CHAPTER III
REVIEW OF RELATED LITERATURE

The present study aims to prepare an instructional design using the models, concept attainment model and synectics model. The design prepared focuses on enhancing both concept learning and creative thinking. Hence, it is attempted to reflect the related studies under the following heads.

3.1 Concept Learning
3.2 Concept Attainment Model
3.3 Creative Thinking
3.4 Analogies and Metaphors
3.5 Synectics Model
3.6 Development of New Strategies

3.1 Concept Learning

Concept learning is the ability to apply knowledge across a variety of circumstances. It requires cognitive processes like generalization and discrimination. Most of the research studies on concept learning highlight the requirements or conditions to promote these cognitive processes in concept learning and also techniques or methods to be employed during the phase of a lesson.

Lin and Atkinson (2011) investigated the potential benefits of using animation, visual cueing, and their combinations in a multimedia environment designed to support learners’ acquisition and retention of scientific concepts and processes. They found that participants provided with animations retained significantly more concepts than their peers provided with static graphics and those afforded visual cues learned equally well but insignificantly less time than their counterparts in uncued conditions.

Nicholas and Ng (2008) reported blending the arts into students’ learning science concepts through role-play and drama. The study points out that by providing the initial "thinking activation" and promoting self-efficacy in the students, they were able to draw on and further develop their communicative, creative and higher order thinking skills in bringing abstract science concepts to a more concrete and visual form leading to a novel outcome.
Onder (2006) compared the effectiveness of conceptual change approach and traditional method and also determined misconceptions students hold about solubility equilibrium on tenth grade students’ understanding of solubility equilibrium concept.

Alparslan, Tekkaya and Geban (2003) investigated the effect of conceptual change to improve learning. The results indicated that the conceptual change instruction that explicitly addressed students' misconceptions produced significantly greater achievement in the understanding of respiration concepts.

Hewson and Hewson (2003) examined the effect of instruction using students’ prior knowledge and conceptual change strategies on science learning. The students’ prior knowledge provides an indication of the alternative conceptions as well as the scientific conceptions possessed by the students. The results showed a significantly larger improvement in the acquisition of scientific conceptions as a result of the instructional strategy and materials which explicitly dealt with student alternative conceptions.

Eryilmaz (2002) investigated the effect of conceptual assignments and conceptual change discussions on high school students' achievement and misconceptions about force and motion. Pretest and posttest data were analyzed using the Force Misconception and Force Achievement Tests (FMFAT) and discussed the effects on the conceptual change discussion on reducing misconceptions students held as well as improving students' achievement in force and motion.

Natesan (2001) studied the effect of teaching concepts in mathematics through video cassette and compared with that of traditional method. The study implied that the increased level of academic achievement of experimental group was due to the teaching of mathematical concepts through video cassette. It was also found that girls’ performance was better than boys.

Haack (2000) made an attempt to study on scaffolded problem-solving, learning approaches and understanding of concepts in an introductory college physics class. Results showed that students who did scaffold problems attained significantly greater understanding of Physics concepts than students who did non-scaffold assignments.

The impact of concept on the achievement of students in physical science was investigated by De, Kamal Krishna (1999). The study reported that girls and rural
students showed notable deficiency in concept attainment and the performance of boys on concept test was better as compared to girls. Achievement in physical science was found to have high positive correlation with scores on the test of concepts in physical science.

McCoy (1996) conducted a study on the use of analogy and models to promote conceptual change and overcome misconceptions about chemical equilibrium. The results indicated that the more concrete analogy was slightly more effective than the others in promoting conceptual change.

Lemberger (1995) examined the relationships between a model-building problem solving classroom and conceptual change learning. The study found that open-ended problem solving promoted conceptual change in learning in science classroom.

Weatherby (1993) studied the effects of different methods of instruction on children’s understanding of science concepts. It was found that the conceptual change method of instruction significantly increased understanding of the science concept, but did not significantly affect the complexity of response.

Pandey (1993) conducted a study to find out the relative importance of Piagetian reasoning, general intelligence and achievement motivation for concept attainment in physics. The results showed that reasoning and general intelligence were very important for predicting the attainment of physics concepts.

Johnson and others (1992) demonstrated a model for teaching concept that gives students experience in conceptual thinking, by studying a particular concept inductively as students work together to come to shared meanings of the concept and then reflect upon their thinking.

Bawa (1991) reviewed the research possibilities on Bruner’s view on conceptual learning and reported that there was a scarcity of research studies in the area of conceptual learning.

Hawk (1986) reported that graphic organizers were very effective for enhancing concept learning. Rosskopf (1985) made a study on the strategies for concept attainment in mathematics. He found that cognitive strain as well as the burden of memory is reduced in those strategies.
Hull and Fedje (1985) stressed the use of simple concepts and concrete objects to strengthen the thinking skills of mentally retarded adults.

Mathew’s (1984) study concluded that concept formation in physics is dependent on pupils’ pre-requisite knowledge in the respective concept.

Anderson and Smith (1983) examined the understanding of science concepts of students. The study reported that majority (78%) of students understood the concepts when they used visual aids to learn the concepts. Pandey (1981) concluded that teaching style had varying effect on concept attainment. Students’ participation was increased by giving background information.

Cook (1981) suggested that positive and negative examples should be given in a mixed form for the better attainment of concepts whereas Tanner (1980) reported that presentation of definition, examples and non-examples did not have any impact on concept learning.

The above mentioned studies on concept learning reveal the effect of conceptual change on reducing misconceptions which, in turn, helps to improve the learning of students. Concept learning of students can be enhanced by adopting proper teaching strategies, using appropriate previous experience of students, presenting positive and negative examples of the unfamiliar concepts in the form of visual aids or any kind of concrete experiences.

### 3.2 Concept Attainment Model

Models of teaching are one of the major areas of research in which a good deal of work has already been done for the last fifty years. Examination of the research works on models of teaching reveals that the most experimented model is the concept attainment model. Here, the investigator made an attempt to discuss the studies carried out in the area of concept attainment model.

Effectiveness of concept attainment model and advance organizer in teaching of english in teacher education course was compared by Ahmed, Gujjar and Ali (2011). They proved that concept attainment model was an effective instructional strategy in teaching english. It was also found that trainee teachers taught through concept attainment model registered better performance on the posttest scores.
Mukherjee (2011) investigated the effectiveness of concept attainment model (CAM) in terms of achievement in science of class VIII. The results of the study indicated that CAM was effective in terms of achievement of students in science.

Rama Rani and Kaur (2010) developed a Mathematics Concept Understanding Test to assess the mathematics concept understanding of students. It is observed from the study that concept attainment model was effective in terms of mathematics concept understanding than traditional method of teaching when groups were matched with respect to pre-mathematics concept understanding.

The study of Kalani (2009) aimed at investigating relative effectiveness of concept attainment model and conventional method of teaching on achievement and retention of students. The study showed that concept attainment model was more effective than conventional method on attainment of concepts in science and in the retention of concepts.

Bairagya, Ghosh and Meta (2005) found that Concept Attainment Model (CAM) was comparatively more effective teaching treatment than the traditional method of teaching economics at the higher secondary school level. It was also found that the CAM was more effective in respect to the cognitive domain of students.

Minikutty (2005) explored the effect of concept attainment model on achievement in mathematics of academically disadvantaged secondary school students. The study revealed that it was more effective than conventional method in teaching mathematics of academically disadvantaged students.

Effectiveness of concept attainment model on achievement in arabic grammar of standard IX students was conducted by Shamnad (2005) and found that concept attainment model was better than the conventional method in teaching arabic grammar.

Sidhu and Singh (2005) made an attempt to compare Concept Attainment Model (CAM), Advance Organizer Model (AOM) and conventional method in teaching physics in relation to intelligence and achievement motivation on scholastic achievement of students for learning concepts in physics. The results indicated that there was no significant difference among various teaching techniques, intelligence and achievement motivation on scholastic achievement of students in learning concepts in physics.
Krishnakumari (2002) compared the effectiveness of Concept Attainment Model (CAM) and Inquiry Training Model (ITM) with traditional method and concluded that CAM and ITM were equally effective and they were more effective than traditional method.

Sharma (2001) developed self-learning cards for developing concepts on the basis of Bruner’s concept attainment model and studied the effectiveness of the cards. It can be found that it was quite effective.

Lekha (2000) and Prabhakaram and Rao (1998) found that concept attainment model was more effective than traditional method in teaching concepts in mathematics at secondary school level.

Ojha (2000) developed an instructional material for teaching economics through concept attainment model and showed that the instructional material was effective in terms of students’ achievement, retention, self-concept and attitude towards Economics.

Mathew (1999) found that concept attainment model and advance organizer model were equally effective in the teaching of population education.

Remadevi’s (1998) study on the application of information processing models showed that concept attainment model was more effective than traditional method in teaching chemistry at the secondary and the higher secondary level.

Sreelekha and Nayar (1998) examined the effectiveness of concept attainment model in learning chemistry at secondary school level. From the t test analysis, the study revealed that the concept attainment model was effective in improving the overall level of achievement of students in chemistry and the concept attainment model was also found to be effective in enhancing the application skills with respect to chemistry for secondary school students.

Agarwal (1997) reported that advance organizer model and concept attainment model were found more effective than the conventional method in fostering concept learning. Jayakumari (1997) determined the effect of concept attainment model on achievement in physics and concluded that it was more effective than the traditional method in teaching physics.

Vaidya (1997) made an attempt to study the effect of mastery learning and concept attainment on achievement in hindi, self-concept and attitude towards hindi of
upper primary school children. The results indicated that mastery learning was more effective than concept attainment model in enhancing achievement as well as self-concept and attitude.

Ayishabi’s (1996) study showed that there was no significant difference in attainment of concepts between the concept attainment group and the traditional method group in learning zoology. But, Shylasree (1996) found that concept attainment model was more effective method in teaching biology at secondary level.

Jang (1995) conducted a study to identify and characterize student’s understanding of concepts about electric circuits, and to examine how concept attainment model helps to construct these concepts effectively. The study reported that the guided inquiry activities which integrate laboratory experiments and exercises were intended to be the main vehicle for concept attainment.

According to Pritchard (1994) concept attainment model helps students to develop skills for inductive and deductive thinking while learning subject matter in any field in a constructive and meaningful way.

Anuradha and Anand (1993) reported that the general and mental ability of students taught through Concept Attainment Model (CAM) of students was significantly higher than those taught through traditional method.

Gupta (1993) undertook a study to find out the relative effectiveness of some information processing models of teaching on mental processes and attitude towards science. Major findings of the study were

- Concept Attainment Model (CAM) was found to be effective in developing reasoning ability, scientific creativity as well as fostering favourable attitude of the students towards Science, whereas it could not foster inquisitiveness, persistency or problem awareness among them.
- CAM and inquiry training model did not differ in promoting attitude of the students towards Science.

Khan and Siddiqui (1992) reviewed the researches in the area of concept attainment strategies. The author reviewed the studies conducted earlier in India and abroad on concept attainment strategies at different levels and reported that

- Concept attainment strategies were more effective over the traditional approach in teaching.
Personality factors had no significant effect on the concept attainment process.

Disjunctive concepts were significantly more difficult than the attainment of conjunctive concepts.

Concept attainment strategies were responsive to the needs of the disadvantaged learners in problem solving situations and attainment of concepts.

Mahajan (1992) showed that the achievement of students who were taught by the concept attainment model based on Bruner’s theory were found to be better than those of the students taught by Ausubel’s advance organizer model and the routine method.

Mohanty (1992) investigated the relative effectiveness of using Jurisprudential Inquiry Model (JIM) and Concept Attainment Model (CAM) in the cognitive development in moral judgement, moral concepts and personal values of secondary students. The findings indicated that JIM was more effective for developing the moral judgement and personal values of students whereas CAM was effective in developing moral concepts.

Viney (1992) investigated the effectiveness of different models of teaching on achievement in mathematical concepts and attitude in relation to intelligence and cognitive style. The study revealed that the computer model of teaching was found to be superior to concept attainment model of teaching for teaching concepts in Mathematics and for inculcating positive attitude.

Concept attainment model was found to be a very effective method to develop higher order thinking skills of students in Gough’s (1991) study.

There were two studies by Kaur (1991) and Jaimini (1991), which aimed at comparing the effectiveness of Advance Organizer Model (AOM) and Concept Attainment Model (CAM) in relation to creativity of students. Kaur (1991) found that AOM was more effective than CAM in teaching concepts in Economics. The interaction between teaching strategies, intelligence and creativity was not found to be significant. Jaimini (1991) found that both AOM and CAM were equally effective in fostering concept learning. AOM was comparatively more beneficial to students with high divergent thinking ability while CAM was more beneficial to students with low divergent thinking ability.
Passi, Singh & Sansanwal (1991) & Bihari (1986) found the significant favourable change among student teachers towards the understanding of, and reaction towards, the theoretical aspect of the concept attainment strategies.

Aziz (1990) examined the effectiveness of information processing models in acquiring chemical concepts and the study showed that concept attainment model and inductive thinking model were superior to the traditional approach for teaching concepts in chemistry.

D’lima and Suvarna (1990) conducted a study on the effectiveness of the reception oriented concept attainment model and selection oriented concept attainment model in teaching of mathematics on VIII grade pupils in Bombay. The study revealed that reception strategy was more effective than selection strategy whereas the studies of Manocha (1991) and Pani (1985) found that there was no significant difference between selection and reception strategy with respect to achievement scores.

Kanniyakumari (1990) & Sood (1990) found that Concept Attainment Model positively influenced the achievement of students. Singh (1990) found that both the models, concept attainment model and inquiry training model were equally effective in the learning of physical science to class IX students.

Agarwal and Misra (1988) investigated the effectiveness of the modified reception concept attainment model of teaching for enhancing the attainment of concepts. The study revealed that the modified reception concept attainment model was effective in increasing the knowledge and understanding of science concepts.

Joseph (1990), Zacharia (1989), Sushama, Srivastha and Singh (1987), & Sharma (1986) proved that CAM was more effective in achievement of students. Makhdom (1983) studied the effect of concept attainment of instructing children to hypothesize and evaluate and found its effectiveness.

The aforesaid studies revealed that concept attainment model is highly effective than conventional method in the learning of concepts and hence, it can be used as an effective strategy in all subjects and at all grades. However, there are studies which revealed no significant effect of the concept attainment strategies over the traditional approach of teaching-learning process (McDonald 1986, Ponick 1986,
Gilmore 1985, Bordelon 1978, Trundnak 1974 and Schaeffer 1971). This might be due to the different types of intellectual operations (Khan and Siddiqui, 1992).

3.3 Creative Thinking

Review of research studies in the area indicates that many studies have been made in India and abroad on different aspects of creativity. Major studies on creativity including nature and measure of creativity, correlates of creativity and development of creativity are presented in this section.

Lin (2010) analysed attribute patterns of creative problem solving ability among upper elementary students in Taiwan. He developed Creative Problem Solving Attributes Inventory (CPSAI) for measuring attributes of creative problem solving and compared with other established instruments. The results showed that creativity is evidenced as multi-faceted and domain-specific. The data showed three different patterns of attribute composition and the threshold effect on students’ creative problem solving. In addition, the CPSAI produced good internal consistency, good construct validity, and marginated discriminant validity with the data.

Karwowski and Soszynski (2008) conducted a training programme for undergraduate education female students with a view to developing creativity using creative imagination, the Role Play Training in Creativity (RPTC). They studied the effectiveness of RPTC. The results showed statistically significant increase of results in the Test of Creative Thinking – Drawing Production and two of three Test of Creative Imagination - fluency and originality.

Joshi and Jawahar (2006) discussed the deep relationship of language and creativity and reported the importance of language in enhancing creativity in their study.

Thabor's (2004) study reported that urban secondary school students have significantly higher creative thinking ability than rural students and also found that non-tribal secondary school students have significantly higher creative thinking than the tribal students.

Chaudhary (2003) made an attempt to find out the relationship between creativity, level of aspiration and personality characteristics among high school students and found a significant difference between the components of creativity,
level of aspiration and personality characteristics of creative and non-creative students.

Singh and Singh (2003) investigated the impact of socioeconomic status upon divergent thinking abilities. The results indicated that differences in socioeconomic status produced differences in divergent thinking abilities. The study reported that higher the SES, better the level of divergent thinking abilities.

Mahaputra (2000) conducted a study on developing creative expression in elementary grades through enrichment programmes. It was found that the experimental treatment had a positive impact on the children. Girls were found to be better in developing composition writing as compared to boys.

Agarwal and Agarwal (1999) found a positive correlation between intelligence and creativity. It was also found that males had higher scores in creativity and intelligence as compared to females. But, Gupta and Sharma (1982) reported in their study that creativity whether verbal and non-verbal didn’t depend upon intelligence and socio-economic status.

Rodd (1999) reported that creative thinking can be encouraged in students through brainstorming and the productive thinking elements of fluency, flexibility, originality and elaboration. It was also suggested that fairy tales can be used to foster the thinking skills and suggests classroom activities.

Pandian and Rengarajan (1998) found a significant relationship between the autonomy in learning and creativity of students when inquiry training model was used.

Dahiya (1995), Hooda (1983) studied the effect of mastery learning strategy on creative abilities and revealed that the strategy was effective for enhancing verbal and nonverbal creativity of students.

Gulati (1995) conducted a study to analyse how instructional materials helped children’s creativity in classroom and its effectiveness in fostering creativity. It was found that the difference between mean scores of pre-test and post-test were consistently significant both in case of flexibility (verbal and non-verbal) and originality (verbal and non-verbal).
Nanda and Pal (1994) studied the effect of cognitive style and creativity on academic achievement and found that cognitive style and creativity were significantly related.

Padhi (1995), Pandey (1992), Srivastava and Srilatha (1992), Dhalla (1990) found a high positive correlation between creativity and academic achievement. The same result is found in Singh’s (1987) study in which he concluded that high creative students have been found to be high achievers. But, contrary to these results, Pathak (1961) demonstrated very low correlation whereas Flescher’s (1963) study showed no relationship between creativity and academic achievement.

Sharma (1994) conducted an experimental study by organizing activities like brainstorming, problem solving, quiz and project work in science teaching and showed significant gains with respect to verbal fluency, verbal flexibility, verbal originality and non-verbal creative thinking. Shan (1989) studied the effectiveness of four selected curricular activities such as brainstorming, problem-solving, quiz and project activity in terms of development of creative thinking of the high school students and the result of the study indicated that the teaching of science involving brainstorming was found to be most effective amongst the four curricular activities followed equally by problem solving and quiz. The project activity was fund to be least effective in the development of creative thinking.

Behra (1993) showed that girls did not differ significantly in all the variables of verbal creativity except the measures of originality from the boys.

O’Neil (1992) revealed that the cognitive function of creativity follows perceptual function and that increasing conscious awareness of perceptual functions yield increase in creativity.

Amin (1988) studied the effect of creative thinking programs on the creative levels of school children and found that the treatment has got a significant effect for creativity and its component measures.

The impact of creativity training emphasizing experimentation, ideal development, positive interaction and empathetic responses upon teacher empathy and interaction with students was examined by Mc Connell and Le Capitaine (1988). It was concluded that after training, teachers were more open to student ideas and
responses reinforced students allowed more experimentation, and listened to students more intently.

Patel (1988) employed brainstorming technique for school children and found that the students of the experimental group did better on a creativity test. Vora (1984) showed that the creativity of students increased as a result of treatment of divergent thinking program in mathematics.

Nandan Pawar (1986) in his study in which he experimented creative methods to improve Marathi language proficiency of high school students found that the experimental group scored higher than the control group in language proficiency, overall creativity and all the abilities involved in linguistic “creativity”.


3.4 Studies Concerning Analogies and Metaphors

The research on instructional analogies and metaphors is growing steadily in recent years. Researchers highlight the importance of analogies and metaphors as powerful instructional tools.

Podolefsky (2008) in his doctoral thesis brought to light on “Analogical Scaffolding”. He developed and validated Analogical scaffolding model in teaching Physics meaningfully through representation and analogy. The result showed that representational forms used to teach with analogies played a significant role in learning. He stressed on the effect of analogies on concept learning and also reported that students’ prior knowledge played a key role in learning by analogy.

Usage and understanding of English and Arabic metaphors was compared by Al Jumah (2007). The results revealed parallels and divergences in Arabic and English metaphorical usage and comprehension by Arab students. The study also suggested that metaphors played a significant role in both English and Arab.

Eryilmaz, Geban and Yilmaz (2006) investigated the effects of bridging analogies teaching strategy and gender on Turkish high school students’
misconceptions in mechanics. The results showed that bridging analogies teaching strategy was an effective means of reducing the number of misconceptions students held about normal forces, frictional forces, tension, gravity, inertia and Newton’s third law.

Paris and Glynn (2004) conducted a study on elaborate analogies in science text and found that elaborate analogies enhanced in learning Science, increased learner’s retention of new ideas and also helped learners to more accurately assess their comprehension of target concepts. It was also found that carefully crafted analogies helped the learners to make correct conceptual inferences without causing them to make misconceptions.

Milne (2002) investigated about reflective practice and instructional uses of analogies by secondary school chemistry teachers and reported that majority of teachers adopted more thoughtful, analytical perspective regarding instructional uses of analogies.

Glynn and Takahashi (1998) examined the role of elaborative analogies when middle school students learn major concepts from science texts. The study revealed that the analogy mapped a familiar, concrete schema onto that of the target concept, making the target concept more understandable and memorable. Dagher (1995) reviewed the studies that dealt with effectiveness of text-based or teacher–based analogies in learning science concepts. Lakoff (1993) developed an elaborate theory of metaphor. According to him, a familiar situation is used to ground understanding of an unfamiliar situation.

Pugh (1992) used metaphor for developing the creativity of students and found significant results. Dennis (1991) inferred that the use of metaphor enhances the creativity of the students. Flick (1991) reported the implications for enhancing teacher understanding of scientific inquiry and inquiry teaching at the elementary level.

Lorenz (1990) used analogy as an instructional strategy in introductory statistics but found no significant results. Regland (1990) examined the efficiency of analogue assessment and concluded that, analogue seems to be a powerful and sensitive measure for the functional assessment of self-injurious behaviour in severely disabled person.
Wong (1990) inferred that conceptual growth can be facilitated by generative analogy. Yacci (1990) investigated the relationship between analogical reasoning, previous pre-positional knowledge and their effect on analogical inference. The results indicated that analogical reasoning is positively related to analogical inference. It was also found that previous pre-positional knowledge is a positive predictor of analogical inference.

Sutala and Krajcik’s (1988) study found that students with high cognitive abilities benefitted more from creating their own analogies connections, whereas students with low abilities benefitted more from having the teacher help them make the analogical connection.

Brown (1987) conducted a study to compare the effects of a teaching method which uses a connected sequence of bridging analogy with a teaching by example method. Both methods encouraged students to become actively involved.

Science education research studies put emphasis on the role of analogies in teaching–learning process. The aforementioned studies emphasize that appropriate use of analogies helps to remove misconceptions, to build up the concepts accurately, systematically and meaningfully and also to enhance students’ interest in learning science. Hence, Science teachers should support students’ learning by using analogies effectively.

3.5 Synectics Model

The survey of research studies on synectics model of teaching reveals that there are not many studies in this area. The available studies on synectics model which highlight the effectiveness of model on achievement and also for enhancing the components of creative thinking are presented in this section.

Bincy (2010) and Meera (2008) showed that synectics model was effective for promoting creativity. Paltasingh (2008) inferred that there was significant difference between the effects synectics model and traditional method of teaching life science in development of creative thinking ability of students. The training in creativity by teaching through synectics model produced significantly higher achievement in science.

Pany (2008) conducted a study on the effectiveness of Making Familiar Strange (MFS) approach of synectics model of teaching on development of learners’
creative thinking ability, development of academic achievement and achievement motivation. The major finding of the study showed that the MFS approach of Synectics model of teaching was very effective in enhancing the creative thinking ability of the learners. But the MFS approach did not prove to be effective in achievement of the learners in science and also it did not put any significant impact upon the achievement motivation of learners.

Savitha kumari (2005) investigated on the instructional effect of synectics model in enhancing creative thinking and achievement in Hindi poetry at secondary level and it was found to be effective. In Prasanth’s (2004) study, synectics model was found to be an effective strategy for learning English poetry.

Talwar and Sheela (2004) investigated the effectiveness of Synectics model of teaching science on creativity and problem solving skills of secondary school students. The results showed that Synectics model was more effective in developing creativity and problem solving ability of students.

Jaya (2001) investigated the effectiveness of synectic model in enhancing creative thinking among students learning civics and found it effective. Ismail (1997) studied the effectiveness of synectics model of teaching english for developing creativity among secondary school students and reported that the model was effective for developing creative thinking of students.

Anandi and Irene (1996) undertook a study to prepare instructional materials based on Synectics model of teaching for developing creativity (cited in Talwar & Sheela, 2004). The instructional materials developed were found to be effective in increasing fluency and flexibility, but were not effective in increasing originality. Jackman and Swan (1994) identified that the instructional model, synectics, was effective for distance education using the interactive video network system.

Hartl (1992) compared three equivalent groups of students attempting to solve partial problems using three different problem-solving techniques. The results showed that Synectics acts as an effective strategy for enhancing problem-solving skills.

In Mack’s (1992) study, verbal fluency was found significantly higher than figural fluency. Phadake (1992) developed monographic material on Synectics for fulfilling the objectives of educating teacher educators. Watson (1992) used Synectics for language arts class and found its significant impact.
Kwanenski (1991) showed from his study that there was significant improvement in actual problem solving skills of students after the treatment.

Kumari (1990) attempted to study the instructional and nurturing effects of Synectics method of teaching on creative ability in language and reported that intelligent students were found most creative in the factors of language creativity, fluency, flexibility, originality and elaboration in Hindi and English and in the first three factors in general creativity. In both Hindi and English, students of high intelligence were found to score better and this model increased group cohesiveness significantly.

Malhotra (1990) showed that synectics method of teaching was effective on the development of language creativity in Hindi. It was also found that students who were exposed to the synectics method of teaching showed significant improvement on all factors as well as on their total scores of creativity.

Martis (1989) attempted to find out the effectiveness of the synectics model in developing ‘MSF’ (Making Strange Familiar) competencies and also its effectiveness in developing scientific and general creativity of graduate student teachers. It was also found that the training in MSF significantly improved general and scientific creativity of school students.

Warute (1990) studied the effect of synectics method and found this model was effective for the development of scientific creativity in high school students (cited in Talwar & Sheela, 2004). Weaver and Prince (1990) offered a better approach for solving problems creatively. Borkmen (1989) found significant improvement in students’ creative problem solving ability. Griffith (1989) and Fishbach and Sell (1986) used synectics as a structured problem solving technique for a teacher education program and found significant results.

Krishnamurthy (1989) took up a study to find out the effectiveness of the strategy, “making strange familiar” of synectics model, through teaching of physics in developing creative thinking ability. It was found that there was significant increase in fluency, flexibility and originality components of creativity. It was equally effective for boys and girls.

Cohen (1988) used Synectics in learning disabled students and found that it was an effective tool for developing a deeper understanding of literature.
Dodd (1988) made a detailed study of the learning behaviour of in-service teachers, learning to use two models, concept attainment model and synectics. Trained teachers used model in their classroom teaching and also trained other teachers. Observation was continued for 8 months, and the possible difference in trained teacher’s behaviour was observed.

Bailey (1987) reported that synectics as an instructional strategy contributes socio-emotional, cognitive and intellectual development. Martis and D’hima (1987) studied the effect of synectics method on pupils’ creative thinking and academic achievement in science and found it was effective.

Stark (1987) conducted a study on developing critical and creative thinking through the use of the synectics teaching model. The study reported that the model encouraged students to develop new ideas using their non-rational and emotional states of mind and was intended to increase creativity, empathy and problem solving capacity.

Venkataraman (1987, 1991) viewed synectics model as a useful technique for producing new ideas. Deethardt (1986) reported that synectics was used effectively for training teacher educators in speech communication. Mishra (1986) presented synectics learning material in Hindi.

Spring field (1986) showed that how upper elementary gifted students can be taught to use synectics in more effective problem solving. Dalton and Dodd (1986) studied about teachers’ thinking processes when they attempted to implement two models of teaching, concept attainment and synectics strategy, in their classroom. The research did not find any significant results in teachers’ performance.

Hofland (1985) reported that synectics model was useful to encourage right brain dominance in the generative steps of the designed process. Passi (1985) tried synectics at a three day workshop on college students and reported that it was effective (cited in Talwar & Sheela, 2004).

Ronald (1985) developed programmes for intermediate academically talented students with a view to providing techniques appropriate for differentiating content and the instructional procedure in the classroom. After testing, he suggests that the synectics approach is an appropriate technique for different contexts.
Hatcher’s (1983) brain research and their educational implications favoured Synectics for achieving hemisphere balance.

Huebner and others (1981) examined different creative problem solving strategy for gifted and talented students, from kindergarten to intermediate levels and found synectics as an effective strategy.

Synectics model was developed by Gordon (1961) and further explained the Gordon’s synectics model (1961) by Prince (1973, 1974, and 1975) and then redeveloped by Joyce and Weil (1972) and Weaver and Prince (1990). Examination of the research studies available indicated that synectics model has not been much investigated in India. Majority of studies emphasized the effectiveness of the model in enhancing creative thinking, achievement or in problem solving ability and considered it as a powerful instructional tool for developing creative problem solving. Research says that it can be used in all ages, in all disciplines and at all grades.

3.6 Development of New Strategies

Needs of learners go on changes due to the rapid advancement of science and technology. Therefore, scenario of the new millennium needs a change to realize future demands of the society. In this context, a wide range of instructional strategies and methods to suit different learning styles of learners are to be developed in the modern educational practice. It is clear from the analysis of related research works that very little work has been done in the area of development of new approaches. Hence, there is a need for designing and conducting research on new instructional patterns which would open up new vistas in education. Experiments conducted on development of new approaches are discussed below.

Jang (2010) evaluated a collaborative concept mapping with co-teaching techniques in elementary science classes. It was found that co-teaching facilitated the implementation of collaborative concept mapping and the construction of students’ concept mapping.

Sastangee, Saxena and Paul (2010) developed a teaching model based on wisdom approach for developing environmental values through the teaching of English. This model extends the original model of Joyce and Weil by the addition of the fifth element of evaluation and feedback in order to take the students beyond conventional thinking that is merely critical and not wise. The study indicated
substantial improvement in the awareness and competence of the trainees in value-based teaching of English. Tracey (2009) designed and validated an overlay instructional design model incorporating the theory of multiple intelligences into instructional systems design.

Sivakumar (2003) developed a strategy based on memory testing model of Harry Lorayne and Jessy Lucas (1974) to enhance memory at primary level. This newly developed strategy involves six steps in accordance with the various principles of memory with special reference to the principles advocated by Harry Lorayne and Jessy Lucas (Sivakumar & Krishnaraj, 2003, p. 162).

Rathod and Varma (2000) developed an integrated strategy using concept attainment model and inquiry training model and compared the integrated strategy with the conventional method. It was found that the integrated strategy improved inductive reasoning of students significantly as compared to conventional method.

Nelson and Pan (1995) conducted a study on integrating the concept attainment model and videodisk images. They investigated pre-service elementary teachers’ responses to a concept attainment task using videodisk pictures and line drawings. Findings indicated that students using videodisk pictures used inferences to construct patterns while students using line drawings in connection with pictures significantly made more observations and developed fewer ideas to make video patterns.

Gagnrade (1987) compared the achievement on science of class VIII and class VII students when taught using a combination of concept attainment model and lecture method and when taught through conventional method by taking separately intelligence, attitude towards science and previous year achievement in science as covariates. He found that the combination of concept attainment model and lecture method was significantly superior to the conventional method of teaching science to class VIII and class VII students when the groups were matched in respect of intelligence, attitude towards science and previous year achievement.

Baveja, Showers and Joyce (1985) conducted a study in which concept and inductive procedures were carried out in co-operative groups. This shows that the combination of social models with information processing models and the treatment
generated gains twice those of a comparison group that received intensive individual and group tutoring over the same material.

**Conclusion**

Successful instructional strategies help students to process new contents effectively. It will activate student motivation and set their expectations. Examination of related studies points out that proper blending of diverse instructional patterns should enhance the quality of learning. The responsibility of the teacher in the new millennium is to provide an appropriate learning environment for self-learning. Hence, teachers should master and use the diverse teaching approaches to suit various learning situations and whereby make the learners more powerful.