Having discussed the problem on hand and established the need for the study, it is necessary for the researcher to probe into the main area of research conducted by other researchers. It serves as a guidepost or a lighthouse. Good (1954) remarks that review of related literature is helpful to the researcher as it

- Suggests methods of research appropriate to the problem,
- Provides ideas, theories, explanations or hypothesis valuable in formulating the problem,
- Locates comparative data useful in the interpretation of the result,
- Contribute to the general scholarship of the investigator.

Turney and Robb (1971) state that the identification of a problem, development of a research design and determination of the size and scope of the problem, all depend to a great extent on the ease and intensity with which a researcher has examined the literature related to the intended research.

Thus, only when a research project is based on all of the relevant thinking and research that has preceded it, it becomes a part of the formulated knowledge in the field and thus contributes to the thinking and research as a whole. It enables us to perceive the gap and lacuna in the field of research concerned.

The studies reviewed have been classified under eight headings:

- Studies related to Role of analogies in learning
- Studies related to Fostering creativity
- Studies related to Inducing problem solving ability
- Studies related to Attitude towards science
- Studies related to Models of teaching in general
- Studies related to Synectics model of teaching
Synthesis of Review

- Studies related to Role of analogies in learning
- Studies related to Fostering creativity
- Studies related to Inducing problem solving ability
- Studies related to Attitude towards science
- Studies related to Models of teaching in general
- Studies related to Synectics model of teaching

Conclusion

3.1 STUDIES RELATED TO ROLE OF ANALOGIES IN LEARNING

Royer and Cable (1976) found that analogies were only employed when the target was difficult to understand i.e. when students felt that it was necessary to look for analogies as an aid to understanding.

Khatena Joe (1977) reports that through a special training programme, the experimental group was taught to use simile, metaphor, personification and allusion as comparison forms within the four analogy classifications, viz. Direct, Personal, Symbolic and Fantasy analogy to differentiate between simple and complex images in the production of analogies. Generally high and low creative experimental s obtained significant originality scores than high and low creative controls. Experimental and controls preferred to use direct analogy, simple image patterns to other analogy and a few fantasy analogies were produced by both the groups, with experimental subjects producing more fantasy analogies than the controls. Although the training programme significantly increased mean originality scores, it did not serve the function of significantly increasing the use of personal, fantasy and symbolic analogies.

Enyeart (1979) for instance, found no general correlation between analogy use and Paigetian levels. There was only a significant correlation between the use of formal analogies (i.e. analogies representing proportions) and formal operation thought. Gabel and Sherwood (1980) reported a tendency for their analogies to be more effective for students of lower formal reasoning ability and not especially useful for more capable students.
Gentner and Gentner (1983) reported that analogies aided problem solving in the area of the electric circuit. They further showed that the analogy employed considerably influenced the creative problem solving process. They found that creative problem solving in the area of the electric circuit among college and high school students was considerably different from when a “flowing fluid” or a “moving crowd” analogy was used. These findings point to the fact that the general framework that the analogy provides has a significant influence on the learning process.

Curtis and Reigeluth (1984) analyzed analogy use in 26 science textbooks. The use of analogies according to several categories (such as type of analogy or placement) was investigated. In total 216 analogies were found i.e. 8.3 analogies per book (ranging from zero to 18). Two main types of analogy were distinguished, namely, simpler ones based mainly on surface similarities and more elaborate ones based on what Curtis and Reigeluth called “functional relationships”. In total, most analogies were of the latter kind (70%). Whereas this number was less than 50% in elementary books, it was substantially higher in Chemistry and physics books (about 90%). This result point in a similar direction to that of Glynn et al. (1989), who found that elaborate analogies were most often used in physics textbooks. It is interesting that in about 50 % of the 216 analogies, the authors made no attempt to describe the analogy or how to strategically use the analogies provided. There are similar findings in the study of Glynn et al. (1989): guidance toward effective use of analogies was not explicitly given in the introduction of textbooks. Curtis and Reigeluth (1984) drew several conclusions from their study that may help to produce powerful analogies. They point out that analogies appear to be most useful for complex and difficult content. They view simpler analogies that are mainly based on surface similarities as only suitable for easier, more concrete topics, whereas more difficult and abstract topics require functional analogies, i.e. analogies based on deep structure similarities.

Gentner and Landers (1985) investigated access to analogies. These findings reconfirm on the one hand the results by Tenney and Gentner (1985) that the inferential power of analogies is governed by similarities of higher order structure. On
the other hand, they found that accessibility is governed by literal or surface similarities but not by similarities from higher order structures.

Tenny and Gentner (1985) summarized findings of studies for water analogies of the electric circuit. Increased familiarity with the base domain was not sufficient to ensure the discovery of a potentially useful analogy. However, increased familiarity did improve the usefulness of the analogies if detected. The results suggest that familiarity with the base domain affects the power rather than the accessibility of an analogy.

Holyoak and Koh (1987) also investigated the influence of structural and surface similarities in access to analogies. They found that both similarities are influential but they did not conclude that surface ones govern access. However, they agree with Gentner and Landers (1985) in that only structural similarities affected student’s ability to make use of an analogy domain once its relevance was pointed out.

Clement (1987) studied the spontaneous use of analogies in a systematic manner. He investigated how novices and experts employ analogies when solving physics problems. The main findings are that both novices and experts frequently make spontaneous use of analogies or at least of comparisons. The studies, therefore, reconfirm that analogies are common tools for explaining and trying to make sense of the unknown.

Black and Solomon (1987) investigated student’s use of analogies for electrical current. They found that the analogies presented helped students to learn. They interpreted this finding from a constructive view; analogies were helpful because they allowed the students to construct their own knowledge by forcing them to view the new knowledge within the framework of the analogy.

Serge and Giani (1987) summarized their findings on analogical reasoning about transport processes in the following way: “Our students are almost unable to employ analogical reasoning to solve similar problems regarding different phenomenologies in the field of transport processes”. They thought lack of their student’s ability to “formalize” was responsible for their negative results. Clement
stated that attempts to use analogies in learning situations did not work because the learners were not able to “see” an analogy. Research on students’ conceptions supports these findings in so far as areas that are seen as obviously similar by the teacher (or scientist) are viewed as being fundamentally different by many students.

Sutala and Krajcik’s (1988) study points in a similar direction. They found that students with high cognitive abilities benefited more from creating their own analogical connection, whereas students with low abilities benefited more from having the teacher help them make the analogical connections.

Tierney (1988) observed four social studies teachers for 20 lessons. He focused on “small scale” comparisons (use of analogies, metaphors and similes as example, or reinforcements of verbal or written explanation of content used in history lessons. Such comparisons were often employed but mostly in a limited manner: “Like comedians, these teachers went with what worked. It was clear that simply telling the story of history was insufficient. Seldom did the teachers stop to chock specifically that students understood the metaphors used”. Very much like analogies used by authors in textbooks, the teachers observed by Tierney (1988) appeared to presuppose that students were familiar with the analogy domain and would use the metaphors, analogies or similes without any guidance.

Steven W. Gilbert (1989) has written teaching materials for two high school biology units with extensive analogies, similes and metaphors. Their effect on learning and attitude was assessed by a comparison to students using a literal version of the same test. Little was found to support the contention that the use of these systems increases students’s achievement, and there was some indication that they may have negative effect on the student attitude.

Glynn et al. (1989) examined the use of analogies in an analysis of 43 elementary, high school and college science textbooks. The analysis was of an interpretive in nature i.e. it was not based on formally developed categories. Glynn et al. have found many simple analogies such as “Mitochondria are the power house of a cell” in textbooks. Elaborate analogies, which were a paragraph or even a page long, were relatively rare. High school physics and physical science books appeared
to contain the largest number of such elaborate analogies the frequency of V in the 19 physics and physical science textbooks varied between relatively extensive and little use. There is another interesting observation. Although it was common in the introduction to provide the reader with hints as to how to use the textbooks effectively (e.g. hints about advance organizers) no mention of analogies was found there – not even in the textbooks in which excellent use of analogies was made.

Dupin and Johsna (1989) conducted a study in which VI, VII, X grade students were instructed about electricity over a period of 20, 24 and 34 hours respectively. The teachers first discussed students’ perceptions, then they presented a mechanical analogy about a continuous train that moves without engine and with identical cars pushed at a station by people. After listing all the elements related to train, the teacher asked the students to find the corresponding elements in the closed circuits, thus emphasizing the conceptual aspect of the analogical mapping. The results indicated a clear difference between the Experimental and Control groups after instruction, and underscored the advantage of sequencing the analogies to reduce the limitation that arise from using the classic water analogy. The authors concluded that the analogies do contribute to the Experimental groups improved performance despite the confounding factor of time.

Tobin (1990) suggested that metaphors might be used as “Master Switches” to change belief sets and teaching practices.

In a study by Treagust et al. (1990) limited use of analogy is also reported. Forty lessons by eight science teachers were observed. The study was carried out within an interpretive research framework (Erickson, 1986). Field notes of lessons and an interview with every teacher at the end of the observation period formed the basis of interpretation. Use of analogies based on structural relationships (rather than surface similarities) was the focus of the study. The teachers in this study seldom used such analogies in their teaching (in the 40 lessons observed, only eight of them were detected) and tended not to use them in an elaborated manner even when such analogies were present in the textbooks used by the class. This finding seemingly contradicts the results of the interview, which revealed that most teachers were very
aware of both the benefits and limitations of analogies. But the teachers in the study seemed not to have a repertoire of good analogies and were not confident concerning the effective use of analogy. Where the broader context of analogy use within a constructivist learning perspective is concerned, the study points out that the teachers mainly held traditional view as of the learning process. Accordingly analogy use, if it occurred, was not based on a constructivist approach to learning.

David Wong E. (1993) in his research study asked the participants to create, apply and modify their own analogies as opposed to applying a specific analogy provided by an outsider – as a heuristic for constructing, evaluating and modifying their own explanations for a given scientific phenomenon. Non-trivial changes in explanation facilitated by the use of generative analogies were observed. Changes in understanding ranged from the emergence of new explanations to the raising of important questions about the nature of the phenomenon. The study has concluded that use of self-generated analogies may facilitate conceptual growth through several time-honored principles of effective instruction. Constructing ones own analogy serves to – 1. Make new situations familiar, 2. Represent the problem in the particulars of the individuals’ prior knowledge and 3. Stimulate abstract thinking about underlying structure or patterns. Further more when students were given the opportunity to work with their own analogies, three important educational outcomes are served. They are, First students are provided with a rare opportunity to problem find, as opposed to simply problem solve. Secondly questions emerging from the specifics of the learner’s prior knowledge are likely to be more interesting, non trivial and personally relevant to the learner and Thirdly individuals can come to identify, confront and work through their prior conceptions with minimal guidance from an outsider, such as a teacher.

Stephen M. Ritchie (1994) in his study “Metaphor as a tool for constructivist Science Teaching” reports how one experienced general science teacher used the metaphor tool during the implementation of constructivist approaches in both biology and physics topics. The Constructivist classroom is characterized as learning place where students are encouraged to take responsibility for their own learning as they
take on the role of an explorer. The study has shown that the metaphor tool is effective when compared with other models and involves an economical commitment of time and resources. Because teachers are busy professionals, they are likely to get advantage.

David E. Brown (1994) in his study “Facilitating conceptual change using analogies and explanatory models” with 40 high school students, who indicated the table would not exert an upward force interacted with a written bridging explanation. Students responded in writing to questions embedded throughout the explanation. Analyses of these written responses supported following hypotheses raised in earlier interviewing studies: 1. Analogies that might seem appropriate to the scientists may not appear so to the students, who would thus reject the analogy relation, 2. In such cases bridging analogies may be necessary in order to establish analogical relationships and 3. These analogies may need to help students construct an explanatory model in order to aid learning (The model of a table as springy on a microscopic scale). This previously unrecognized microscopic springiness can help the student make sense of the idea that the solid table can exert an upward force by helping the student focus on previously hidden mechanisms operating in the target situation.

Zoubeida R. Dagher (1995) in his study examined teachers’ analogies in context and highlighted some of their special characteristics. The purpose of this analysis was to increase our understanding of how analogies operate in naturalistic instructional settings and to generate new research questions about science teaching and learning in view of the broader dimensions of the curriculum. The findings of the study are 1. Teachers’ analogies represent windows into their values, concerns, pedagogic content knowledge and skill in engaging their students. 2. Teachers’ show sensitivity in their analogies to students’ knowledge frames. The source domains selected include actual life experience, observed life experience, science fiction, personalized stories and common objects. 3. Teachers used analogies mainly in an explanatory or descriptive capacity, but never in an evaluative one. Finally it is concluded that the recognition that analogies take on a life of their own in the minds
of students requires teachers to be careful about the context and level of detail used in relation to students’ knowledge, and requires researchers to redress their questions in a way that enables them to capture the creative elements that go into the restructuring of concepts and conceptual schemes in and about science.

3.2 STUDIES RELATED TO FOSTERING CREATIVITY

In Research on Creativity are programmes for stimulating creativity like Reflective Thinking Approach (Dewey, 1933), Attribute Listing and Idea Check-list (Crawford 1954), Inquiry Learning (Bruner and Such Mann, 1966), Morphological Analysis (Zwicky 1969), Bionics Principle (Papanek, 1969), Synectics (Gordon 1971), Brainstorming (Osborn 1971), Use of Random Words (Michalko, 1998) and many others. In the present review, studies related to techniques for stimulating creativity have been emphasized owing to the nature of investigation.

Torrance (1964) cites the study of Anderson (1963) in which the investigator employed three conditions, sample being a class of general education course in industrial arts. In addition to usual control condition and in the other he merely handed out from time to time sheets giving information about the creative process, becoming more creative and the like. No classroom time was devoted to the discussion of these sheets. Any discussion that held was among the students and on their own time outside class. Students in this later condition showed significantly greater growth in measured creative thinking abilities than their peers who had not been given these handouts.

Covington and Crutch Field (1965) have devised Auto-instructional programmes composed of detective and mystery story material for fifth and sixth grade children. The results revealed that the subjects who used the programmes markedly performed better than the control subjects on certain problem solving, creativity and relevant attitude measures.

Oltan (1967) investigated mainly the extent to which thinking and problem solving of fifth grade students could be improved by the use of self-instructional programmed lessons (The productive Thinking Programme). The sample included 704 students. The results showed statistically significant increments in thinking and
problem solving performance on a wide variety of productive thinking measures. These instructional benefits occurred for virtually all types of students regardless of sex or general IQ level, and were especially marked for students in classrooms having environments that were providing little support and encouragement for the development of productivity thinking.

Shackel and Lawrence (1969) developed an auto-instructional programme that attempted to increase the factors of creativity viz. fluency, flexibility, originality and elaboration. They found that the six programmed textbooks, they devised were effective.

Wardrop and others (1969) developed self-instructional programmed lessons and conducted a controlled experiment on 44 fifth grade classrooms to investigate the extent to which creativity and problem solving skills of children could be nurtured through these self-instructional programmed lessons. Experimental group, which received the programmed lessons, scored significantly high in creativity and problem solving skills. Improvements in productive thinking skills were found for boys and girls of both high and low IQ.

Davis (1971) developed a programme in the form of dialogues among four characters, a scientist-inventor, a relative of famous secret spy and others, with the humor as an ingredient. The Characters try to become idea finders and use “attribute listing”, “morphological synthesis”, “checklist procedure” and “synectics”. The report of the investigation revealed that 23 students who used the programme produced 65 percent more ideas on three divergent thinking tasks than 32 control students.

John E. Penic (1973) studied the effect of two patterns of training on aspects of verbal and figural creativity in fifth grade science students. This was a single group study. The training patterns are Student Structured Learning in Science (SSLS) and Teacher Structured Learning in Science (TSLS). ANCOVA was used for analysis of data. It was found that there was no significant difference in verbal creativity between the two groups.

Torrance and Torrance (1973) in their review of 142 studies have considered twenty-five experimental studies involving complex programmes with packaged
instructional materials. The three main programmes have been (i) the Covington, Crutch field and Davies Productive Thinking programme, (ii) the Purdue Creative Thinking programme, and (iii) the Myers and Torrance idea books. In the evaluations, each of these sets of materials scores fairly well, especially when there is class and teacher involvement in their use. The ‘percentage success’ for these and other programmes together has been 72 percent.

Allencar (1974) studied the effects of the Purdue creative thinking programme on pupils creative thinking abilities of fourth and fifth grade of public and private schools of Brazil. The children in the experimental groups heard story of a famous American pioneer from the teacher and worked on some creativity exercises. It was found that the programme had a positive effect on the development of pupil’s creative thinking abilities. The experimental group out scored the control group on the Torrance test of creative Thinking.

Johnson (1975) studied the effects of Special guided lessons on Creative Thinking prepared with the help of classroom ideas for encouraging thinking and feeling by Williams (1970), upon the creative thinking ability of randomly selected 353 fourth grade students in twenty classrooms. He also investigated differences in creative thinking abilities between the males and females experimental subjects. Significant F-ratio was not got in favor of experimental group on total creative thinking, as well as on the tests of flexible thinking and elaborate thinking. An analysis of variance between experimental boys and girls revealed a significantly high F-ratio for girls on total creative thinking and on the test of flexible thinking.

Sharpe (1975) tried to enhance the verbal and figural creative abilities of Educationally Handicapped (EH) children, using brainstorming and programmed instruction techniques, nine intermediate EH classes were randomly assigned to four experimental treatments viz., I) brainstorming, II) Programmed instruction, III) Combination of Brainstorming and the Programmed instruction and IV) Control. The programame lasted for eight weeks. Alternative forms of Torrance test of creative thinking (TTCT) were administered as pre and posttests. Post hoc tests of significance showed that the brainstorming group scored significantly higher than the programmed
Blankenship (1976) investigated the effects of ten hours of creativity training comprising fifteen activities, upon the creative performance, achievement and self-concept of first graders. Four classes, each of twenty-four students was randomly assigned to an experimental and a control group, with two in each school. The pretest and posttest parallel groups design was used. The analysis of the variance indicated that the experimental subjects made significant improvements of fluency, flexibility, originality and elaboration. The control group did not improve significantly in any of the variables.

Nirpharake (1977) took up training of VII standard students in a study. This was pretest, posttest matched group study of six groups consisting of six boys each. One was control group, whereas the remaining four took one programme each viz., training in creative perception, training in divergent production, and training in creative appreciation and training in creative problem solving, the sixth group was trained in all the four areas. The training programmes appreciably improved the creative thinking of the subjects on Torrance test of Creative thinking (TTCT). Training in the areas other than divergent production contributed significantly in the improvement. The group, which had training in, all the four areas scored higher than the remaining groups.

Organ (1977) in her study had eighty second and third grade children ranging in age from 7.6 to 9.6 years, who were randomly placed in two groups- Experimental (twenty boys and twenty girls) and Control (twenty boys and twenty girls). The experimental subjects were introduced to a creative thought production instructional programme, which composed of (I) a time period for discussion and (II) a presentation of motivational model charts developed by the investigator and
administered by four trained research assistants. The control group received a comparable period of group discussion and visual situation, without systematized instruction by the class teacher. The programme lasted for five weeks of forty minutes per day. The children were pre-tested and post-tested on figural forms A and B of Torrance test of Creative Thinking (TTCT). By analysis of variance it was found that there was significant difference on fluency, flexibility, originality and elaboration scores between the experimental and control groups with different programmes. There was no significant sex difference and there was no significant interaction between the sex and treatment on each of the four measures of creative thinking.

Sunaree (1977) prepared lesson plans based on William’s Cognitive Affective Teaching Model to foster creative abilities of children. Eighteen plans were developed, each one on Paradoxes, Attributes, Analogies etc., for VII standard children of Thailand. All of them are culture free and could be used in Indian Classrooms also.

Williams (1977) while reviewing the studies, reports that Purdue creative thinking programme developed by Feldhusen, et al. (1970) has been found effective in studies by Bahlke (1967) and Feldhusen, Bahlke and Treffinger (1969).

Davis and Bull (1978) in their study on two groups of eighty seven and sixty undergraduate students provided a five week course which was a mixture of academic material and hands on involvement activities. The course included topics such as creative and problem solving process, the creative personality, creative dramatics, creative thinking techniques, brainstorming etc. Class A took “How do you think” (HDYT) on the first day and “Adjective Checklist” (ACL) on the last day. Conversely the class B took ACL on first day and HDYT on the last day. For both groups the trained subjects scored significantly higher than their respective before training controls. In both the groups the training effects was stronger for females than males. The ACL – creativity appeared to be more sensitive to creativity training, which may be due to the large number of biographical items in HDYT.

Pillay G.S. (1978) studies the effects of patterns of teaching upon creative thinking among adolescents. The objectives of the study were to find out the effect of
Creative Teaching Method (CTM) (Combination of morphological analysis, brainstorming and traditional method) on general creative ability, on creativity in geography and achievement in geography. The study employed multifactor co-variance design having experimental and control groups. The sample consisted of seventy-one eighth grade students (36 control and 35 experimental group). Madhockar Intelligence Test and Passi’s test of Creativity were used as tools. Creative thinking and achievement in geography were tested using the tools developed by the researcher. Mean, SD, t-ratio, biserial correlation and ANOVA was used for analysis of the data collected. The findings of the study indicated that the CTM when compared to traditional method did not produce differential effect upon general creative thinking and on creative thinking in geography too. Out of thirty mental abilities, seven were developed significantly by CTM whereas memory for word meanings was improved by traditional method.

Schneider (1978) took eighteen activities from the talent areas of Productive thinking for treatment and forecasting for a nine-week period. 191 fifth and sixth grade pupils from six rural elementary schools formed the sample. The experimental group consisted of forty males and fifty-eight females’ and control group fifty-one males and forty-two females. Torrance Test of Creative Thinking (TTCT) and Coppersmith self-esteem inventory was used for pre-test and post-test. The major conclusions were (I) the activities employed in this study showed significant gains in flexibility and total creativity scores but not on fluency and originality, (II) the activities had no effect on self-esteem scores and (III) girls at the fifth and sixth grade levels scored higher on verbal creativity measures than boys.

Deshmukh (1979) studied the relative effectiveness of brainstorming and role-playing techniques in the secondary school children of Nagpur. It was found that brainstorming was relatively superior to role-playing in terms of significant differences on the creativity tests. The investigator also surveyed the instruction in schools, to find out the plug points, where creativity fostering could be put.

Lazarowitz and Huppert (1980) in their study, aimed at developing creative thinking in the secondary school biology students. They exposed 20 students of
experimental group s to a problem: In a certain town, a serious intestinal disease erupted. People knew that the cause of this disease was a bacterium. Suggest as many ways as possible to protect against this disease. The other problem was: Suggest hypothesis describing the properties you think color should have to stain living cells in the most effective way so that they can be examined under a light microscope. There were 19 students in the control group and they followed the traditional method of teaching. After two weeks, another problem was posed both the groups. The problem was: “Suppose you are working in a drug factory and you receive a research grant for developing an effective medicine against specific disease. What data would you look for before you start to carry out scientific experiments for developing such a medicine?” In this problem students were asked to give maximum number of responses they could give in 30 minutes time. Responses in the experimental group ranged between 0 and 29, with a mean of 9.55, and that of control group ranged between 0 and 18, with a mean of 5.15 responses. Responses were classified under 23 major ideas. Mean flexibility score of the experimental group was 3.95 and the control group 2.70. Further, for originality component, it was 8 in the experimental group and 1 in the control group. It is evident form the study that short treatment of two lessons produced difference in fluency and flexibility scores of the students.

Jaben (1980) stimulated the creative thinking of learning disabled experimental children, using the Purdue creative thinking programme, comprising twenty eight audiotapes and exercises aimed to develop divergent thinking. A group of learning disabled control children and another group of normal children acted as the control group. A clinical problem-solving task was administered as a posttest to ascertain the effectiveness of the creativity training to extend the problem-solving skills along with a different form of Torrance Tests of Creative thinking (TTCT). Analysis of the data revealed that learning disabled children can be taught creative verbal behaviors as measured by TTCT, and that Creative training effectively extended to problem–solving skills as measured by problem solving task.

Teeling (1980) studied the effect of a process approach to teaching creativity on the creative thinking performance of third and fifth grade students. Multiple talent
approach was employed for teaching. The sample consisted of 226 third and fifth graders. Pre-test and post-test control group design was used. The conclusions were:
1. The girls appear to benefit more than boys from the Multiple Talent Approach to teaching.
2. Fifth grade students appear to benefit more than the third grade students
3. The creativity test score gains favoring the experimental students seem to justify the conclusions that it is potentially possible to enhance creative thinking through a teaching process.

Jerial (1981) took immediate problems (Verbal and Non-verbal) of the environment, some divergent and some convergent and developed twenty-five lesson plans. Each lesson had four steps viz., Preliminary work, Introduction, Statement of the problem and Exercises. The item was presented on the first day and the discussion was held on the second day. Gains on Torrance Test of Creative Thinking (TTCT) form: B were highly significant compared to form: A.

Shah (1981) conducted an experimental investigation of the effects of four selected teaching strategies on development of creative thinking and achievement in science. Four groups of students of seventh grade and four student teachers were selected for the experiment. A 4x4 Latin square design was used for the study. Selected teachers taught these groups for fourteen weeks. The data was analyzed using ANOVA and test of significance difference (t-test). It was found that the four strategies of teaching had significantly differential effects on the development of originality and flexibility but not in the case of fluency. The effects of strategies were dependent upon the level of intelligence, sex and creativeness of pupils. The results also highlighted the importance of maximum use of audio-visual aids in classroom teaching for enhancement of creative thinking.

Upadhya R (1981) undertook a study to find the effect of stimulating environment on change in creative ability of young children. This was an experimental study with twin group pretest-posttest design. The sample comprised of 400 students of three to six years of age. A random sampling technique was followed for selection of the sample. The researcher developed creativity test for pre-schools. It was found that stimulating environment significantly increased the creativity scores of
the experimental group in all three dimensions of creativity viz., Fluency, Flexibility and Originality.

Bhaskara S. (1982) studied the effectiveness of verbal creativity instructional materials at school stage. The researcher developed the instructional materials. Passi’s Test of Verbal creativity translated to Kannada was used. 570 students of 6th grade from two urban and two rural schools formed the sample. It was found that the creativity instructional materials were able to increase the creative thinking abilities. Urban students were better than rural students and boys were better than girls in terms of gain scores of creativity tests.

Mohamed Miyan (1982) studied the effectiveness of methods of teaching mathematics in developing mathematical creativity. Students of three sections of class nine of a school formed the sample. Test of mathematical creativity developed by the researcher was used for both pretest and posttest. It was found that none of the three methods was significantly different in developing mathematical creativity. The Guided discovery method was most effective in enhancing originality compared with Tell and do and Pure discovery methods.

Carter Lindakay (1983) studied the effect of Multi Model Creativity Training on creativity of twelfth graders. The sample comprised of forty-eight students of a school. Torrance Test of Creative Thinking and interviews were the tools used for final assessment. This experimental study followed the twin group – Control Experimental, Pretest-Posttest design. It was concluded that the treatment did not significantly improve the creativity of the students.

Vora, Gira.C. (1984) investigated the impact of divergent thinking programme in Mathematics (DTPM) on creative levels of the children of seventh and eighth classes. The investigator constructed the Divergent thinking Programme consisting of three types of problems 1) Multi response type 2) Hidden shape type and 3) Make-up problem type. The sample comprised of 271 students of which 130 were from seventh and 141 were from eight grades. ANCOVA was used for data analysis. The findings indicated that the experimental group was superior in fluency and originality.
components of creativity for both the grades. The programme worked well for both high and low creative students.

Gupta P.K. (1985) undertook a study to develop and evaluate a creative training programme (CTP) for sixth grade children. The study also intended to find the interaction effect of intelligence and sex with CTP on fluency, flexibility, originality and composite creativity. The sample comprised of 357 students (188 girls and 169 boys). The tools used were Jalota’s Group test of General Intelligence and Baqer Mehdi’s Test of Creative Thinking. The data was processed using ANOVA, Hartley’s test and t-test. It was found that CTP was successful in developing creative thinking abilities. CTP was equally effective for both boys and girls. There was no significant interaction between intelligence, sex and CTP for any of the components of creativity.

Singh B.D. (1985) studied the effect of a specially designed teaching strategy and some socio-psychological factors on creativity among middle school children. The sample consisted of 277 male students of seventh and eighth grade. Mathematical Creativity test and General Creativity test by Baqer Mehdi and Thorndike’s Dimensions of Temperament test was used before and after treatment. The main findings of the study indicate that the specially designed teaching strategy had a significant effect on the different dimensions of creativity. The high and low general creative did not significantly differ with reference to ten personality factors measured by Thorndike’s Dimensions of Temperament.

Below Mary Eleanor (1986) examined the effects of creative reading materials when used by teachers with varying degree of creative attitude on creative thinking skills of the students. The researcher designed the materials. The sample consisted of 267 fourth grade students divided into experimental and control group. Pretest and posttest design was used. Torrance Test of Creative thinking was used. It was found that posttest mean scores were significantly high in the experimental group. It indicated that a teacher with a high creative attitude trained in creativity and who used creative training materials of his/her own design can be influenced in affecting child’s creative thinking skills.
Patel J.Z. (1987) investigated the effectiveness of the Purdue creative Thinking Programme on creative abilities of elementary school children. Eight classes of different schools were equated based on the scores from Creative Ability Tests by J.Z. Patel. Four classes formed experimental classes where programme was implemented and the remaining four formed the control classes. The programme was translated into Gujarathi. ANOVA was used to analyze the student’s performance. It was found that the effect of training on experimental group was significant for creativity and its two components viz. fluency and originality. The main effect of IQ was significant but not sex.

Ryan Michael V. (1988) prepared and tried out the programme for developing creative thinking ability (CTA) in the students of the age group 10+ and 12+ controlling some psycho-socio factors. The objectives of this study were to prepare a programme for developing CTA and to study the effectiveness of CTA development programme. The sample comprised of 330 fifth, sixth and seventh grade students selected from three schools. Two experimental groups and one control group was formed. ANOVA was used for controlling intervening variable. Verbal and Non-verbal creative thinking ability criterion test developed by the investigator was used. The researcher also prepared a non-verbal and verbal programme for developing CTA. It was found that experimental group gained by CTA. The CTA treatment was more effective when different variables like anxiety, parental behavior, self-done activities; school achievement, self-sufficiency, neurotism, emotional stability and IQ were controlled.

Agarwal, Kanta Prasad (1988) concentrated his study on types of schools and corresponding factors as predictors of Creativity at Secondary school level. The sample comprised 480 male science students of class IX from four types of schools namely - Aided schools, government schools, Kendriya Vidyalayas and Public schools apart from 275 teachers. The tools employed were Verbal and Non verbal tests of Creativity, Learning Environment Inventory and Socio Economic status scale. Major findings of the study were – 1. Significant differences were found among grade XI students of four types of schools in respect to Creativity and Verbal and Non –
Verbal Creativity and their components. 2. No substantial differences were found in the Learning environment of four types of schools. 3. Significant difference on some Learning environment factors was found among high and low creatives’. 4. Verbal Creativity was related only with one learning dimension, namely, material environment in Aided schools; with two dimensions: Friction and Innovation, in Government schools; with Competitiveness in Kendriya Vidyalayas; with Cohesiveness, Friction, Goal – direction, Favoritism and Competitiveness in Public schools; and with Friction, Difficulty, Competitiveness and Innovation in the Total Sample. 5. Negative relationship was found between Verbal creativity and Learning Environment dimensions. 6. Few Learning Environment dimensions could predict Creativity and its Components. 7. The Predictive effectiveness of significance found with learning environment components varied in degree from school to school. 8. A high degree association was found between the ranking and perceptions of the teachers from different schools about the characteristics of an ideal pupil. 9. Very low association was found between the perceptions of teachers and of the Creative experts of personality. 10. The students of the all the four schools differed in case of their socio-economic status. 11. Socio–economic status influenced creativity and its three types namely Verbal Ability, Verbal Creativity and Non – Verbal Creativity significantly in Aided schools and in the Total sample. However, neither the Creativity nor its types were found to be influenced significantly by socio-economic status in the remaining three schools namely Government schools, Kendriya Vidyalayas and the Public schools. 12. Socio–Economic status influenced Creativity and its components to a moderate degree only.

Guptha, Krishna Kumari (1988) focused her study on the creative development of 200 secondary school children between 11 – 15 years in relation to Sex, Intelligence and Urban and Rural backgrounds in Government Aided secondary schools in Aligarh district. The tools used are Creative Thinking test (verbal and Non verbal) developed by Giriraj Kishore and Molisins general Intelligence Test. Major findings of the study are - 1. Urban and Rural boys and girls developed rapidly in creativity from the age of 11 (Grade VI) to the age of 13 (in the case of males) and 14
(in the case of females – Grade VIII) but later there was a sharp decline up to the age of 15 (Grade X). 2. In general Creativity had a tendency to rise from the age of 11 (Grade VI) and continue to do so up to Grade VIII and IX. After this stage there appeared a sharp decline. The development of creativity was at its peak between the ages 13 – 14 (grades VIII and IX). 3. Creativity had a significance correspondence with age and grade up to 13 years (Grade VIII). 4. In general females showed excellence as compared to males in creative development between the ages of 13–15 years both in Urban and rural areas. 5. The trends of creative development of females and males were not linear. 6. Urban students were superior to the rural students in creative development especially during the age of 11 – 15 years. 7. There existed a low but positive relationship between creativity and intelligence of secondary school males and females of urban and rural areas. 8. The creativity and intelligence of rural children were lower than urban children. 9. Creative factors were positive but slightly correlated with intelligence at each grade level i.e. from grades VI to X both in urban and rural areas. 10. The value of correlation coefficient between creativity factors and intelligence in the case of rural students was comparatively lower than in the case of urban children. 11. Creativity had a significant correspondence with intelligence from grade VI to grade VIII i.e. from the age of 11 to 13 years, both in urban and rural areas. 12. There was a decline in the relationship between creativity and intelligence of grade level IX, X i.e. from the age of 14 – 15 years both in urban and rural areas.

Bhandarkar S. (1989) in an experimental study to find out the Intellectual and Creative suppression/stagnation being faced by 140 meritorious students of VIII and IX, in the present curriculum, from 15 secondary schools of Chandrapur district. The tools used included IQ test by Madhukar Patel, Test of Creative Thinking by Torrance, Scholastic and Creative suppression measuring scale prepared by the researcher and the Merit enhancing programme including thirteen various experiences. The study revealed that 1. There is very little difference in the highest and the lowest mean of the suppression expressed by the students. 2. The high level group showed more suppression than the low level group. 3. School was found to be
most suppressing factor, and the Environment and the Literature were the factors causing least suppression. 4. It was found that “Family” was more of a suppressing factor than a “Fiend” factor.

Datta K.L. (1989) tried to find out the difference in scientific creativity among 500 higher secondary students from four districts of Jammu province. The tools were Scientific Creativity Test, Group Verbal Test of Intelligence by Joshi, Socio–Economic scale questionnaire by S. Jalota et al. and Aggregate marks scored in previous examination. The findings of the study were the Constructed Test of Scientific Creativity proved to be reliable and valid. 2. Sex difference did not exist in scientific creativity. 3. Scientific creativity was a normally distributed trait. 4. Scientific creativity depended on Intelligence, Academic achievement and Socio economic status. 5. Dominant factors of scientific creativity were Fluency, flexibility, originality in the case of boys and girls. 6. Fluency and flexibility depended upon Intelligence but independent of academic achievement and socio economic status. 7. In both the sexes, scientific creativity was found to be independent of socio economic status but dependent upon intelligence.

Reddy, Sudhakara Y. (1990) investigated with an aim at analyzing the creativity of 900 adolescent children in relation to certain variables like sex, locality, length of schooling, personality traits, mental ability, socio economic status etc., The tools used were a creativity Test battery by Venkata Rami Reddy, Raven’s Standard Progressive Matrices, S.V. Socio Economic status scale, Higher secondary personality Questionnaire (HSPQ) by Cattle and a Personal data sheet. The major findings of the study were – 1. In case of Verbal Test urban children were found to be more creative than the rural children. 2. There was a significant difference between the creativity of VII, IX and X. Each group differed from the other. 3. Though males scored better than females the difference between the means was no significant. Similar results were obtained for all three components of creativity viz. Fluency, Flexibility, Originality and Complex of Creativity. 4. In case of Non – Verbal Test, males scored significantly better than females. 5. There was a significant difference between the Creativity of VII, IX and X children. Each group differed from the other.
Similar results were obtained for all the components of creativity and complex creativity. 6. Rural children tended to score better than urban children on all the components. The difference between the means was significant in the case of Flexibility, Originality and complex creativity but not in the case of Fluency. 7. When creativity as measured by both types of Tests put together was analyzed, it was found that – A) there was a significant increase in the creativity of children from VIII to IX and IX to X and this was true for all the components of creativity. B) Males scored better than females but the difference between the means was significant only in the case of Fluency. C) Similarly urban students scored better than rural children but the difference between the means was not significant in the case of Fluency only. 8. The increase or decrease in Creativity (drawn from the whole group) was differentiated by all the personality factors except Q4, as measured by the Higher Secondary Personality Questionnaire (HSPQ). Rise in creativity scores is related to the rise on factors B, C, F, G, H, I, J, Q2 and Q3, while decrease in creativity scored higher on factors A, D, E and O. 9. When the analysis was carried out separately for different sub groups (Boys – Girls, Urban – Rural children, of classes VIII, IX and X) slight difference in the pattern cited above were seen. 10. There was a significant difference between A) the Mental Ability and B) socio-economic status of high creative and low creative in favor of the former group. This was true for all the sub groups’ children. 11. Compared to fall in creativity a larger percent of highly creative: a. tended to do things in an unconventional way; b. read story books, magazines etc, move frequently; c. had a between general state of health, d. tended to come from nuclear families and e. perceived a close affinity between the members of the family. 12. High and Low creative did not differ on a. the frequency with which they get silly ideas, b. the number of friends they had, c. the liberty given by the parents in doing things, d. the frequency with which they were punished by the parents for their mistakes and e. the birth order. 13. Multiple regression analysis showed that about 37% of the variance in creativity was predicted by the different variables included in the study.
Dhalla, Tripti (1990) tried to a profile of Creative children in the area of psychology and education. She also attempted to find some commonality among creative children. Five (Two VII and Three VIII) students of national public schools formed the sample of the study. The tools used are Verbal test of Creative Thinking by Baquer Mehdi, ravens Progressive matrices Test, Attitude Scale towards school, home, self, Attitude of parents towards children and teacher perception. The major findings of the study revealed that 1. The creative children were: a. above the 90th percentile in “Originality” and at 99th percentile in “Elaboration”, b. high in “Intellectual Capacity” and c. “Fluent” and “High Achievers”. 2. Creative individuals did not have good reading habits. 3. Creative individuals were confident about their future aspirations. 4. Usually the children did not have leadership qualities but possessed some special talents. 5. They did not perceive themselves as popular in the classroom but happy about the world around. 6. They had high positive self-concept and wee very optimistic about life. 7. Parents of creative children had a democratic style of parenting and 8. They were quick, attentive and disciplined.

Goel, Tanuja (1990) attempted to study the impact of Institutional Locale and sex on the development of creativity components among 300 Rural and urban junior higher secondary students. The tools used were Verbal Test of Creative Thinking by Baquer Mehdi. The major findings of the study are 1. A significant developmental change in the mean creativity scores was perceptible among teachers of Classes VI to VIII but the change between classes VI and VIII was only marginal and insignificant. 2. Females were significantly superior to males in creativity. 3. Developmental difference in creativity existed between the urban students of Class VI and VII; VI and VIII as well as their counterparts in rural areas.

Afsan (1991) studied to find out the Vocational interests and creativity of 410 rural gifted girl students and 425 urban gifted girl students of class IX from different higher secondary schools of Srinagar and Baramulla districts. The tools used included Information Blank sheet, non-language preference schedule by Chatterji, and Verbal test of Creative Thinking by Baquer Mehdi and Standard Progressive Matrices Test by Raven. The findings of the study revealed - 1. Rural and Urban girls did not show
any characteristic difference in parental education and occupation. 2. Rural gifted girls in comparison to urban gifted girls were found to be higher in Creativity, but difference between the mean scores couldn’t reach any level of significance. No significant difference was found between the two groups on the components of Creativity viz. Fluency, Flexibility and Originality. 3. The Vocational Interests of Rural gifted girls and urban gifted girls were more or less similar when compared to one – to – one basis.

Gujarathi, Nalini. M (1992) dealt with the identification and development of scientific creativity in 60 students at the school level to enable them to face the challenges and problems of the 21st Century. The tools used were Majumdar’s Scientific Creativity test (part I and II), Scientific creativity test developed by the researcher and the Standard Progressive Matrices by Raven. The findings of the study reveal that 1. On the scientific creativity test, the experimental group received higher “Z” scores than expected. The results were highly significant. 2. On results for the researcher’s Scientific Creativity Test, as the experimental “Z” scores was much higher than the table value of “Z” on all the four scores of creative abilities the results were highly significant. 3. The main objective of preparing an integrated training program in scientific creativity was achieved. 4. The test in scientific creativity constructed by the researcher was reliable and valid for measuring the effectiveness of the training program. 5. The gain in the tests of scientific creativity by the experimental group was highly significant.

Kumari, Usha M.C. (1993) studied the effect of CORT treatment upon Creative thinking and problem solving of ninth class students. The students were exposed to tasks and problems and were encouraged to produce a large number of creative solutions. The results of her study supported the hypotheses regarding the usefulness of guided discovery methods and educational materials.

Sharma D. (1994) conducted an experimental study by organizing activities like brainstorming, problem solving, quiz, and project work in a science teaching class. She found that the students of the experimental group showed significant gains
with respect to verbal fluency, verbal flexibility, verbal originality and non-verbal creative thinking.

Mehrotra, Sushma (1995) studied the application of specific imagery exercises among Grade IV children from diverse socio-economic status and measured their effect on creativity. The study was carried on 374 students. Imagery exercises, of three types namely – Divergent-Thinking – Processing - Imagery exercises (DTPIE), Synthesis – Destructuring – Imagination – Imagery Exercises (SDIIE) and both DTPIE and SDIIE combined are found to have positive influence on creativity. Further they have allowed expression of latent thoughts, imaginations and emotions without any pressure or demand.

Bawa S.K. and Kaur, Parvinder (1995) have studied the relationship between creativity and academic achievement. Their sample contained 600 class X students. Their findings revealed significant positive correlation between all the four measures of creativity and achievement in all the school subjects except social studies. Achievement in languages tended to be better related to the creative thinking than in Social studies and General science.

Gulati, Shushma (1995) conducted a study to analyze how instructional materials helped children’s creativity in classroom and its effectiveness in fostering creativity. The sample comprised of students of class V. Alternate uses test of Guilford, Parallel lines of Torrance and Unusual uses and circle of Torrance and a questionnaire were the tools used. The collected data was treated with mean, SD, and t-ratio. It was found that the differences between mean scores of pretest and posttest were consistently significant both in case of flexibility and originality.

Gulati, Sushma (1997) in her study titled “Understanding Creativity = The psychometric View” attempted to analyze the nature of the abilities which have been used very often as measures of creativity in terms of their relation ship with intelligence (Gf and Gc), personality – temperament and motivation measures. Treating all the variables within the same theoretical frame, the main objectives of the study were to ascertain and compare the proportion of variances attributable to fluid
intelligence, crystallized intelligence, personality and motivation to both verbal and figural creativity and study their underlying factorial structure. The sample comprised 400 girl students of class XI and the tool administered were Torrance Test of Creative Thinking (TTCT) with words form – A, TTCT – with pictures form – A; Cattle’s Culture Fair Intelligence Test Scale – 2 form – A; Hundal’s General mental Ability test; high school Personality Questionnaire and 4F or 16 PF Questionnaire (16PF) and School motivation Analysis Test. The data with score of 43 variables has yielded the following results: - 1. There is a significant positive but low relationship between the measures of Creativity and Intelligence. 2. Verbal creativity measures are contributed to more by Gc while figural measures are attributed to more by Gf, but there is not much difference between the variances of both Gf and Gc in figural Creativity measures except elaboration. 3. Creativity and Intelligence constitute distinct factor relatively independent of each other. 4. Verbal and Figural creativity measures synthesize into separate factors indicating creativity is multifactor in nature. 5. Verbal creativity measures involve to a lesser extent the variance of personality – temperament than motivation measures while figural creativity measures are affected more by variations due to motivation measures. 6. The overall relative efficacy of fluid and crystallized intelligence, personality and motivation measures varies with the two types of creativity. Verbal creativity measures relate more closely to the measures of intelligence particularly Gc while figural creativity measures relate more closely to the measures of personality – temperament traits.

Pachaury A.C. (1997) aimed at uncovering the perceptions of Indian scientists regarding the creative students. The study focussed on the characteristics of creativity in students endorsed by scientists and compared these to the perceptions of experts in the field of creative personality. No difference was found in the perception of the scientists and experts in creativity regarding the characteristics of creative students. Some of the traits common to both and ranked most desirable were: Curious, Courageous in convictions, Independent in judgment, and preoccupied with tasks. Traits ranked by both the groups as least desirable in students were: timidity and haughtiness.
Girjesh Kumar and Santhosh Singh (1999) have studies different dimensions of creativity in relation to Locality of Scheduled castes and Non-scheduled castes students. The tool used in the study is Torrance Test of Creative Thinking. The study revealed that scheduled caste students belonging to the urban locality have been found significantly superior to their rural counterparts in all the dimensions of Verbal and Figural (Except Originality) creativity. In originality of figural creativity also the mean score of urban group was slightly higher than that of the rural groups. Among the non-scheduled castes students also the urban group maintained its significant superiority to the rural group students in all dimensions of Verbal creativity (except originality) and figural creativity. This shows that the environment significantly influences the creative thinking of students.

Ashok K. Hota (2000) in his study of the Creative potential achievement motivation and self-concept of Urban, Rural and tribal adolescents” tried to study the Creative Potentiality, Verbal and Figural Creativity, Sex difference in creativity, differences in achievement motivation, self concept and relation between intelligence and creativity of Rural, Urban and tribal adolescents. The tools used for the study are a. Wallach and Kogan test of Creativity adopted in Oriya by Tripathy, b. Achievement Motivation test by Mohan, c. Personality Word List by Deo and d. Cattle’s Culture Fair test of intelligence Form A -factor “g” scale –II. The findings of the study were 1. High creative urban adolescents, as compared to low creative urban adolescents, in general, possess higher achievement motivation or greater achievement need. 2. High creative rural adolescents as compared to low creative rural adolescents, in general, possess greater achievement need. 3. High creative tribal adolescents, as compared to low creative tribal adolescents, in general, possess greater need achievement. 4. The perceived self-concept of high creative urban adolescents as compared to low creative urban adolescents, in general, is significantly higher. 5. The perceived self-concept of high creative rural adolescents, as compared to low creative rural adolescents, in general, is significantly higher. 6. The perceived self-concept of high creative tribal adolescents does not differ markedly. In other words, perceived self-concept of low creative tribal adolescents is as higher as their high
creative counterparts. 7. The relationship between verbal creativity and intelligence is significant but low. 8. The relationship between figural creativity and intelligence is significant but low. 9. The relationship between composite creativity and intelligence is significant but low.

Mrs. Disha Shrivastava and Prof. Bhupendra Nigam (2004) in their correlation study on Achievement, Intelligence and Creativity of Higher secondary students of Jabalpur division, Madya Pradesh, comprising 750 male and female students of Urban and Rural and Tribal area, have revealed that 1. Achievement was a direct correlate of Intelligence. 2. Achievement was a correlate of Creativity (Except in tribal girls). 3. Intelligence was a correlate of creativity (Except in tribal girls). The tools employed in the above study were Self-prepared test for Achievement, Standard Progressive Matrices by Raven and Baquer Mehdi’s Test for Creativity.

Some studies aimed at finding out whether or not the students from academic streams, namely, science, arts, home sciences, and commerce differ among themselves with reference to creativity.

Srivastava and Jha (1977) and Srivastava (1978) reported that the science students were superior to arts and commerce students as far as their achievement in creativity is concerned. Science students were found to be significantly higher than arts students in fluency, flexibility components of creativity (Awasthy). In non-verbal creativity (NVC) too, science students were found to be superior to arts students, but in verbal creativity (VC) arts students were significantly superior to science students (Jarial, 1981). Kaur (1980) observed that commerce students were significantly superior to science and home- science students in VC, while science students scored higher than the home science students in VC. No significant difference in VC was found between the group of arts and science students (Rawat and Garg, 1977), between arts and commerce students (Srivastava and Jarial, 1879) and between science and commerce students (Sansanwal and Jarial, 1979). From the available evidences, it may be concluded that students from arts, science, home science and commerce streams differ among themselves in Creativity.
3.2.1 Rural v/s Urban Groups Creativity

Some of salient findings from the studies reviewed with reference to Rural and Urban groups’ creativity are discussed below.

A number of studies (Torrance, 1960; Sharma, 1972 and 1974; Mehdi, 1973; Azmi, 1974) reported the superiority of rural children than their counterpart (Urban Children). Aaron et al (1969) found no significant difference between creativity scores of rural and urban boys as against the urban superiority in creativity.

In a classical study involving several thousand children, Torrance (1960) found that in America there were differently more signs of tolerance of non-conformity in thinking among rural and town children than among the urban children.

Sharma’s (1972) study on urban- rural differences revealed that rural children were significantly more creative than their urban counterparts. In a workshop on “Creativity through Education” organized by the Regional College of Education, Bhopal, Mehdi (1973) mentioned that on both verbal and non-verbal tests rural children appeared to be doing well than their urban counterparts on fluency and flexibility tests, though in originality they were poor. Sharma (1974) studied 204 urban and 210 rural Xth class male students and concluded that rural male students are more creative than the urban counterparts. Azmi (1974) again confirmed the superiority of rural children utilizing Mehdi’s tests of Creativity. Hussain and Subay (1975) reported that the tribal were equally creative as their urban counterparts.

A few studies (Singh, 1980; Dharmagandhan, 1981; Shukla, 1982;) showed the superiority of Urban children as against their rural counterparts. Singh (1980) studied the patterns of creativity between rural and urban children in relation to socio-economic status and he found that urban children were more creative than the rural children. In verbal part of the creativity test urban children scored significantly higher than rural children (Dharmgandhan, 1981). Contrary to Sharma’s (1972, 1974) findings, Shukla (1980) a verbs that among rural school students there is comparatively low level of creativity as against the students of urban schools.

Interestingly Mishra (1986) found that unlike urban and rural disadvantaged children creativity differed significantly between advantaged and disadvantaged
children in both rural and urban sub-cultures. Advantaged children scored more than the disadvantaged. Further creativity scores of the disadvantaged children in rural, urban and tribal subjects differed significantly. The rural group secured highest scores in verbal creativity subjects, tribal were the second highest and urban the least. But in case of non-verbal creativity sub-tests, tribal scored the highest score, rural children secured second highest and the urban disadvantaged children secured the lowest scores.

Shukla and Sharma (1987) in a study on a randomly selected sample of two hundred and thirty five representative Indian pupils from grade VII and VIII of middle school belonging to four culture groups i.e. urban, rural, tribal and refugee Bengali located in Raipur and Rajnandgaon districts of Madhya Pradesh administered tests of scientific creativity by the investigators for measuring fluency, flexibility and originality dimensions of scientific creativity of the pupils. The results revealed interesting facts that the mean scientific creativity scores of Indian tribal pupils were found lowest on various dimensions of scientific creativity though there existed no significant difference between the tribal and rural, tribal and refugee pupils on the flexibility and originality. Further it was found that rural pupils scored higher on fluency dimension than refugee Bengali pupils but there was no flexibility and originality components of creativity.

### 3.2.2 Sex As Related To Creativity In Different Groups

Strauss and Strauss (1968) in a composite study of Indian and American children, reported lower creativity of girls than those of boys. Sex difference in creativity was greatest in India. The smaller sex difference in creativity among American children is interpreted in terms of greatest freedom allowed to American girls. Their study is further supported by Raina (1969, 1871) conferring that girls were less creative than boys.

Badrinath and Satyanarayan (1979) mentioned that except in originality, there was no sex difference in respect of other components of creativity. Nianatara (1981) reported that males excelled, as compared to females, on measures of verbal fluency, verbal flexibility, figural originality and figural elaboration. The contention that male
students, in general, are more creative than female students was supported by the findings of Shukla and Dharmagandhan also. Pandey (1981) reported a dual trend that boys were better for fluency and flexibility than girls. Whereas girls were found better for Originality and Composite creativity than the boys. However, Pandey and Pandey (1984) reported that there was no consistent sex difference in respect of various factors of creativity.

Dutta (1982) on a sample of 148 adolescents in the age group 15 from class IX of six schools administered Mehdi’s test of Creativity. It was found that there was no difference in verbal creativity among tribal boys and girls though, the non-verbal creativity of girls is higher than boys. Contrary to the above findings superiority of females over males in creativity is reported by MacGrego and Smith (1965), Harlow (1967), Ogletra (1971), Passi (1972, 1973), Harison (1973) and Hussain (1974). Singh (1978) recorded that girls possess higher levels of word fluency, expressive fluency, spontaneous fluency, and originality than boys, but mainly in semantic content and in figural elaborating the two groups found same.

3.3 STUDIES RELATED TO INDUCING PROBLEM SOLVING ABILITY

Davis and Houtman (1968), in their creative problem solving programme, taught the sixth to eighth grade students some effective strategies for designing, inventing and improving physical products. They gave seven possible hints and suggestions. These were: change color, make new size, change shape, introduce new material, add or subtract something, rearrange and introduce new design. Students were encouraged to make objective evaluation of their own thinking. It is observed that the students who make evaluation of their own thinking are less likely to be inhibited in future functioning.

Parnes (1971) discusses in detail the procedure of creative problem solving course at the University of Buffalo. The pupils were taught the technique of brainstorming in detail, with the use of checklist procedures and forced fit techniques. Importance of record keeping, differed judgment, free wheeling etc., is stressed and informal procedures are used in the training. Analysis of the results indicate that I) the creative problem solving students show substantial gain in quantity of ideas on two
test, than the control group, II) on three tests of idea quality, the creative problem solving students showed substantial dominance, but showed no significant changes in “self-control” or “need to achieve”.

Torrance and Torrance (1973) in their review of 142 studies provide 91 percent success for Osborn-Parnes creative problem solving courses and/or modifications. The reasons for the success of creative problem solving courses are: 1) the problem solving is very much similar to the creative thought process itself, 2) the solving of creative problems are enjoyed by the children because of their novelty.

Biles (1977) took forty graduate and professional students and randomly assigned them to two groups. Twenty-three subjects took the creative problem-solving course based on the textbook by Osborn (1971) and the workbook by Parnes (1967) for ten hours. The Torrance Test of creative Thinking (TTCT) was selected as the criterion for evaluating the outcomes of the course and the two forms were used. The experimental subjects benefited from the experience in terms of significant improvement on scores for two of the three verbal factors and one of the four figural factors.

Kealey (1977) used a pretest and posttest control group design with eighteen foreign language student teachers at Ohio University. The experimental treatment received by the group A, consisted of a six week abbreviated version of Parnes (1967) creative problem solving course. The control condition A2, consisted of seminar sessions in which specific student teaching problems were discussed. Verbal creativity (VC) was measured by Torrance Test of Creative thinking (TTCT) and Operation Creativity (OC) by student ratings on a tool developed by the investigators. Results indicated no significant differences between groups on either TTCT or on student ratings, but significant correlations existed between the two, - TTCT and student ratings.

Jain, S.C. (1982) studied the problem solving behavior in physics among certain groups of adolescent pupils. The objectives of the study were to study the need for selected hints, at various stages of problem solving and to study the problem
solving ability of adolescent pupils, boys and girls at high, average and low creativity levels. A sample of 180 pupils (90 boys and 90 girls) of class IX (Science) was selected randomly. Creativity was measured by Baqer Mehdi Verbal test of creativity. Ten problems in Physics based on different reasoning patterns were arbitrarily framed to measure the problem solving ability. The findings indicated that the hints when presented systematically and logically were helpful in making the students conscious about the analysis of the problem and recalling of the relevant knowledge, and to some extent for the correct use of reasoning patterns. No significant differences for problem solving ability scores were observed among the three groups differing in Creativity.

Rai (1982) has studied the process of problem solving in creative science and non-creative science students. Two groups of creative and non-creative students identified by Creativity Test of Mehdi, totaling 200 of Patna were tested on problem solving in the same conditions. It was found that creative children need more tasks as assignments in their curriculum.

Talegaonkar (1984) developed teaching strategies to encourage students to solve problems in science creativity. The study was conducted with the purpose of encouraging students for the problem solving in science creativity. 34 students of class IX formed the sample. Pretest-posttest matched group design was adopted. Different strategies employed for the improvement of creative problem solving, games observation, question storming, group discussions, laboratory work and supply of instructional materials to students. Two self-made verbal tests highlighting fluency, flexibility and originality were used to find difference shown in abilities to solve problems creatively. One was used as pretest and the other as posttest. These tests were not standardized. Training was given for 18 hours and extended over a period of six months. Data was analyzed qualitatively through graphic representations and through median test. The findings indicated that there was no significant increase in their ability of lateral thinking of the students, but they responded well during the conduct of the experiment. The students could not reach the final solution due to lack of time and equipment for experimentation.
Raina, K. (1986) in his correlation study included three psychological variables (Problem solving ability, Achievement in sciences and Intelligence) and five social variables (Sex, Type of school, SES, Birth order and Type of family) – as independent variables and Scientific Creativity as dependent variable. A sample consisted of 1000 students from various types of schools. The tools administered were – 1) Guptha Scientific Creativity Test, 2) Manju’s Problem solving ability in science 3) Joshi Group Test of Intelligence. 4) Achievement Test in science 5) SES Scale. Major findings of the study were 1. Achievement is significantly correlated with scientific creativity 2. Problem solving ability is significantly correlated with the three components of creativity Fluency, flexibility and originality. 3. All the three components of Creativity are significantly correlated with IQ 4. Boys and Girls differed on the intelligence and fluency components of scientific creativity and girls had higher scores than the boys. 5. Students with high problem solving ability scores had high score in scientific creativity. 6. Students belonging to middle SES with middle Problem-solving ability scored highest where as students coming from the low SES group and middle problem solving ability scored the least on scientific creativity. 7. First born students are more creative than the second and the third borne. 8. Sex as a single main variable did not show significant variations in scientific creativity of the students.

Darchingpui (1989) studied the relationships among variables such as Achievement in science, attitude towards science and problem solving ability under certain conditions such as location, socio economic status, parental education, occupation and typology of school among 812 Ix secondary school children. The tools employed were the science test developed by the researcher himself, the science attitude scale by Avinash Grewal and the Problem solving ability test by the investigator. The study indicated that 1. There are significant relationships between the scores on science attitude and achievement in science. 2. Significant sex difference in achievement in science and problem solving ability existed. 3. High SES, family facility and type of school attended favored achievement in science, science attitude and problem solving ability.
Kumari U.M.C. (1993) tested various methods of Creative Problem solving with Guided discovery. The students were exposed to tasks and problems and were encouraged to produce a large number of creative solutions. Creative problem solving ability was measured with the help of a realistic and interesting test. The results of the study supported the hypothesis regarding the usefulness of guide discovery methods and educational materials across different types of assessment tools and samples.

Tapaswini Sahu NeeDas (1995) in her research focused on the effect of Free play (Object Play) on Convergent and Divergent problem solving tasks of Pre–schoolers assumed that in that context of object play there would be discovery of principles to solve problems, modification of strategies used, collaboration of ideas and enhancement of learning. The findings revealed that on convergent task there was no significant difference between the performance of play and instructed group. An interesting trend was that School–II (Public School) performed better than the School–I (Government Middle school). In Divergent task–I again no significant difference was observed between the groups. On Divergent task–II group differences were observed on fluency and flexibility measures. Play group also gave more number of Original responses than the instructed group. There was a delayed transfer of play experiences and the enduring effect of play was noticeable.

Padhi J.S. (1998) in his study aimed at evaluating the perceptions of the Oriya Elementary and Secondary teachers on the Creative Personalities of students. The sample included 120 teachers i.e. 60 each from elementary and secondary schools. The shortened version of “Your Ideal pupil Check” list developed by Torrance (195) is used as a tool for data collection. Findings of the study reveal that 1. Elementary and secondary teachers supported Creativity traits like curiosity and pre occupation with tasks. 2. Both the teachers did not value traits like “Independent Judgments” and “Questioning” as characteristics of creativity. 3. Both agreed with experts judgment about the three least valued characteristics i.e. Fearfulness, Timidity, haughty and Self satisfied.

B.L. Hoovinabhavi, V.N. Kattamani and A.E Digar (2004) in a study on Problem solving ability of college students have found that the students of science
and arts faculty differ significantly but boys and girls of science faculty have not shown any significant difference in their problem solving ability. The factors like education, heredity, curriculum, and intelligence etc., influenced on the problem solving abilities of college students. The problem solving ability test developed and standardized by L.N.Dubey was employed in this study.

3.4 STUDIES RELATED TO ATTITUDE TOWARDS SCIENCE

Sood (1974) studied the attitude towards science and scientists among the students and teachers and found that the understanding of science positively related to it.

Sarah, Shanta Kumari, Williams A. (1983) have studied Attitude of high school pupils towards general science and its relationship with achievement in a stratified proportionate sample of 3000 that formed 26.64% of the total population. The major findings of the study were - 1. The attitude of the high school pupils towards science and science education in Tamilnadu was generally favorable but there was a wide disparity in their attitude. 2. When their attitude towards science and attitude towards science education were partial led out, the coefficient of correlation between their achievement and SES was found 0.1164 and it was significant at 0.01 levels. 3. When the effects of the pupils attitude towards science as well as their SES were partial led out, the coefficient of correlation between the attitude towards science education and achievement was found to be 0.4062 and it was found to be significant at 0.01 levels. 4. When the effect of attitude towards science education and their SES were partial led out, the coefficient of correlation between their attitude towards science and their achievement was found to be 0.07661 and it was not significant. 5. It was found that about 30% of the variance in science achievement was accounted for by ones attitude towards science, ones attitude towards science education and SES.

Bandhopadhyay J. (1984) studied Attitude towards science and related factors in a sample of 420 adolescents (221 boys and 199 girls) from 21 schools of Calcutta. The data were represented by charts and tables and analyzed by statistical tools like t-test, ANOVA and Chi – square test. He found that parents education and SES led to
favorable attitude towards science besides other contributory factors like teacher’s influence, peers’ influence, vocational value of education and the future aim in life. The pupils who had a favorable attitude towards science possessed higher ability in mechanical comprehension and visualization of objects in space. They were higher achievers in physical and life sciences. There existed significant interactions between (a) Source of inspiration and achievement in Physical science, (b) Source, Achievement in Physical science and Space relations and (c) Source, Achievement in Life sciences and Space relations.

Goalwalkar S. (1986) studied scientific attitude, creativity and achievement of tribal students of Rajasthan. The findings from the sample of 270 tribal students and 270 non-tribal students of classes IX and X offering science as an optional subject, reveal that non-tribal students were superior to tribal students on three components and no significant difference in seven components of scientific attitude. Non–tribals had higher levels of creativity than the tribal students. The non-tribals had a higher scholastic achievement in science subjects than the tribal students.

Cheryl L. Mason, Jane Butler Kahle (1988) have designed a project to foster the full and fair participation of girls in high school science classes addressed obstacles, both perceived and actual, to equal participation. In order to modify existing classroom techniques and environments, a teacher intervention program was designed. By personal communications, teachers were sensitized to the importance of a stimulating gender free learning environment. In addition they were presented with a variety of methods and materials, which had been shown to encourage girls in science. Twelve teachers who were selected randomly, taught in diverse communities throughout one Midwestern state. The subjects tested were students in 24 general biology classes taught by the 12 teachers. Using ANOVA’s, treatment group by student sex, a comparison of the mean score was made for all students, as well as for all females and all males. The results indicated that the experimental group, compared to the control group, had significantly higher mean scores on tests of attitude towards science, Perceptions of science, extra curricular science activities and interest in science related careers.
Mandela, Shyam Singh (1988) focused his study on assessing the attitudes of secondary students towards science curriculum and its relationship with achievement motivation on a sample of 500 students. The tools employed are Attitude Scale develop by the researcher and Achievement Motivation by Prayag Mehta. The major findings of the study are 1. Students from rural school and urban schools as well as male and female had favorable attitude towards science curriculum. 2. There were significant differences in some aspects such as Science Temper, and teaching methods. 3. Students from urban schools scored higher on achievement motivation tests. 4. Most of the weak students scored less on achievement motivation test. 5. Female students scored higher than their male counterparts. 6. Enriched academic programs helped in developing favorable attitudes.

Kar D.K. (1990) examined the problem of relationship between attitude and achievement in general science of 700 class IX students from 10 high schools of Cuttack city, also included are 74 science teachers, science experts, professors, educationists and head masters of the sample schools. The tools used to collect data were Questionnaire, interview schedule, achievement tests in science and attitude scale. The major findings of the study are 1. The distribution of the attitude score was negatively skewed. 2. Boys are found to be more favorably disposed towards science than girls 3. There was positive relation ship between attitude and achievement.

Rao, Digumarthi Bhaskara (1990) in an attempt to compare scientific attitude, scientific aptitude and achievement in biology at the secondary school level took a sample of 600 IX standard students through a stratified sampling procedure. The tools used in the stud included Science Attitude Scale of J.K. Sood and R.P. Sandhya, and Kerala University Science Aptitude test of Nair et al. Major findings of the study are – 1. The science attitude in secondary school pupils was average. There was no significance of sex on science attitude. But the pupils studying in Private schools, Residential schools, English medium schools and Rural schools held relatively better science attitude than their counter parts. 2. The Science Aptitude in secondary school pupils was also average. The pupils of Private schools, urban schools, English medium schools and Residential schools held relatively better science aptitude.
achievement in Biology was also average. The Rural schools, Government schools, English medium schools and Residential schools were better in achievement. 4. There was a highly significant and positive association among science attitude, science aptitude and achievement in biology.

Sharma, Munishwar Kumar (1990) investigated the incidence of science literacy, Attitude towards science and the personality traits of certain groups of students and teachers. The tools used are Science Literacy scale and Attitude towards science and Cattle’s 16 PF Questionnaire. The findings of the study revealed that 1. The total sample had high level of science literacy than the theoretical mean. 2. There was significant difference between the general group and the scheduled caste and scheduled tribe groups. 3. The total sample had favorable attitude towards science. 4. There was effect of type of school and sex on attitude towards science. 5. There was no significant difference between the students and teachers on personality factors.

Dale R. Baker and Michael Piburn (1991) have investigated the effects of Scientific Literacy Course (SLC) on the Skills, Cognitive Ability and Attitude towards Science in the first years of High School. The research examined 1. Whether incoming student characteristics affect the development of Attitude and cognitive ability. 250 students (126 males and 124 females) ninth grade students were enrolled in a specially designed Scientific Literacy Course, which met for 3 hours and 20 minutes each week for 39 weeks. Students were pre-tested for Logical, Spatial, and Verbal and Mathematical ability as well as for Attitude towards science and Self-concept and Psychological type. The course was successful in teaching skills. In addition, there were significant increases in Cognitive ability were predicted by Logical ability, Measurement skills and Academic self-concept. Attitude declined due to participation in the course. Self-concept and Mastery were related to Cognitive variables and Motivation, Mastery and Control were related to Psychological type.

Malviya, Dharma Shila (1991) studied the attitude towards science and interest in science among 820 school going class IX adolescents and 193 teachers of Madhya Pradesh. The tools used are Attitude scale (Likert Method of summated rating scale—
5 – point) and Interest inventory by Raghuraj pal Singh. The major findings of the study are 1. A positive attitude towards science was observed among all the six groups of students (Boys – girls; Tribal girl student primary school and educational school; Rural students – urban students and high SES – Low SES of students), 2. Significant difference between the means of rural school and urban school – boys and girls revealed that sex had no effect on the attitude towards science differed in respect of sex in early ages. 3. No significant difference between male and female teachers attitude towards science revealed that sex had no effect on the attitude towards science in the later years. 4. Significant difference between the means of rural school and urban school – boys and girls revealed that the attitude towards science differed in respect of area. 5. No significant difference between male and female teachers attitude towards science revealed that sex had no effect on the attitude towards science. 6. No significant difference between experienced and new teachers’ that an increase in age had no effect on the attitude towards science. 7. Significant difference between the mean scores of boys and girls on different factors of attitude towards science and significant in mean scores of students and teachers on different components of attitude towards science revealed that age, sex, profession and socio–economic status had no effect on attitude towards science. 8. Coefficient correlation between the different factors of attitude towards science showed moderate correlation with each other. 9. Coefficient correlation between the different factors of Interest showed moderate correlation with each other. The correlation of scientific factor was comparatively higher than other factors. 10. The mean scores and standard deviation of the science interest factor was higher than the interest factors. This showed that the students who had got high positive attitude towards science could also have high interest in science. 11. Attitude and different factors in scientific interest i.e. Mechanics, Business, Scientific, Aesthetic were significantly correlated. Attitude and clerical factor of interest was also significantly correlated. Other two factors of interest namely Social and Outdoor factors did not show any significant relationship with attitude. 12. Obtained value of “F” on the basis of one – way ANOVA showed significant difference between the different groups of students in the attitude towards
science. 13. The value of “r” in case of science factor was higher than other factors. It clearly showed that the student who had positive attitude towards science also had greater interest in science. 14. A “t” test analysis of Attitude towards science showed significant positive gain in Attitude towards science for the entire groups of students.

Gabriel Adeniji Ajewole (1991) has investigated the effects of Discovery and Expository Instructional Methods on the Attitudes of students in Biology. The sample consisted of 240 students from IV Biology students randomly drawn from six selected Secondary schools in the Oyo state of Nigeria. They were assigned into two groups – Experimental and Control. The Experimental group was exposed to Discovery Instructional Method and the Control group to the Expository Instructional Method. The science class of Form IV in each of the six schools was selected intact for the study. A non-randomized pretest and posttest control group design was employed. The major instrument was the 40-item Scientific Attitude Questionnaire (SAQ). It is a Likert type questionnaire using five scales. Two hypotheses were tested. Results showed that the Experimental groups evinced a significantly more favorable attitude towards Biology than the Control group. It was also found that the high-, average- and low ability groups in the Experimental class evinced a more favorable attitude towards biology than their counter parts in the Control class. However, there was no significant difference in the attitudes of male and female students exposed to the Discovery Instructional Method or Expository Instructional Method. It is recommended that Science Learning using the Discovery Method may enable the learner to evince more a favorable attitude towards problem recognition and problem solving than when learning by Expository Method.

Luanne Gogolin (1992) has investigated the attitude towards science of non-science college students (NSCS) using quantitative and qualitative forms of inquiry. Quantitative methods were used to determine – a. how attitude towards science of NSCS compare with attitude of science majors and b. whether attitude towards science change with instruction. Qualitative assessment was used to investigate attitude development as it relates to science. The subjects were 102 NSCS and 81 science students. Six attitudinal variables were investigated using the attitude towards
science Inventory as the Quantitative instrument. Holteling’s T2 showed a significant difference (p= 0.0001) in attitudes between the two groups. T tests revealed significant differences between the two groups for all six variables. A significant difference (p = 0.001) was found between pre- and post-test results for the NSCS. t-tests showed significant difference between the two sets of scores for all six variables, indicating a favorable change in attitudes. An interview questionnaire was used to investigate factors contributing to attitude suggested that attitudes towards science are formed by interactions of both school and non – school variables.

Srivastava, Veena (1992) investigated creativity in relation to Scientific Aptitude and Attitude towards Science on a large sample of 600 boys and 600 girls from higher secondary schools of Agra city. The tools used were Creativity Test by Chauhan and Tiwari, Scientific Aptitude battery by K.K.Aggrwal, Samoohik Manasik Yogyata Pariksha by R.K. Tandon and the Attitude towards Science by Avinash Grewal. Findings of the study revealed that 1. The science students of higher secondary classes having more scientific Aptitude were more creative than those having less scientific aptitude. 2. In the field of creativity, the boys having favorable attitude towards science were slightly better than those having unfavorable attitude towards science where as the girls with favorable and unfavorable attitude towards science did not differ. 3. The girls were more creative than the boys. 4. The boys had more scientific aptitude than the girls. 5. The girls had more favorable attitude towards science than the boys.

J. O’Brien and G.C. Porter (1994) have reviewed the situation in Ireland in relation to the number of girls studying physics and chemistry. A scheme of intervention projects to reduce the under – representation of girls in the physical science is described. The measured attitudes of students based on a Likert type scale are also reported. The effects of a number of factors on those attitudes were investigated. Students in Project schools were shown to have similar attitudes to physics than those in the Control school indicating the success of the intervention in establishing the teaching of physics and in increasing the number of girls who study the subject. Students in the Project schools have positive attitude in relation to girls’
ability in physics, while boys have more positive attitude to everyday application of physics. Students in the Co-education schools tend to have more negative attitudes and the larger the school the more negative the attitudes of the students. The effect of the changing involvement of the visiting teacher is reported and in relation to girls’ ability, attitudes generally became less positive the longer a school is within the scheme.

Marshall D. Sundberg and Michael L. Dini Elizabeth Li (1994) in their study demonstrated a small but significant difference in prior understanding of basic biological concepts between students enrolled in majors’ versus non-majors’ introductory biology courses. By the end of their respective courses, non-majors demonstrated greater improvement in posttest scores than did majors. Furthermore, although initially students in the major course had significantly more positive attitude towards science, especially in terms of personal comfort with science, by the end of the course this difference disappears. Following a semester of instruction, the attitudes of non-majors generally improved, but students’ attitudes in the majors’ classes declined in nearly all categories. The results further suggested that some instructors have a consistently strong impact on their students attitudinal change. It is concluded that there was a strong association between improving student attitudes and student performance on subject content.

Paul J. Germann (1994) used path analysis techniques to test a hypothesized structural model of direct and indirect causal effects of student variables on science process skills. The model was twice tested using data collected at the beginning and end of the school year from 67 Ninth and Tenth grade biology students who lived in a rural Franco-American Community in New England. Each student’s variable was found to have significant effects, accounting for approximately 80% of the variance in Science processing skills achievement. Academic ability, Biology knowledge and Language preference had significant direct effects. There were significant mediated effects by Cognitive Development, Parent Education and attitude towards science in school. The variables of Cognitive Development and Academic ability had the greatest total effects on Science process skills.
Mary Ann Evans, Myrna Whigham and Morgan (1995) in their in-school intervention project used female role models to change the attitudes of 964 Iowa girls and boys in 57 ninth grade science classes towards science, math and technical curricula and careers. The differences between the students mean pretest and posttest scores on each of six factors found to be associated with students attitude towards science and math and technical careers were analyzed to determine which of five experimental groups responded most positively to the intervention. Higher difference scores indicated that the attitudes of girls and boys who participated in the intervention improved more than the attitudes of girls and boys in the control groups, suggesting that the use of female role models in the science classroom is an effective way to change students attitude towards science, math and related career.

Padhi J.S. (1994) has attempted to find out - I. The nature of relationship existing between the high school students perceived science classroom environment (SCE) and their attitude towards science, II. There was significant effect of gender and classroom environment on their attitude towards science and III. Classroom environment dimensions that affect attitude towards science different types of schools. The sample comprised 200 students of Class IX of different types of high schools of Orissa i.e. Navodaya Vidyalaya, Kendriya Vidyalaya, Government schools and private schools in Urban and Rural areas. The tools employed were Individualized classroom environment Questionnaire by Fraser and science Attitude Scale by Grewal (1977). Findings of the study were – I. Significant relationship was found between Classroom Environment Score and Attitude towards Science scores of High school students II. Personalization and participation dimensions influenced students Attitude towards Science and III. Boys and girls differed significantly with respect to their Attitude towards Science.

Molly Weinburgh (1995) in his Meta analysis covering the literature between 1970 and 1991 examined gender differences in students’ attitude towards science and correlations between attitude towards science and achievement in science. 31 effect sizes and 7 correlates representing the testing of 6,753 subjects were found in 18 studies. The mean of the unweighed effect size was 0.20 (SD=0.50) and the mean of
the weighed effect size was 0.16 (SD = 0.50) indicating that boys have more positive attitude towards science than girls. The mean correlation between attitude and achievement was 0.50 for boys and 0.55 for girls, suggesting that the correlation is comparable. Results of the analysis of gender differences in attitude as a function of science type indicates that for Biology and Physics the correlation is positive for both, but stronger for girls than for boys. Gender differences and correlations between attitude and achievement by gender as a function of the selectivity of the sample indicate that general level students reflect a greater positive attitude for boys, whereas the high – performance students indicate a greater positive attitude for girls. The correlation between attitude and achievement as function of selectivity indicates that in all cases a positive attitude results in higher achievement. This is particularly true for low – performance girls. The implications of the study were to continue research that examines strategies in the classroom for improving students attitude towards science especially those of girls, to continue research that examines Attitudes, gender and grade level and the last implication is that the greater differences needs to be examines by race in order to determine differences in girls of different ethnic backgrounds.

Lynne E. Houtz (1995) in his sequential methodological elaboration study investigated differences between middle school and the junior high instructional strategies and the effects on adolescent attitude towards science in school and science achievement. Subjects of the quantitative phase were 570 seventh and eighth grade students in one school in Urban School district in the Mid - West US during a transition year from Junior high to Middle school. German’s attitude towards science in school Assessment and the School District’s Bench Mark Exam were employed to measure students pre – and posttest attitude and achievement. Variations within grade level, gender, race, general ability and SES were evaluated. Results of split plots revealed no significant difference in attitude towards science between the Experimental Middle school group and the Junior High Control group at this phase. However there was significant improvement in attitude in both seventh grade population, but no change in attitude in either Eighth grade population. No significant
differences in Attitude were found between males and females and Caucasian students and Students of color. The conclusions arrived from this study was that:

1. In the first year of transition from the junior high instructional strategy to the Middle school instructional strategy, it may be difficult to achieve significant differences in Attitude towards science and Achievement.

2. Traditional methods of assessment of learning objectives may not be appropriate for the approaches advocated by the middle school philosophy.

3. It is also recommended that teachers involved in implementing new instructional strategies can be expected to have a wide variety of concerns, which will effect the success of the implementation process, they need a milieu of personal support as well as orientation information about the change.

Mary M. Atwater and John Wiggins (1995) in their research project have gathered demographic data, intentions to engage in science, and attitudes of Urban, Middle school students. Scores on the Simpson – Troost Attitude Instrument were analyzed using the Statistics Analysis system. Results indicate less than 50% of the students show any interest to engage in science at the high school level, yet many plan to enter a science related career. Less than 50% of the students come from high school graduated parents who work full time to support their family. A majority of the students possessed uncertain attitude towards their science teachers and science curricula. However, all possessed high achievement motivations, strong positive attitude towards their families and high self-concept.

Maitra, Krishna and Alka (1997) through their study “To explore the Attitude towards laboratories and other related practical work in science” have attempted (a) to explore the notion of science as perceived by students, teachers and other professionals towards teaching of science, (b) attitude towards practical aspects of science teaching, (c) specific attitudes towards teaching science, (d) to evaluate the effect of attitudes of students and teachers on the student’s performance in science and (e) the system of evaluation of science in schools. The sample comprised of 296 students of IX and X, 20 teachers teaching the classers IX and X and 5 other professionals. The data were collected through an attitude scale and interest inventory for students, questionnaire for teachers and semi-structural interview for other
professionals, all developed by the researchers. Mean, SD, t-test and content analysis were used for data analysis. Findings of the study revealed that – 1. Rural girls of class X had very high and positive attitude towards science, 2. Boys had more positive attitude towards science as compared to the girls towards the science practical where as girls emphasized the knowledge aspect more, 3. Students of class IX and X had similar attitude, 4. Boys who showed a more positive attitude towards science as compared to the girls were unable to reflect the same in their performance, 5. Science being a dynamic discipline needs constant updating of ones knowledge, which was lacking in most of the teachers, 6. The maximum number of teachers failed to show their innovativeness in procedure for evaluating their students, 7. Though all the teachers were familiar with the doctrine of “Learning by doing” but failed to implement this in their own pedagogy, 8. The professionals asserted that teaching of science must include both processes and products and the curriculum should necessarily include numerous practical, 9. Professionals expressed that evaluation process for practical in class X should be through the external examination, and 10. It was found that the teachers’ attitude also influence attitudes of students and their performances.

3.5 STUDIES RELATED TO MODELS OF TEACHING IN GENERAL

Among the four families of models of teaching classified by Bruce Joyce and Marsha Weil (1980), research seemed to have been concentrated on Information Processing Family.

Battacharya, Gopal Chandra (1985) studied the effectiveness of various models of teaching geography in relation to institutional resources. The objectives of the study were to compare the effectiveness of teaching geography through Concept Attainment Model (CAM) and Inductive Thinking Model (ITM) in relation to institutional resources and to find the interaction effects of the different educational institution resource status, models of teaching and types of concepts taught on the gain achievement score of students in geography. The sample comprised of 324 students of class VIII from 30 secondary schools using quota-sampling technique. The tools used were: Test of General Mental Ability or Intelligence by M.C. Joshi,
Test of Study Habits and Attitude by M.C. Joshi and Panday, Educational Institution Resource Status Index (EIRS), SES Index and Achievement Test by the researcher. The collected data were treated with ANOVA and t-values. The findings of the study indicated that Inductive Thinking model emerges as the best suitable model for all types of institutions. High EIRS institution groups showed better achievement irrespective of the models and concept types than the low EIRS ones and no significant combined interaction effect was observed than that of the main effects only.

Pandey S.N. (1986) studied the effectiveness of Advance Organizer Model (AOM) and Inquiry Training Model (ITM) for teaching social studies to class VIII students. Purposive sampling technique was used. Final sample comprised of 86 students of class VIII. Two experimental groups formed AOM group and ITM group consisting of 29 and 28 students respectively. The Control group consisted of 29 students. All the students included in the sample were boys in the age group of 13-14 years. ANOVA, t-test and Chi-square test were used for drawing conclusions. It was found that ITM and AOM were more effective than conventional teaching in terms of improving students’ achievement and those pupils reacted favorably towards ITM and AOM.

Sushma (1987) investigated the effect of Concept Attainment Model (CAM) and Biological Inquiry Model (BSIM), for teaching biological sciences, on achievement and attitude to science and also compared their effectiveness. 78 standard eight-girl students were selected using purposive sampling technique. One experimental group was taught by CAM and the other by BSIM. The control group was taught by Traditional approach. Both the models were found to be effective. The CAM was found to be more effective when compared with BSIM and BSIM was found to be more effective than Conventional teaching with reference to changing the attitude favorably and improving their achievement level.

Agarwal R and Mishra K.S. (1988) studied the effectiveness of the Modified Reception Strategy of Concept Attainment Model of Teaching (MRCAMOT) in enhancing the attainment of science concepts. The study is pretest and posttest
designed on a randomized sample of 18 students of class VII of the Government girls’ Intermediate College, Allahabad. The findings of the study are – 1. The MRCAMOT was decidedly effective in increasing the knowledge and understanding of science concepts of class VII students. 2. It helped in students’ concept attainment.

Kaushik N.K. (1988) has investigated the long-term effect of Advanced Organizers on achievement in Biology in relation to reading ability, intelligence and scientific attitude of the learners. It was found that the general introduction or an overview, which generally precedes learning material, is less effective when compared to Advanced Organizers.

Sau T. (1988) conducted a critical review of some researches on Information Processing Models of Teaching. The findings of the study indicated that most of the studies were one-dimensional, although the concept was multi dimensional.

Baveja B. (1989a, 1989b) conducted two comparative studies to investigate the effectiveness of Concept Attainment Model (CAM) with Taba’s Inductive Thinking Model (ITM) with regard to concept learning in biology and also analyzed the thinking strategies used by the learners. The two studies had different sample population and elaboration. The findings of both the studies support the role of inductive thinking process in the process of conceptualization and generalization.

Chaudhury K. (1989) investigated and found that the teaching skills and competence developed among student teachers through the use of Concept Attainment Model (CAM) are easily transferable into other teaching situations, besides the teaching of concepts. This study also recommended the use of CAM technique to develop the teaching skills.

Singh D.K. (1990) investigated the effect of Inquiry Training Model (In.TM) and Concept Attainment Model (CAM) over Traditional Methods for teaching physical sciences. It was found that both the models were equally effective in teaching physical science to class IX pupils.

Sood K. (1990) conducted a comparative study on effectiveness of Advanced Organizer Model (AOM) and Concept Attainment Model (CAM) for the acquisition of language concepts in relation to cognitive style, intelligence and creativity. It was
found that CAM was more effective than AOM in teaching the concepts in Hindi. Intelligence, Creative levels and cognitive style were redundant factors so far as the learning of concepts was considered.

Gupta, Naresh Kumar (1991) attempted to compare the effectiveness of Concept Attainment Model (CAM) of Bruner et al., and the Inductive Thinking Model of Hilda Taba on achievement, self-concept and attitude towards science. The experimental study was conducted on a sample of 64 IX class students. The two groups were controlled in respect of age, sex, physical conditions, etc., The tools used are Jalota’s General Metal Ability Test, the scale of attitude toward science by Avinash Grewal and the Self concept Questionnaire of Saraswat. The findings of the study are 1. Inductive Thinking Model of Hilda Taba was found to be more effective than the Concept Attainment Model (CAM) of Bruner et al, 2. Inductive Thinking Model of Hilda Taba was found superior to the Concept Attainment Model (CAM) of Bruner et al, in promoting the right attitude towards science. 3. Neither the CAM nor the IThM was effective in bringing about significant changes in self concept.

Gupta S. (1991) conducted an experimental study on the effectiveness of Ausbel’s Advanced Organizer Model (AOM) in developing teaching competence of student teachers and their attitude towards teaching. It was found that AOM was effective in developing teaching competence among student teachers under simulated as well as classroom conditions.

Jamini, Nirupama (1991) investigated the relative effect of Advanced Organizer Model (AOM) and Concept Attainment Model (CAM) on conceptual learning efficiency and retention of Chemistry concepts in relation to divergent thinking. The findings indicated that although both AOM and CAM were equally effective in fostering concept learning, the AOM was comparatively more beneficial to pupils with high divergent thinking while CAM with low divergent thinking pupils. AOM was found to be more effective than CAM in the retention of concepts irrespective of the level of divergent thinking.

Kaur R.P. (1991) investigated the effectiveness of Bruner’s Concept Attainment Model (CAM) and Ausbel’s Advanced Organizer Model (AOM) for
teaching of Economics to high and low achieving students across creativity levels. It was found that for teaching of economics both the models are effective and that AOM is more effective than CAM. The interaction between teaching strategies, intelligence and creativity were not found to be significant.

Manocha V. (1991) studied Reception and selection Strategy in comparison to the conventional method of teaching of concepts in biology. The findings indicated that there is no significant difference between reception and selection strategies with respect to achievement scores.

Pal and Misra (1991) investigated the effect of Jurisprudential Strategy of teaching on development of social consciousness and ability to solve value conflicts among pupils of class IX. It was found that the individual Jurisprudential Inquiry Approach was less effective than the group approach.

Pandey S.P. (1991) studied the instructional and nurturant effects of Jurisprudential Inquiry Approach. It was found that intelligence and the socio economic status of pupils interacted with the development of certain values such as equality, tolerance and justice.

Khan and Siddiqui (1992) reviewed the studies on effectiveness of Concept Attainment Strategies. It came up with the findings that concept attainment strategies were more effective over the traditional approach and attainment of disjunctive concepts is more difficult than the attainment of conjunctive concepts.

Mahajan (1992) took up a comparative study of effectiveness of two models of teaching viz., Bruner’s Concept Attainment Model (CAM) and Ausbel’s Advanced Organizer Model (AOM) on teaching abilities of student teachers and on achievement of students in various schools. It was found that the group taught by CAM was superior to groups taught by AOM as well as the routine method as far as the teaching ability of student teachers is concerned.

Mohanty (1992) compared Jurisprudential Inquiry Model (JIM) with Concept Attainment Model (CAM) in development of moral concepts and judgment and personal values of class VIII pupils. The findings of the study indicated Jim was more
effective for developing the moral judgment and personal values of students whereas CAM was effective in developing moral concepts.

Panda B.B. (1994) attempted to ascertain the effectiveness of Ausbel’s Advanced Organizer Model (AOM) and Set Induction (SI) in enhancing learning retention and transfer. The study intended to find the effect of AOM and SI on learning of class IX, to compare the effectiveness of AOM and Traditional Method (TM) and SI and TM, AOM and SI on achievement and to determine the influence of interaction between methods of instruction, sex and criterion test. The sample for the study comprised of 69 students of class IX of a school. The data were collected using General Mental Ability Test of Jalota and Criterion Test developed by the researcher and were treated with Mean, SD, three-way ANOVA and t-test. It was found that students studying through AOM and SI scored higher than traditional method. There was no interaction between methods of instruction, sex and immediate delayed test, and there was no significant difference between achievement of boys and girls.

Singh S.N. (1994) in his study investigated the effectiveness of Inductive Thinking Model (ITM) in comparison to Traditional Method (TM) of teaching economics to class XI. The study intended to study the effectiveness of ITM in terms of achievement in economics as well as reaction of students towards ITM, to compare ITM with TM in terms of achievement, inductive reasoning, concept formation, higher mental ability in economics, scientific attitude and creativity separately by considering intelligence, achievement motivation as covariates, to study the effect of treatment, sex and their interaction on the dependent variables separately. The sample comprised of 350 class XI students. The data were analyzed by mean, SD, coefficient of variance, chi-square, ANOVA and correlated t-test. It was found that ITM was more effective compared to TM in terms of achievement in economics and reaction towards ITM. Intelligence significantly influenced the dependent variables. Interaction between treatment and sex influenced the achievement. TM was suitable for both male and female students in teaching economics in comparison to TM.

Ajatha Swamy (1995) investigated the effect of Inquiry Training Model (ITM) of teaching science on science process skills, creativity and curiosity of secondary
school students. The study intended to compare the effectiveness of ITM and Conventional Method (CM) of teaching science in terms of - (1) developing science process skills, (2) fostering fluency, flexibility and originality components of creativity, (3) boosting curiosity and to investigate the interaction between treatments and levels with reference to the dependent variables. It also aimed to investigate whether the students sustain the skills, creativity and curiosity boosted by ITM of teaching science. The sample consisted of 36 matched pairs of students with one as the Control group and the other as the Experimental group. The tools used for collecting the data were Verbal Test of Creative Thinking of Baquer Mehdi, Science Process Skills Test and Curiosity Test by the investigator. The data collected were analyzed by two-way ANOVA, Schaeffer’s test and t-test. It was found that ITM was more effective than CM in developing the science process skills for above average and below average groups. ITM was more effective than CM in fostering fluency and originality components of creativity. ITM was more effective than CM in boosting curiosity. It was also found that the students sustained the skills developed, curiosity boosted and creativity fostered through ITM of teaching science.

Guptha, Naresh Kumar (1995) studied the relative effectiveness of some information processing models of teaching i.e. Concept Attainment Model (CAM), Inductive Thinking Model (IThM) and Inquiry Training Model (ITM) on mental processes and attitude towards science. The main objectives of the study were to (i) design and develop institutional plans for teaching selected units in science for IX stage based on CAM, IthM and ITM of teaching, (ii) to study the individual effectiveness of teaching through these models on a) development of pupil’s mental processes, b) development of reasoning ability, c) fostering scientific creativity and d) enhancing ability to see problems. (iii) Development of favorable attitude of students towards science. A purposive sample of 140 students in the form of three non-equivalents intact sections of class IX in same school were drawn by incidental sampling technique. The tools used were Group General Mental Ability Test by S. Jalota, Reasoning Ability Test (RAT) by K. Bayati, Passi’s tests of Creativity, Science Attitude Scale by Avinash Grewal and verbal Test of Scientific Creativity by
V.P. Sharma and J.P. Shukla. Quasi-experimental method was employed in a natural setting with pre-test and post-test parallel group design. It was found that CAM was effective in developing reasoning ability, scientific creativity whereas it could not foster inquisitiveness. ITM was effective in developing reasoning ability, scientific creativity, and problem awareness ability however it could not bring significant gain in inquisitiveness and persistence. CAM, ITM and ITh.M did not differ in effectiveness in terms of enhancing reasoning ability or scientific creativity. ITM and ITh.M rated better than CAM in fostering problem awareness ability. However ITh.M and ITM did not differ in fostering the ability to see problems.

Anandi Martis (1999) took up an action research study to find out the effect of desensitization Model of Teaching on Fears of Adolescent boys of a local school. The objectives of the study were to find if unrealistic fears could be removed in adolescents by desensitzing. It aimed at preparing lessons for sessions on desensitization Model of Teaching and to find the effect of it on the scores of fears measured by the Fear Survey Scale. Action research methodology with a single group pre-test and post-test research design was used. 300 adolescent boys of standard IX were surveyed on Fear Survey Scale. Sixty adolescent boys were selected as the sample for the experiment. “t”-test was used foe analysis of data. It was found that mean pre test scores were significantly higher than the mean post-test scores i.e. the model of teaching helped in reducing fear.

Kasinath H.M. (2000) examined the relative effectiveness of the Inductive Thinking Model of teaching science and the Conventional method in fostering science processing skills, creativity and curiosity of the learners. A sample of 72 students of IX grade were divided into experimental and control groups using IQ as the control variable. The pretest and the posttest parallel design was used. The Inductive thinking model was found effective in fostering the skills and Creativity components fluency and flexibility.

**Studies Related To Training For Models Of Teaching**

Passi, B.K., Singh L.C. and Sansanwal D.N. (1985) developed a training strategy for models of teaching. The objectives of the study were to study the
effectiveness of Inquiry Training Model (ITM) and Concept Attainment Model (CAM) in terms of – a) understanding of the model, b) reaction towards the model, c) to study the resultant willingness of teacher educators to implement the models in teacher education programmes and d) to develop a strategy of training in models of teaching. 45 teacher educators representing 25 institutions from nine states and five union territories were selected by purposive sampling. The teacher educators were invited to attend a 8-day workshop on Models of Teaching held at Devi Ahilya Vishwavidyalaya, Indore in April 1985. Single group pretest-posttest design was employed. The treatment comprised of orientation in the theory of model, a lesson plan guide and a teacher analysis guide through lectures and discussion. This was followed by demonstration lessons and practice. The tools used were, theory checkup for CAM and ITM by Joyce and Weil at Indore and reaction scale for CAM and ITM and willingness scale for implementation of models developed for the study. It was found that training in CAM and ITM comprising lecture demonstration, discussion and peer practice plus feedback enhanced the understanding of teacher educator’s theoretical aspects of CAM and ITM. The training strategy was found effective in terms of developing understanding, favorable reaction and willingness to implement models of teaching in a teacher-training programme.

Das B.C. (1993) studied the effectiveness of CAM in terms of teaching competency of pre-service student teachers. The objectives were to study the effectiveness of CAM in terms of – a) teaching competencies of pre-service students, b) understanding the model, c) training the model, d) coaching the model and e) reaction towards the models at various stages of training. The sample for the study comprised of sixteen student teachers studying B.Ed., of the department of education belonging to the Devi Ahilya Vishwavidyalaya, Indore. Tools used were theory check-up test by Bruce Joyce, Modified theory checkup by Sansanwal, Reaction scale by B.K. Passi Singh and Sansanwal, teaching analysis guide by Bruce Joyce. The collected data were analyzed by Mean, SD, t-values, Correlated means, coefficient of variation and rank order correlation. It was found that CAM was effective in developing teaching competencies of pre-service student teachers. The training given
to student teachers increased understanding about theoretical aspects of CAM. The training affected the teaching behaviors of student teachers at coaching stage. CAM was effective in terms of training. The training process from theory to practice had brought significant changes in the student teachers reaction towards CAM.

**Studies Related To Developing Models For Teaching**

Exemmal J. (1980) took up a study to construct certain models for teaching school botany using Environmental and Ethnic resources, to test the efficacy of such models by comparing the achievement in Botany. It also aimed to compare the effectiveness of the Environmental Approach and the Formal Approach realizing certain education outcomes and to examine the effect of Environmental Approach on the attitude of pupil towards teaching and learning. The tools employed were teaching models in Botany, a rating scale on teaching models, achievement test in Botany, attitude towards science teaching and learning, judgment schedule for teachers and students, verbal intelligence test and a science interest inventory. This was an experimental study limited to eight schools. Six topics of Botany of standard IX were selected for construction of teaching models. The findings indicated that the Environmental Approach was superior to Formal Approach in stimulating cognitive growth in pupils, in developing interests in scientific activities and in scoring high marks. Environmental Approach was significantly superior to Formal Approach in terms of immediate post-teaching and delayed memory scores.

Hymavathi K. (1993) attempted to evolve a new teaching model for developing the effective aspects of 5 to 8 years children. The objectives of the study were to define affective domain in terms of functional behavior, to develop and consolidate approaches for developing affective functional behavior into a model form, to implement, verify its validity and to improve the model for implementation at the National level. The sample comprised five experimental schools with 100 students and five control schools with 100 students from class I to III. Rating scale and interview schedule were used as tools. The collected data were treated with mean, SD and critical ratios. It was found that the affective functional behavior could be developed through various activities and methods that are practicable in schools.
3.6 STUDIES RELATED TO SYNECTICS MODEL OF TEACHING

Before directly presenting the studies related to Synectic model of teaching, views of researchers about synectics procedure of nurturing creativity has been presented.

Marran (1966) reported that Synectics has significant application on all secondary school grade levels, in that; it provides a well-structured methodology for both creative and critical thought processes. Palmer (1974) used synectics approach in workshop. Gordon (1974) tried it on IX grade Vocational students and found significant increase in their flexibility and originality. Beada (1979) used “Synectics Model” and found it had effect on ideation output. Gordon and Poze (1981) tried paradox analogue technique for the instruction of biology class to keep gifted, interested in creative thinking.

Hofland (1985) presented a paper at annual meeting of American Theater Association described that three techniques that encourage right brain dominance in the generative step of the design process were random stimulation, lateral thinking and Synectics. Passi (1985) tried Synectics at a three-day workshop on college students and reported it effective. Springfield (1986) and Hartic (1986) used synectics on upper elementary gifted students and found it effective in problem solving activity. Starck (1987) used synectics model in a class to teach family and communication at UG level. It encouraged new ideas and increased creativity.

Warute (1990) studied the effect of synectics method and found it effective for development of scientific creativity in high school students. Kawenski Mary (1991) in “Encouraging Creativity Design” describes a six-week course for design students called “Needs Awareness and design” which stresses development of creative thinking skills. Here he stresses Synectics for actual problem solving and creativity. Soriano-de-Alencar, Eunece M.L. (1993) in his study, “Thinking in the future: The need to promote creativity in Educational context”, suggests the use of synectics. Lone – Cathben and others (1994) in “Teaching strategies to facilitate learning” discusses synectics as one of the teaching strategies.
Martis, A.D’him G.G. (1987) conducted an experimental study to find the effect of Synectics model on pupils’ creative thinking and academic achievement in Science. The sample consisted of Class IX students selected randomly from two sections of an English medium school. Twin group pre-test and post-test design was adopted for the experiment. Torrance test of creative thinking and achievement test developed by the investigator were the tools used. It was found that verbal and figural creativity and academic achievement of experimental group had been significantly increased after the treatment. The difference between the pretest and posttest mean scores were significant at 0.01 levels for the experimental group.

Krishna Murthy B. (1989) took up a study to find out the effectiveness of Synectics model through teaching of Physics in developing creative thinking ability. The study adopted first strategy – “Making familiar strange”. 40 students of VIII grade formed the sample for pretest and posttest experimental design. Baquer Mehdis’ creativity test was used. After ‘t’ ratio analysis a significant increase in fluency, flexibility and originality components of creativity was found. It was equally effective for both genders.

Malhotra S.P. (1990) has investigated the effect of Synectics model of teaching on development of language creativity in Hindi. To study the nurturing effects a 2 x 3 x 3 x 2 factorial nesting cum crossing design was followed. The tools used for data collection were of two types: Treatment Tools and Measurement tools. The treatment Tools included lesson plans, lesson plan formats and Work sheets. The investigator according to the assumptions, objectives designed and syntax of the instructional procedure prepared these. The measuring tools included Language Creativity test in Hindi by Malhotra and Sucheta. Essay and Paragraph analysis scale in Hindi. Verbal test of creative thinking by Baquer Mehdi, The group cohesive ness scale in Hindi developed by the investigator, Raven’s Progressive Matrices and the Kurukshetra Socio economic scale (Urban). The students showed more improvement on the fluency, flexibility and originality and elaboration components in the various areas of language skill. The improvement had a high positive correlation with the intelligence level of the students. Levels of SES also showed a contribution in
improving language creativity amongst students. After the treatment, the students of high SES showed highest improvement on the factor of fluency.

Martis A. (1990) attempted to find out the effectiveness of the Synectics Model in developing “Making strange familiar” (MSF) competencies, scientific and general creativity of graduate student teachers. It was found that the training in MSF comprising theory, discussion, demonstration and practice, developed the desired competencies and generated favorable reactions in pupil teachers as well as the high school students towards the model. The training in MSF significantly improved verbal, non-verbal and scientific flexibility and originality of trainees. These achievements in turn led to the development of general and scientific creativity of school students. The findings of the study also suggested that MSF needed to be slightly modified in the light of classroom situations.

Kumari Sucheta (1990) studied the Instructional and Nurturant effects of Synectics model of teaching on creativity in Hindi and English language teaching. A sample of 250 students, from VII, VIII and IX grades, is selected from the urban area of Shahabad, Markanda District, Haryana. To study the nurturing effects a 3 x 3 x 3 x 2 factorial nesting cum crossing design was followed. The tools used for data collection were of two types: Treatment Tools and Measurement tools. The treatment Tools included lesson plans, lesson plan formats and Work sheets. The investigator according to the assumptions, objectives designed and syntax of the instructional procedure prepared these. The measuring tools included Language Creativity test in Hindi and English by Malhotra and Sucheta. Essay and Paragraph analysis scale in Hindi and English developed by the researcher. Verbal test of creative thinking by Baquer Mehdi, The group cohesive ness scale in Hindi and English developed by the investigator, Raven’s Progressive Matrices and the Kurukshetra Socio economic scale (Urban). The major findings of the study with regard to Instructional effects are – 1. Grade levels effected the improvement of language Creativity in hindi, English and in general. In all the three spheres, the students of class IX were found the most creative and class VII students were the least. However class VIII students were found more creative than class IX for the total as well as for the factor Language
creativity, concerning flexibility and Originality. 2. The Synectics model of teaching effected the improvement in all the five aspects of Language creativity in Hindi, English and general viz. Plot – building, Dialogue – writing, poetic – diction, descriptive style and Vocabulary test. 3. Intelligence affected improvement in all the three spheres of Language creativity. The intelligent students were found more creative in four factors of language creativity viz. Fluency, Flexibility, Originality and Elaboration in Hindi and English and the first three factors in general creativity. With regard to the nurturing effects – a) The synectics model of teaching affected improvement in the gain scores of Essay and Paragraph writing in hindi and English. b) Improvement was noticed in all the four components eg. Unity, Coherence, Originality and fallacies

Venkatraman D. (1993) investigated the effect of Synectics training on creativity and hemisphericity of higher secondary students of Tamilnadu. Students exposed to Synectics were found to have greater ideational and verbal fluency.

Anandi and Irene (1996) undertook a study to prepare instructional materials based on Synectics model of teaching for developing creativity. The developed instructional materials were found to be effective in increasing fluency and flexibility scores and not effective on originality scores i.e., of verbal creative thinking. The worksheets of pupils were very useful for systematic presentation of matter and for evaluation. Further stretching exercises are a must for Synectics approach.

Chaudari, Vaidya, Navalaka and Mahapatra (1999) through a four month duration experimental study on the effectiveness of three treatments – Synectics Model (SM), Gaming strategy (GM) and Traditional Method (TM) of teaching towards creativity and their interaction with sex, found that the overall creative scores of the learners taught through SM, GM and TM have significant differential effect upon creativity of boys and girls. The sample comprised 162 learners of VI grade with intelligence and age controlled.
Likhia K.S. (1998) has studied the effectiveness of the “Making strange Familiar strategy” of Synectics on scientific creativity on a sample of 80 IX grade students. The tools used are Verbal test of scientific creativity by Dr. V.P. Sharma and Dr. J.P.Shukla. The results have shown that the experimental group had significantly higher scores on scientific creativity as compared to control group.

Sheela (2000) has studied on the effectiveness of Synectics model of teaching science on creativity and problem solving ability of Class IX English medium students in 30 pairs of parallel experimental and control students. Raven’s Progressive Matrices, test of higher mental ability in science by Sansanwal and Anuradha Joshi, Baquer Mehdi’s verbal test of creative thinking and investigator’s Problem Solving Ability test were the tools. Two-way ANOVA and ‘t’ – test revealed that Synectics model of teaching Science is more effective than the Conventional method of teaching in developing components of Creativity and Composite creativity as a whole and so is Problem solving ability, are effective at all levels and for both sexes due to Synectics model of teaching.

3.7 SYNTHESIS OF REVIEW

3.7.1 Synthesis Of Review On Studies Related To Role Of Analogies In Learning

A number of studies reviewed emphasize the role of analogies in learning and a few show negative effects. Some of the studies have analyzed role of analogies from teacher’s perspective.

Analogies have been described as an aid to understanding complex and difficult concepts of the content (Royer and Cable, 1976; Curtis and Reigeluth, 1984), found effective on the students of low reasoning ability (Gabel and Sherwood, 1980), Effective on Originality scores (Katena Joe, 1977), Problem solving processes (Genter and Genter, 1983), Familiarity facilitates accessibility (Genter and Landerts, 1985; Genet and Tenny, 1985; Holyoak and Koh, 1987), a tool for explaining and trying to make sense of the unknown concept (Clement, 1987), help the learners to construct their own knowledge base (Black and Solomon, 1987). Benefited the
students of high cognitive abilities (Serge and Giani, 1987; Sutala and Krajicik, 1988), Self generated analogies facilitate conceptual growth (David Wong, E 1993), and Conceptual Change (David E. Brown, 1994).

Some of the studies criticized that teachers seldom evaluate the usefulness of the Metaphors and appeared to presuppose that students were familiar with the analogy domain neglecting further guidance (Tierney, 1988), analogies used were not based on Constructivist approach (Treaghust et al.1990).

In other studies analogies were found useful as “Master Switches” to change belief sets and teaching practices (Tobin, 1990), involving an economical commitment of time and resources (Stephen M. Ritchie, 1994), One of the studies warned the teachers to be careful about the context and level of detail of an analogy in relation to students’ knowledge (Zoubeida R. Dager, 1995), and the other had analyzed the different textbooks and found to lack hints on the analogies used (Glynn et al., 1989).

Only two of the studies reviewed have found negative effect of analogies on attitude (Steven W. Gilbert, 1989) and no correlation with Piagetian levels (Enyeart, 1979).

3.7.2 Synthesis Of Review On Studies Related To Fostering Creativity

For the past seventy-five years a number of approaches have been designed and tried to stimulate creative thinking on various age groups ranging from primary students to corporate executives. All the studies have been successful in fostering creativity as a whole and also its components.

Certain approaches like Reflective Thinking (Dewey, 1933), Attribute Listing and Idea Checklist (Crawford, 1954), Information on Creative Processes approach (Anderson, 1963), Auto instructional programs (Covington and Crutch Field, 1965; Shackel and Lawrence, 1969), Inquiry Learning (Bruner and Suchmannn, 1966), The Productive Thinking program (Oltan, 1967; Davies, 1971), Self – Instructional programmed lessons (Wardrop and Others, 1969), Morphological Analysis (Zwicky,
Brainstorming (Osborn, 1971), Teacher and Student Structured Learning program (John E. Penic, 1973), Purdue Creative Thinking program (Feldusen et al., 1970, Allen car, 1974), Special Guided Lesson programs (Johnson, 1975; Williams, 1970), Use of Random Words (Michalko, 1998) and many others were successful in stimulating creative thinking abilities.

Torrance and Torrance (1973) have reviewed 142 studies with 72 percent success in fostering creativity and considered three main programmes being more effective. They are 1. The Productive Thinking program (Covington and Crutch Field, 1965; Davies, 1971), 2. Purdue Creative Thinking program (Feldusen et al.1970, Allen car, 1974), and 3. The Myers and Torrance Idea Books Program.

Michael V. 1988), Instructional Materials Effectiveness Approach (Gulati Sharma, 1995).

Certain researchers have attempted to study the impact of Brainstorming and Programmed instruction Technique (Sharpe, 1975) and Purdue Creative thinking programme (Jaben, 1980) on the Creative abilities of Educationally Handicapped and Learning Disabled students respectively.

Some studies aimed at finding out whether or not the students from academic streams, namely, science, arts, home sciences, and commerce differ among themselves with reference to creativity.

Srivastava and Jha (1977) and Srivastava (1978) reported that the science students were superior to arts and commerce students as far as their achievement in creativity is concerned. Science students were found to be significantly higher than arts students in fluency, flexibility components of creativity (Awasthy). In non-verbal creativity (NVC) too, science students were found to be superior to arts students, but in verbal creativity (VC) arts students were significantly superior to science students (Jarial, 1981). Kaur (1980) observed that commerce students were significantly superior to science and home-science students in VC, while science students scored higher than the home science students in VC. No significant difference in VC was found between the group of arts and science students (Rawat and Garg, 1977), between arts and commerce students (Srivastava and Jarial, 1879) and between science and commerce students (Sansanwal and Jarial, 1979). From the available evidences, it may be concluded that students from arts, science, home science and commerce streams differ among themselves in Creativity.

Some of the studies reviewed have tried to find out Correlation effects between the Vocational interests and creativity of gifted girl students (Afshan, 1991), types of schools on creativity and related factors (Agarwal, Kantha Prasad, 1988), Creative development with Different age groups and Related psychological and social factors (Gupta, Krishna Kumari, 1988), Achievement, Intelligence and Creativity (Disha Shrivastava and Bhupendra Nigam, 2004), Intelligence and Creative


Miyan, Mohammed (1991) reviewed the existing “Tests of creativity” developed by Indians and concluded that - 1. Almost all the Indian creativity tests have been patterned on the lines of Guilford’s structure of Intellect model. 2. Torrance Tests of Creativity follows the cognitive approach to assess creativity. 3. The various dimensions scored by almost all tests included Fluency, Flexibility, Originality and Elaboration, and 4. The items in almost all the tests represent a heavy intake from foreign tests.

3.7.3 Synthesis Of Review On Studies Related To Problem Solving Ability

Only a few studies are available related to inducing the problem solving ability.
Torrance and Torrance (1973) in their review of 142 studies have rated 91 percent success for Osborn-Parnes creative problem solving courses (Parnes, 1971; Biles, 1977; Kealey, 1977).

Further strategies like Creative problem solving programs (Davis and Houtmann, 1968), Problem solving Behavior in Science subjects (Jain, S.C. 1982; Rai, 1982; Talegaonkar, 1984), Creative problem solving by Guided Discovery (Kumari, U.M.C. 1993), Free Play Strategy (Tapaswini Sahu Nee Das, 1995), have been effective in inducing Creative problem solving ability. Problem solving ability has shown positive correlation with Scientific Creativity (Raina, K. 1986) and so is with Attitude towards science (Darchigpuji, 1989) and with a variety of psychological and social factors (Hoovinabhavi, Kanthamani and A.Edigar, 2004)

The outcomes of the studies were measured with Torrance test of Creative thinking (Biles, 1977; Kealey, 1977), Baqer Mehdi’s Verbal test of Creativity (Jain, S.C. 1982), Self Made Tests by Talegaonkar (1984) and Guptha’s Scientific Creativity test (Raina, K. 1986).

3.7.4 Synthesis Of Review On Studies Related To Attitude Towards Science

Development of favorable attitude towards science in students is found positively effective by the Understanding of science (Sood, 1974), Achievement in science (Sarah, Shanta Kumari, Williams, A. 1983; Molly Weinburgh, 1995; Lynne E. Houtz, 1995; Kar, D.K., 1990), Mechanical Abilities, Teachers influence and Future aim of Life (Bandhopadya, J. 1984; Malviya, Dharma Shila, 1991), Perceptions of Science, extra Curricular activities and Interests in Science related Careers (Cheryl L. Mason, Jane Butler Kahle, 1988; Malviya, Dharma Shila, 1991), Method of Instruction among science majors (Luanne Gogolin, 1992), Performance in Science subjects by Non-Majors (Marshall D. Sundberg and Michael L. Dini Elizabeth Li, 1994), Science process skills (Paul J. Germann, 1994), Female role models on girl students (Mary Ann Evans, Myrna Whigham and Morghan, 1995), Classroom environment (Padhi, J.S. 1994), Science Curriculum and Achievement Motivation (Mandila, Shyam Singh, 1988), Science Aptitude (Srivastava, Veena, 1992) and
Achievement (Rao, Digumarthi Bhaskar, 1990), Scientific Literacy and Personality factors (Sharma, Munishwar Kumar, 1990) and Teachers’ attitude towards science (Maitra Krishna and Alka, 1997). It is also found that when the students were taught in Discovery Method of Learning (Gabriel Adeniji Ajewole, 1991) developed favorable attitude and also the girl students in Project Schools (J. O’ Brien and G.C. Porter, 1994).

Further certain studies have interestingly found that attitude towards science declined when the high school students were enrolled in a Scientific literacy Course (Dale R. Baker and Michael Piburn, 1991), in Co – education school students and Larger Schools – Students’ (J. O’ Brien and G.C. Porter, 1994), and Uncertain attitude towards Science teachers and Science Curricula (Mary M. Atwater and John Wiggins, 1995) was processed by Urban students and Non – Tribals’ and Tribals’ did not differ in their Scientific Attitude (Golwalkar, S. 1986).

### 3.7.5 Synthesis Of Review On Studies Related To Models Of Teaching

Various prospective researchers have studied the effectiveness of various models of teaching over the other models and also the conventional methods. It is critically reviewed that most of the researches on information processing models of teaching were one – dimensional, although the concept was multi – dimensional (Sau, T 1988).

The Inductive Thinking Model (IThM) was found to be more effective

- On all types of educational institutions (Bhattacharya, Gopal Chandra, 1985) over Concept Attainment Model (CAM).
- In fostering problem awareness ability than CAM and equally effective with Inquiry Training Model (Guptha, Naresh Kumar, 1995).
- In teaching economics - in terms of achievement, inductive reasoning, concept formation, higher mental ability in economics, scientific attitude and creativity (Singh S.N., 1994)
- On the process of conceptualization and generalization besides CAM (Baveja, B. 1989a, 1989b). The Inquiry Training Model (ITM) was found
➢ To be equally effective when compared with Advanced Organizer Model (AOM) in teaching Social Studies (Panday S.N., 1986), CAM in teaching physical sciences (Singh D.K., 1990).

➢ To be more effective in fostering components of creativity, boosting Creativity and also in sustaining the skills developed (Ajatha Swamy, 1995) through science. The Concept Attainment Model (CAM) was found to be more effective

➢ Than the traditional method (Khan and Siddiqui, 1992)

➢ Than the Biological Sciences Inquiry Model (BSIM) with reference to attitude and achievement levels (Sushma, 1987)

➢ In its reception strategy in enhancing the attainment of science concepts (Aggarwal R and Mishra K.S., 1988). On the teaching skills and in its flexibility (Chaudhry K., 1989)

➢ Than the AOM in teaching concepts in Hindi (Sood K., 1990), and with pupils of low divergent thinking abilities (Jamini, Nirupama, 1991)

➢ Over AOM on the teaching ability of student teachers (Mahajan, 1992)

➢ In the attainment of Disjunctive concepts (Khan and Siddiqui, 1992).

➢ The Inductive Thinking Model (Guptha, Naresh Kumar 1991).

The Advanced Organizer Model (AOM) was found effective

➢ Than the conventional method of teaching (Kaushik N.K., 1988)

➢ In developing teaching competency (Guptha S., 1991)

➢ With pupils’ of high divergent thinking and in the retention of concepts than the CAM (Jamini, Nirupama, 1991). In teaching Economics (Kaur R.P., 1991)

➢ Equally with CAM in concept learning (Jamini, Nirupama, 1991)

➢ Equally with Set Induction in enhancing learning retention and transfer (Panda B.B., 1994).

Among the other models of teaching Jurisprudential Inquiry Model was less effective than Group Approach (Paul and Mishra, 1991), more effective in developing the moral judgment and personal values (Mohanty, 1992), in developing equality, tolerance and justice (Pandey S.P., 1991). The Reception and Selection Strategy is
not effective on Achievement Scores (Manocha V., 1991). The Desensitization Model of Teaching successfully reduced the fears of adolescent boys (Anandi Martis, 1999).

Of the few studies available CAM and ITM comprising Lecture Demonstration Method, Discussion and Peer practice plus Feedback enhanced the understanding of teacher educators in theoretical aspects. The training strategy is found effective in developing the willingness to implement models of teaching (Passi Singh and Sansanwal, 1985) and in another study training process from theory to practice had brought significant changes in the student teachers reaction to CAM (Das B.C., 1993).

Certain researchers have widely attempted to develop models of teaching. In one such attempt Exemmal J. (1980) has found Environmental Approach being superior over Formal approach in stimulating cognitive growth in pupils, in developing interests in scientific activities, in immediate post – testing and delayed memory scores. In another study Hymavathi K. (1993) has shown that Affective Functional Behavior could be developed through various activities and methods that are practicable in schools.

3.7.6 Synthesis Of Review On Studies Related To Synectics Model Of Teaching


MSF – Synectics Strategy of teaching was found effective in fostering Problem – solving ability (Sheela, 2000; Likhia, K.S., 1998) in students and developed scientific and general creativity (Martis, A, 1990; Likhia,K.S., 1998) in graduate student teachers. Of Synectics, Gaming and Traditional methods of teaching, Synectics is found to be effective towards Creativity and its interaction with Sex. (Chaudri, Vaidya, Navalaka and Mahapatra, 1999).
Out of the studies reviewed there is only one study with reference to instructional and Nurturant effects of Synectics that were found significant on creativity (Kumari Sucheta, 1990; Malhotra, 1990) and creativity and Hemisphericity (Venkatraman, 1993).

3.8 CONCLUSION

The foregoing has revealed that the research in the models of teaching, in particular, is in the exploration stage. Among the four families of Models of teaching, research on Personal Models family is recent in origin.

There has been a major stress to introduce strategies that induce right brain functions to foster Creativity. Synectics from the personal models family is found to be the best-suited model to foster Creativity, besides it nurtures Problem-solving ability.

From the review it is also found that there are very few studies conducted on Synectics Model of teaching and is generally receiving due importance.

There are two strategies of teaching in Synectics Model. They are
1. Creating Something New or Making Familiar Strange (MFS) and

Of the two, the second strategy is found effective in Indian settings at secondary school level.

From the review it is evident that the studies conducted were at secondary level in Metropolitan English Medium schools, no study is found with reference to Urban and Rural Secondary schools, no attempt was made to find the effect of Synectics Model of teaching Science in the regional languages and no study has attempted to find the combined effect of Synectics Model of Teaching on Creativity and Problem Solving Ability on Attitude towards science. Thus, it is concluded that there is no attempt to find answers for the questions -
1. Whether Synectics Model of Teaching succeeds in fostering Creativity, Problem Solving Ability and Favorable Attitude towards the subject taught, in Rural and Urban students?
2. Whether the Urban and Rural students differ in their creativity levels fostered through Synectics Model of Teaching?

3. Whether the Creativity and Problem solving ability, fostered through Synectics Model of Teaching, affect favorable Attitude towards the subject taught?

4. Whether the Urban and Rural students differ in their Problem Solving Abilities fostered through Synectics Model of Teaching?

5. Whether Synectics Model of Teaching fosters favorable attitudes towards the subject taught?

6. Whether the Urban and Rural students differ in their Attitude towards the subject taught even after teaching through Synectics Model of Teaching?

Finding answers to the above questions is a major research gap. Hence, the present research study becomes a modest venture in reducing the gap.

Every modest venture to reduce a research gap needs a well-knit process of study – The METHODOLOGY. The methodology followed in the study is being discussed in the next chapter.