmental factors which have idiosyncratic effects on the development of scientific creativity are: (i) protectiveness (decreased amounts), (ii) rejection (decreased amounts), and (iii) overall stimulation in home environment (increased amount) as perceived by girls and decreased amounts of cognitive stimulation, cognitive encouragement as perceived by boys (Misra, 1984). But on the other hand, Verma and Darshana (1984) studied the role of home environment and parents' influence on the development of scientific creativity among students they found that the scores on scientific creativity were independent of the qualification of parents. Kreshner, John and Ledger (1985) suggested that performance on each of the creativity subsets may be strongly influenced by different psychological, intellectual and social factors. In the light of this study Chaudhari and Bindal (1986), administered a questionnaire assessing verbal and non-verbal creative thinking, experimental attitudes and students' perception of parents' attitude towards creativity to 400, 9th and 10th grades arts and science students in Ratlam, India to assess the effects on creativity of caste status. Students included 100 Scheduled Caste/Scheduled Tribe (C/T) members and 300 non C/T members. S.D. and t-value scores resulting from data analysis indicated that, on all aspects of
verbal and non-verbal creativity. Non C/T members scored higher than C/T members in case of both arts and science subjects.

Raina (1986) found the psycho-social correlates of scientific creativity of high school students. He reported that socio-economic status of students had no effect on their scientific creativity. The first born child in the family was found to be scientifically more creative; and the type of family or family structure whether single or joint did not have any relationship with scientific creativity.

A study by Paul (1987) tested relationship between 10 family environmental factors (Cohesion and sense of support, encouragement to self expression, disharmony encouragement towards independence, pressure to achieve intellectual-cultural interests, active recreational pursuits, need to plan tasks, rules and regulations and concordance by family members in the presence of these factors) and four types of creativity (figural, semantic, symbolic, social) in 25 families where one parent or child was known to be highly creative, using independent ratings of creative productivity and achievement. Children younger than 10 or older than 22 were excluded as were adults specifically involved in parenting thus leaving 92 study participants. Family environmental factors positively associated with creativity were (a) degree of commitment, help and support members provided each other, (b) extent parents felt members were encouraged to express
feeling directly, (c) degree children perceived openly expressed hostility and anger, (d) extent fathers and daughters perceived members participation in social and recreational activities, and (e) differences in members' reports about their families environment. The more family members were found to be creative the more these traits were present.

The factors negatively associated with creativity was the degree families had cost work, school and recreational activities into an achievement oriented and competition framework.

Suedf ld, Metcalfe and Bluck (1987) studied the enhancement of scientific creativity by restricted environmental stimulation technique. They investigated that five psychology faculty members each spent 690 min session setting alone in their office and 6.1 hr sessions, floated in a restricted environmental stimulation tank (REST) (Warm saline solution, darkness and silence). The results indicated that novel ideas generated after Rest were better (more creative) than those developed in office session.

Anne (1988) conducted a psychological study examining how differentiation of self and stress relate to adults' scientific and engineering creativity. For the purpose of present study, 500 subjects, that is scientists and engineers employed by a solid state device technology research and development organisations. The Family System Personality Profile (FSPP) was used to determine the level of differentiation
of self and Life Experiences Survey (LES) was used to ascertain the degree of stress. Measure of subjects creativity included expert judgements - managers' responses to selection guidelines provided through the candidate identification, worksheet for identifying someone as highly creative; patents, presentations and publications self report data solicited through a Demographic Data Inventory and a composite criterion - a combination of expert judgements, patents, presentations and publications for each subject. Results of point-biserial correlation showed that subject with higher level of differentiation of self, as measured by the Family Systems Personality Profile, were more often associated with the highly creative group. Analysis of other developmental and family background variables relative to creativity, using a composite creativity criterion, demonstrated significant gender, age, education and procreativity findings. Correlation among the creativity criteria and overall performance produced unequivocal significance.

The field of environmental factors and scientific creativity relationship, still lies unexplored and need a lot of further research.

3.7 HYPOTHESES :

Consequent upon the research trend as crystallized from the review of related literature and based on the objectives, the following hypotheses were formulated for the conduct of the present study.
1(a) Intelligence of urban and rural students correlates differently with their scientific creativity Part-A.

(b) Intelligence of urban and rural, students correlates differently with their scientific creativity Part B.

2(a) Personality traits of urban and rural students correlate differentially with their scientific creativity Part A.

(b) Personality traits of urban and rural students correlate differentially with their scientific creativity Part B.

3(a) Cognitive style of urban and rural students correlates differentially with their scientific creativity Part A.

(b) Cognitive style of urban and rural students correlates differentially with their scientific creativity Part B.

4(a) Environmental catalysts, such as home environment, school environment, personal attributes, socio-economic status and psychological environment of the urban and rural students correlate differentially with their scientific creativity Part A.

(b) Environmental catalysts, such as home environment, school environment, personal attributes, socio-economic status and psychological environment of the urban and rural students correlate differentially with their scientific creativity Part B.
Variables of intelligence, personality, cognitive styles and selected environmental catalysts cluster together in group factors with scientific creativity of the urban students.

Variables of intelligence, personality, cognitive styles and selected environmental catalysts cluster together in group factors with scientific creativity of the rural students.

The factor structures underlying the variables of intelligence, personality, cognitive styles, selected environmental catalysts and scientific creativity of the urban and rural students differ.

Variable of intelligence is a significant predictor of scientific creativity Part A and Part B of the urban students.

Variable of intelligence is a significant predictor of scientific creativity Part A and Part B of the rural students.

Variable of personality is a significant predictor of scientific creativity Part A and Part B of the urban students.

Variable of personality is a significant predictor of scientific creativity Part A and Part B of the rural students.
Variable of cognitive styles is a significant predictor of scientific creativity Part A and Part B of the urban students.

Variable of cognitive styles is a significant predictor of scientific creativity Part A and Part B of the rural students.

Variable of environmental catalysts is a significant predictor of scientific creativity Part A and Part B of the urban students.

Variable of environmental catalysts is a significant predictor of scientific creativity Part A and Part B of the rural students.

Variables of intelligence, personality, cognitive styles and selected environmental catalysts conjointly contribute greater variance towards the scientific creativity Part A and Part B of urban students, as compared to their individual contribution.

Variables of intelligence, personality, cognitive styles and selected environmental catalysts conjointly contribute greater variance towards the scientific creativity Part A and Part B of rural students, as compared to their individual contribution.

Urban students differ significantly in their scientific creativity Part A and Part B on different levels of intelligence.
(a') Rural students differ significantly in their scientific creativity Part A and Part B on different levels of intelligence.

(b) Urban students differ significantly in their scientific creativity Part A and Part B on the basis of different types of cognitive styles.

(b') Rural students differ significantly in their scientific creativity Part A and Part B on the basis of different types of cognitive styles.

(c) Urban students differ significantly in their scientific creativity Part A and Part B on the basis of sex differences.

(c') Rural students differ significantly in their scientific creativity Part A and Part B on the basis of sex differences.

(d) Urban students differ significantly in their scientific creativity Part A and Part B on different levels of environmental catalysts.

(d') Rural students differ significantly in their scientific creativity Part A and Part B on different levels of environmental catalysts.

(e) Urban and Rural students differ significantly in their scientific creativity Part A and Part B.