CHAPTER 2

REVIEW OF LITERATURE

This chapter is devoted to review the literature so as to look into the philosophical basis of the study. The studies done in the field of various creativity training programs have been reviewed along with studies on concept maps as assessment tool so as to frame hypotheses. The basic assumption behind collecting these studies was that creative thinking just like other types of thinking is a skill and can be improved by providing suitable environment. Therefore only those studies have been reported here that comply with the said assumptions. The sub sections of review of literature are as follows:

- Studies related to Concept Mapping
- Studies related to Concept Mapping at International Level
- Studies related to Concept Mapping in India
- Studies related to Concept Map as an assessment tool of Creativity
- Studies related to Creativity Training Program Abroad
- Studies related to CoRT Thinking Lessons
- Studies related to Creativity Training in India

2.1.0 Studies related to Concept Mapping

The principle of a concept map is that it provides a visual means of showing connections and relationships between hierarchies of ideas ranging from the very concrete to the abstract. The body of literature supporting concept mapping as a teaching and learning strategy is enormous, although many of the studies focus on the use of concept mapping as a tool to investigate student understanding rather than evaluating its usefulness in facilitating student learning. Studies in relation to concept map as an assessment tool are less but very much consistent in results. The studies are distributed in to two parts: international as well as national. These are as given below:

2.1.1 Studies related to concept mapping at International Level

The history of development of concept mapping as an instructional tool can be traced to the early work of Ausubel and others in the 1970s when Joseph D. Novak in his
article mentioned all about concept mapping technique, what are concept maps, concept, and significance of concept map in science education and how to prepare concept maps. He concluded that the process of meaningful learning, as understood through assimilation theory, is fundamental to both the psychological process of cognitive development of individuals and the epistemological process of new knowledge construction.

Cañas et. al. examined concepts, propositions and Rob Kremer (1998) focused on visual languages; in particular, on concept map-based visual languages. He concluded that concept maps are a general kind of visual language and are used for many purposes. Novak (1990) described the genesis and development of concept mapping as a useful tool for science education. He provided an overview of the current status of knowledge representation.

Hanna et. al. (1992) described the use of concept mapping in design, instruction and assessment, related to a microbiology program prepared for high school students in Israel. Roth (1992) studied how concept maps act as tool for meaningful learning in the elementary classroom. He found that working on concept maps encourages students to explain information that they "know" by gut feeling, but which they don't really understand. Shavelson et al (1993) found that concept mapping technique varied widely with no less than 128 possible variations identified. They also drew attention on the issue of importance of student’s familiarity with and skills of using concept maps, and the possible negative impact of teachers teaching to the assessment if students have to memorize concept maps provided by textbooks or themselves.

As a learning strategy, concept mapping is most effective if it is conducted on an ongoing basis over the course of instruction (Pankratius, 1990; Zeitz, 1992; Zeitz & Anderson-Inman, 1992). This allows pupils to modify their maps as learning occurs and conceptual understanding grows.

Moreira et. al. (1994) introduced concept mapping as an instructional strategy in 7th grade mathematics in a Brazilian public school. The study revealed that students from the experimental group were more able to build the equations of a mathematical problem and to find relevant data in problems. The computational ability of experimental and control groups seemed to be the same. Shavelson et. al. (1996) reviewed & characterized a concept map used as an assessment tool.
Aidman et al. (1998) found that the idea of using concept mapping demonstrated that the knowledge retained by students was “accurate and meaningful”. Kinchin (1998) focused his paper on the use of concept mapping as a tool for achieving constructivist learning methods in the classroom. Same way Ray McAleese et. al. (1998) used a theoretical framework for concept mapping as an instance of a learning environment Rice et. al. (1998) implemented a study in seventh-grade life science grade levels with the students’ regular teacher serving as teacher/investigator. In the study, a method of scoring concept maps was developed to assess knowledge and comprehension levels of science achievement. High correlations between the concept map scores and unit multiple choice tests provided strong evidence of the content validity of the map scores. Similarly, correlations between map scores and state criterion–referenced and national norm–referenced standardized tests were indicators of high concurrent validity. McClure et. al. (1999) evaluated the psychometric characteristics and practicality of concept mapping as a technique for classroom assessment. The maps prepared by the subjects were scored by using one of six different scoring methods. Stoddart et al (1999) chose to assess student learning using an open-ended concept map activity combined with a rubric which extracts quantitative information about the quality of understanding from each map.

Kinchin (2000), Kinchin & Hay (2000) discussed value of concept mapping in planning, teaching, revision and assessment, and the attitude of students and teachers towards its use. They described a qualitative approach to analyzing students’ concept maps. Michael (2000) suggested that a concept map taps into a substantially different dimension of learning than conventional classroom assessment techniques. Ruíz-Primo (2000) described concept maps as an assessment tool to measure one aspect of achievement, the organization of propositional (declarative) knowledge in a domain. Kinchin, Hay, and Adams (2000, 44) described Concept maps (used for integrating new knowledge in to previous one) as valuable because they ‘provide the opportunity for individuals to reveal their understanding of conceptual relationships and to adjust and readjust the map as understanding changes’.

Hughes & Hay (2001) concluded that concept mapping has proved to be a powerful tool in achieving the best out of a design team. Schau et al (2001) explored the validity of scores from select-and-fill-in (SAFI) concept map assessments as measures of students’
connected understanding of science. SAFI scores were strongly related to scores from a standardized multiple-choice (MC) achievement measure for middle school students. Results provide initial evidence of the validity of scores from SAFI maps as measures of connected understanding of science in middle school and undergraduate introductory science students.

Bilesanmi et. al. (2002) investigated the relative effectiveness of concept mapping and lecture methods on the academic achievement of Nigerian High School Studies in biology using gender and locus of control as intervening variables. They concluded that teachers should use the concept-mapping strategy in teaching both the male and female students because this method has been found to be effective in the teaching of students, irrespective of their gender and locus of control. Chang et. al. (2002) found that incorporating concept mapping helps to improve text comprehension in fifth grade students. Clarke & Ryder (2002) concluded that Concept Maps can clarify logical connections in complex physical ideas but most physics undergraduates represent knowledge in list form. Coffey et. al. (2002), Cynthia (2002) examined the use of concept maps to aid reading comprehension of science articles by 10th grade students (n=49) in a Florida high school biology classroom. By comparing scores on reading comprehension tests for two articles, one read without concept mapping and one read while organizing concept map key themes and ideas in the article, significant evidence for the effectiveness of concept mapping was found for one of two groups of participants. Jackson & Trochim (2002) argued that the concept mapping method offers a unique blending of the strengths of these approaches while minimizing some of their weaknesses. Concept mapping cuts analysis time down significantly. Klein et. al. (2002) examined the validity of knowledge mapping as an assessment tool in science. Result showed knowledge maps to be sensitive to difference in students’ competency level, with students scoring higher on hearing tasks rather than on vision tasks. They concluded that knowledge mapping is measuring something valuable and some deeper conceptual scientific understanding. Walker & King (2002) investigated alternative methods for assessing students’ conceptual knowledge, and integrating an array of diverse competencies into the curriculum. Hypolite (2003) determined how concept maps
inquiry-based, whole-plant instructional strategy would affect pre service elementary teachers’ understanding of plant science principles.

Leake et. al. (2004) explored factors affecting human judgments of concept importance in determining the topic of concept maps. Analysis of the results shows that subjects were significantly influenced by concept map topology, but little influenced by other aspects of concept map layout. Roy & Poindexter (2004) examined the relationship of structural knowledge as measured by network maps to three traditional learning outcomes: identification, terminology, and comprehension. Result indicated that the proposition specific treatment had the greatest effect on comprehension outcome. Yin et al. (2004) examined the equivalence of two construct-a-concept-map techniques: construct-a-map with created linking phrases (C) and construct-a-map with selected linking phrases (S). Based on the characteristics of the two techniques, if used as an assessment tool, the C mapping technique is suitable for formative assessment, and the S mapping technique is a better fit for large-scale assessments.

Kinchin & Hay (2005) examined how to stimulate interest in application of concept mapping strategies as an approach in the practical classroom. Ozdemir (2005) used concept map as an assessment tool. The study examined the relationship between the scores in concept maps with the scores obtained on multiple choice test items and the scores obtained on traditional written examination in teaching Mathematics. The study concluded that concept maps can be used as an assessment tool.

Rebich & Gautier (2005) evaluated the students’ learning in the Mock Environment Summit course through the use of concept mapping. They concluded that concept mapping provides useful information about gaps in knowledge.

Shavelson et. al. (2005) focused on an important but often neglected aspect of learning science - the conceptual structure of the domain. They concluded that Concept and cognitive maps are windows into a student's mind and provide visual representations of some aspects of a student's declarative knowledge structure (connected understanding) in a particular knowledge domain.

Vanides et al (2005) commented that open ended activities where students create their own phrases and map structure are preferable because they are more accurately reflect differences across students’ knowledge structures. They concluded that for insights into
students’ thinking about science, a carefully designed concept map activity can be a tremendous asset.

Bunting et. al. (2006) concluded that that concept mapping can be introduced into tertiary-level tutorial grade levels. Deyu (2006) suggested that students’ performance in concept linking can be used to help predict their performance in retention of information, which was acquired and reorganized through concept mapping. Nesbit et. al. (2006) made a comprehensive review of the research extracted from 55 studies involving 5,818 participants on school age and post-secondary students’ construction of concept maps, or use of already created concept maps, for learning purposes. They concluded that use of concept maps was associated with increased knowledge retention across several instructional conditions, settings, and methodological features.

Maria (2006) discussed the use of concept maps in early childhood education. She concluded that in preschool education, direct instruction and modeling of concept map creation are needed in order for children to see their purpose and eventually create their own concept maps. Stoyanov et. al. (2006) concluded that that the concept mapping instruction method is significantly better than the traditional concept mapping instruction in a problem solving situation. Vanhear (2006) described the merging of Vee Heuristics and Concept Mapping with an advanced learning system.

Asan (2007) determined the effects of incorporating concept mapping on the achievement of fifth grade students in science class. The results from study indicated that concept mapping has a noticeable impact on student achievement in science grade levels.

Frode (January 16, 2007) investigated methods for computerized tutoring support that is adapted to the individual student by using concept maps as a means for students to model their own knowledge.

Hay (2007) used concept mapping to reveal patterns of student learning (or non-learning) in the course of master’s level teaching for research methods. The work was done with a group of 12 postgraduate students. The results showed that deep, surface and non-learning are tangible measures of learning that can be observed directly as a consequence of concept mapping. Amundsena et al (2008) found that the concept mapping process provided an alternate means to rethink course content, encouraged a view of the course as an integrated whole, and frequently provided the occasion to make explicit the types of
thinking required in the course in higher education (computing science, business and management). Chang & Chang (2008) used an online concept mapping activity (CMA) featuring peer learning to enhance learning achievement in concept application. They concluded that CMA motivated students to adopt deep learning approaches and develop effective cognitive information processing ability for better concept application.

Chiou (2008) examined whether concept mapping can be used to help students to improve their learning achievement and interests. The participants were 124 students from two grade levels enrolled in an advanced accounting course at the School of Management of a university in Taiwan. They indicated that concept mapping can help them to understand, integrate and clarify accounting concepts and also enhance their interests in learning accounting. They also stressed that concept mapping could be usefully used in other curriculum areas.

Hay et al (2008) examined how concept mapping can be used to measure the quality of e-learning. It suggested that students’ prior knowledge is a key determinant of meaningful learning. Kinchin et al (2008) concluded that concept mapping can be used to explore personal understanding because it facilitates discrete statements of meaning. Hay et al. (2008) studied the role of concept mapping as a tool for enhancing teaching quality in higher education. They concluded that it is not that the university level teachers should abandon their tried and tested methods but the quality of what they do needs significantly enhanced by the use of concept mapping. Tastan et al. (2008) investigated the effect of concept maps, together with conceptual change in texts, given to eleventh grade students’ on the subject of molecules carrying genetic information. It was found that the conceptual change texts accompanied by concept mapping instructions produced a positive effect on students’ understanding of the concepts.

Alkhatani (2009) verified whether the CoRT Thinking Lessons can enhance creative ability and improve concept map complexity. Results of the analysis indicated that participants who received creativity training developed significantly more complex concept maps than those participants who received no such creativity training. Kinchin and Cabot (2009) presented concept mapping as a tool for enhancing clinical dental education. They concluded that this approach can be used to develop active teaching
strategies and engaged learning approaches that support the development of clinical expertise

Somers (2009) examined seven pre-service teachers’ perceptions of their science content knowledge, teaching practices, and reflective processes through the use of the metacognitive strategy of concept maps. Findings showed that concept map usage clarified students' understanding of the organization and relationships within content area and that the process of creating the concept maps increased participants' understanding of the selected content. Trochim (2009) called concept mapping a Creative Technology that is particularly useful for enhancing group or organizational creativity. He concluded that this integrated creativity technology might be used to help to define an organization, what it means to be creative and measure the effects of that creativity.

Weiping et al. (2009) identified the relationship between interdisciplinary concept mapping abilities and creativity. In addition, this study attempted to clarify whether students who perform differently in constructing an interdisciplinary concept map possessed differing capacities for creative thinking. The results indicated that the abilities of interdisciplinary concept mapping and scientific creativity had a strong positive correlation. They concluded that interdisciplinary concept mapping and scientific creative thinking shared similar mental capacities.

Hannoun (February 2010) investigated the effect of using concept maps as learning tools under the cooperative and individualistic mode of learning on students’ performance on biology tests that require higher order thinking skills. Ajaja (2011) noted that concept maps help in understanding ideas by showing the connections with other ideas. Continuing, Ajaja noted that since its introduction, the concept map has become a very useful tool in teaching and learning and particularly in science education research. Barouch, et. al. (2011) suggested that concept mapping is useful instructional tool applicable with learners across a range of proficiency levels, without contextual limitations. They concluded that concept mapping offers inherent metacognitive benefits and are the ideal for Limited English proficient students’ success in the classroom.

Edward (2011) found that once teachers understand how concepts can be used in curriculum design, they have no difficulty in identifying relevant applications in their own subject areas. Karakuyu (2011) in his study determined the thoughts of primary
science and technology teachers, primary class teachers, pre-service primary class teachers and pre-service primary science and technology teachers’ about concept maps. Research findings obtained show positive attitudes of teachers’ and pre service teachers’ towards the use of concept maps. Schwendimann (2011) investigated how different concept mapping forms can support students’ integration of evolution ideas using case studies of human evolution. Khajavi & Ketabi (2012) studied the effect of concept mapping strategy on reading comprehension and self-efficacy of intermediate EFL students in Iran. Motivated Strategies for Learning Questionnaire (MSLQ) was applied to measure students’ self-efficacy beliefs. The results revealed that students in the concept mapping group showed greater achievement in reading comprehension and self-efficacy than students in the traditional method strategy group. Adlaon (August 2012) determined the effectiveness of using concept maps in improving the science achievement of 10th -grade students and compared it with a traditional approach for a Biology unit. Concept mapping has a potential to be an effective instructional strategy. Smith (2012) used two tools namely concept mapping and vee diagram as a way to promote successful learning among college-level science students. Both of these metacognitive tools were given to students enrolled in a microbiology lecture-laboratory course. Ajaja (2013) compared the relative effectiveness of concept mapping, cooperative learning and learning cycle methods with the intention of identifying which one among them will be most appropriate for teaching biology. It was concluded that the adoption of either learning cycle or cooperative learning strategies will be appropriate for the teaching and learning of biology. O’Connell et. al. (2013) examined research on the use of concept maps to support and enhance learning. They located 28 studies altogether, 26 of which found that the use of concept maps was associated with higher student performance. They found that the use of concept maps with students with learning disabilities found positive effects associated with the use of concept maps.

In addition to the above studies, in science education, concept mapping has been widely recommended and used in a variety of ways. It has been used to help teachers and students to build an organized knowledge base in a given discipline (Pankratius, 1990). Findings from these studies indicate that the concept mapping is an effective tool for
aiding student comprehension and retention of science material. Students using concept maps scored higher on posttests than students receiving more traditional types of instruction. Furthermore, concept mapping has been used to assess what the learner knows and to reveal unique thought processes. Moreover, concept mapping has been used to promote positive self-concepts, positive attitudes toward science and increased responsibility for learning.

Also, the benefits of concept mapping tools across several content areas (social studies, mathematics, Spanish as a second language, vocabulary, reading, and writing), multiple grade levels (first through senior high school), and different student populations (regular education students and students with learning disabilities have been verified in the several experimental studies.

2.2.0 Studies related to Concept Mapping in India

Rao (2004) studied the use of concept maps as a strategy to enhance meaningful learning and to improve upon the process skills of students in science. The results of the study revealed that concept mapping as an instructional tool has had an effect on the achievement of students and their cognitive skills in science. The students also reflected a positive attitude towards concept mapping as an effective instructional tool.

Ahuja (2008) found in his study that concept mapping as a pedagogic technique helps to enrich learning in science, to assess understanding or diagnose misunderstanding, facilitate knowledge elicitation, helps in identifying valid and invalid links and ideas held by the learner. Ahuja (2009) studied the effectiveness of concept mapping as an instructional tool in problem-solving situations, in learning and retention of concepts among students as compared to the conventional method of instruction.

Kharatmal et. al. (2009) compared the Refined Concept Mapping tool with the other modes of representations by assigning the same task to a homogeneous sample and analyzed the node names and relation names. Kharatmal (2009) reviewed concept maps in science with an illustration of case study in Indian School context. The case study showed that there is an increased number of concepts and valid relations when students used concept mapping method for showing their understanding about cell biology. Kharatmal et. al. (2010) attempted to make the implicit meaning explicit by re-
representing the relation names. They suggested substituting the ambiguous relation names with well-defined relation names to concepts consistently while mapping a domain. They observed that this transformation method of RCM can be used in teaching-learning context.

Budharam et. al. (2011) developed concept mapping package for the teaching of Philosophy for B. Ed. Students and found that it has a positive impact on the students. The sample of the study consisted of 40 students studying in one B.Ed. College in Solapur district. The students of experimental group were taught with the Concept Mapping Package and the control group through the lecture method by investigator.

Sthapak (2011) found out the effect of concept mapping on the academic success of students. The study was conducted by survey method on 99 students of eighth grade with the objective to find the relationship between scholastic achievement and cross domain concept mapping ability for which the investigator used a self-made inventory. This showed that students who score more in academic achievement are found to have better ability in cross-domain concept mapping.

Dhaaka (2012) verified by the study conducted on IX grade Biology students of different schools of NOIDA that habit of precise thinking and interest in enquiry can be developed among the learners by Concept Mapping. She concluded that for learning of concepts in Biology of ninth class students Concept Mapping was more effective than conventional method of teaching.

Hiremath (2012) developed concept mapping for effective teaching in the selected units of civics for Std. VI students. Selected units were The Gram Panchayat; The Panchayat Samiti; and The Zila Parishad. This study indicated that concept maps can effectively promote learning of students and thus, can be added to the teaching strategies of civics teachers.

Sonwane (2012) concluded that we live in a world of concepts rather than a world of objects, events, and situations and there are many internal factors that influence concept learning. The goal of concept mapping is not to produce a “pretty” graphic but to enrich the meaning of a learner’s educational experience.

Dammani (2012) studied the effectiveness of Concept Mapping for improving Reasoning. She found Concept Mapping effective in developing reasoning when Intelligence was
taken as covariate. Moreover, reasoning was found to be independent of Intelligence which meant that Concept Mapping was effective for both high and low intelligent students.

Kumar et. al. (2012) during their study, basics of CM was introduced and a test was conducted. The participants were asked to create maps, representing their understanding the concepts taught during the session. The maps were scored and the results were analyzed and assessed the impact of using CM as KR tool in the educational settings. They concluded that the CMs can be utilized as a KR tool to teach, learn concepts and evaluate the understanding of the learners.

Ahuja (2013) found that there is imperative need to work out some constructivist approach to impart instructions in science keeping in view the dynamic nature of learner, subject and environment which must focus on meaningful learning also-Concept Mapping is such response in this regard which, being a two dimensional technique for hierarchical arrangement of concepts, sub concepts and their relationship(s), represents the cognitive structure of learner with respect to the concerned concept(s) in context.

Chacko et. al. found the effect of concept mapping on cognitive processes and the scholastic achievement of the seventh standard students. This study showed that there is a direct relation between the pedagogy used (concept mapping strategy) on cognitive processes and achievement of the students. The opinions of the students showed that they felt concept mapping helped their effort in understanding concepts and believed that concept mapping had a direct effect on their achievement, ability to reflect on science concepts and increased their interest in science. Thakur et. al. determined the effects of pictorial concept mapping on the achievement of VIII standard students in the topic of “sources of energy”. The study was conducted with 114 students at a secondary school in Mumbai. The students were tested with teacher constructed pre- and post-tests containing multiple, one word and descriptive questions. The descriptive questions were mainly based on understanding and application level. Test scores were analyzed for any statistically significant difference in the scores with respect to gender and their learning style. The results from the study indicated that concept mapping has a noticeable impact in student achievement in science education. Students showed a positive attitude towards using pictorial concept mapping in teaching.
The topic of concept mapping is all new in India; therefore, the studies are less but show encouraging effects and results in Indian context.

### 2.2.1 Studies related to Creativity Training Program abroad

Some programmes, namely, Myres- Torrance work book (1964, 1965a, 1965b, 1966a, 1966b and 1968), Parnes Program (Parnes, 1967b), Purdue Creative Thinking Programme (Feldhusen, et. al., 1971), Khatena’s Training Method (1970, 1971, 1973), Productive Thinking Programme (Covington et. Al., 1974) and many more have been developed and their effectiveness have been evaluated in different context all over the world.

The movement that promotes creativity training as an essential practice in schools started during the 1950’s. Torrance (1963) has argued that increasing the level of creative thinking is important and he also offered some reasons to reinforce the desire of both teachers and parents to give children a chance to learn and think creatively. Runco's argument suggests that whilst all people have creativity, some people have more than others. Just as some people can enhance their physical strength through exercise, he argues that creativity can also be increased through techniques and exercise presented in creativity programme. If this argument is valid creativity training can, as one would suspect, help individuals to perform more creatively.

The above argument by Runco is in line with other investigators' arguments that creativity is very much a feature of humanity. Perhaps it can be found to some degree in everyone and creative abilities are teachable and measurable in terms of fluency, flexibility, originality, and elaboration (e.g. Amabile, 1983, 1989; Blagg, 1991; Dacey, 1989; Getzels and Jackson, 1962; Guilford, 1967; Parnes, 1963; Sternberg, 1995, 1999, 2000; Torrance, 1962a, 1963, 1972; Torrance and Safer, 1989).

Torrance analyzed 103 experimental studies which used nine different programmes to enhance creative ability and the Torrance tests of creative thinking (TTCT) was used to measure the effectiveness of each programme.

De Bono, 1972 recommended for thinking skills training when he insisted that the specific instruction of thinking would be inside an isolated curriculum. A new method of
creative thinking was introduced by de Bono and was named CoRT Thinking Program to enhance creative thinking of students.

Meichenbaum (1975) investigated that a significant increase in originality and flexibility on tests of divergent thinking, an increase in preference for complexity, a significant increase in human movement responses to an inkblot test, and concomitant changes in self-concept occurred. The results indicated that subjects who received focusing training reported that they felt more creative by the time of the posttest.

Worsham and Austin 1983 found Think a program in which secondary students engaged in problem-solving activities in which they were encouraged to discuss the rationales leading to their conclusions, considered that the development of thinking skills and abilities depend on extent the individual is exposed to an array of unconventional experiences.

Bass, 1984 investigated the relative effects of CAI and conventional instruction in enhancing the critical thinking skills of seventh grade students. Of the four kinds of skills taught and tested, students performed better after CAI instruction in two and better after conventional instruction in the other two.

McKim (1986), through her research paper proposed three condition to foster thinking that is productive and creative; Challenge, good conceptualization and creative actions of all kinds are enhanced considerably by fantasy; reflection and mental playfulness, rules is minimal and the mind is allowed.

Sternberg and Bhana 1986 studied Instrumental Enrichment (IE) in which upper elementary and secondary students engaged in clusters of problem solving tasks and exercise that were designed to make students “active learners” and enhance their general learning ability. They found the program effective which was further supported by Baum, 1990. Sternberg and Bhana 1986, in their work cited programs like ODYSSEY, Philosophy for Children Problem Solving and Comprehension to be very effective. They found that Odyssey was used by upper elementary or secondary students, focusing on six aspects of cognitive functioning-the foundations of reasoning understanding language, verbal reasoning, problem solving decision making and inventive thinking and considered it effective. Philosophy for children according to them was designed to develop thinking and reasoning skills through classroom discussion of philosophical
topics, the program was organized around six novels in which children applied philosophical thinking to their daily lives. Baum, 1990, also found this program effective. Sternberg and Bhana 1986, studied problem solving and comprehensive and found that this program concentrated on four problem solving components decoding skills vocabulary, basic arithmetic operations, and precise thinking. They also found that SOI was based on Guilford’s structure-of-intellect theory and was organized around the development of 120 intellectual skills from foundation level to higher order and emphasizes reasoning as the key component of successful learning. Baum, 1990, also found SOI effective.

Sternberg and Bhana, 1986 as well as Baum, 1990 found that Sage was designed for gifted elementary students and extended the regular curriculum through incorporation thinking skills development activities, mini-study units, and independent study.

A study by Crump et al, 1988, found Talents Unlimited (TU) to be effective. TU was designed for elementary students and helped participants develop multiple thinking skills (Called “talents” in the program). Teachers received training to instruct their students in productive thinking, decision making, planning forecasting communication and knowledge base development. Baum, 1990 also found TU effective.

Similarly Pogrow, 1988, found HOTs (Higher Order Thinking Skills) to be effective for teaching how to think. He mentioned that HOTS was a computer laboratory program for chapter 1 and other elementary students that used readily available computer software in concert with specific teaching practices to enhance skills in metacognition, inferencing, and de-contextualization, i.e. taking something learned in one setting and applying it to another.

Crump et al 1988 presented results of an evaluation of the effectiveness of training nearly all teachers and administrators in an Alabama school district in the Talents Unlimited model for teaching higher-order thinking skills. The performance gains of middle and high school students on thinking skills assessments indicated that the program was successful.

Even Baum, 1990 supported the same. In his research Baum, 1990, found Institute for Creative Education (ICE) to be as effective as the other programs. Baum, 1990 also found Kids interest Discover Study (KIDS) KITS effective where elementary schools conducted
surveys of students’ interests and, based on results students were engaged in active, self-directed learning and higher-level thinking around selected topics. Baum 1990 identified ten thinking skills programs that were proven effective in increasing students’ cognitive performance. Programs were organized by whether they involved infusing thinking skills into the established curriculum or provided a separate thinking skills course. All programs included teacher training. Baum 1990, found comprehensive school Mathematics Programme (CSMP), an elementary level math curriculum that focuses on classification, elementary logic and number theory very effective. Through this program, he observed that children used computers, calculators and geometry models to pose problems, explore concepts, develop skills, and define new ideas. He also considered CORT (Cognitive Research Trust) effective. His research work found that this program was intended for use by students of any age/grade level, the program develops critical, creative, and constructive thinking skills over a three year period.

Cotton (1991) cited the following programs because they are widely known and used, are representative of the kinds of thinking skills programs in current use in schools, and have been studied by investigators. A lot of programs like CORT, HOTS, ICE, KIDS, SAGE, TU and THINK etc. were even found sufficiently effective.

Integrating the cognitive research trust (CORT) program for creative thinking into a project-based technology curriculum by Barak, Doppelt (1999) described the Creative Thinking in Technology (CTT) program in which creative thinking was presented as a synthesis between lateral thinking and vertical thinking, analyzed student projects in light of this definition of creativity, and explored the role technology can play in developing students’ higher thinking skills.

Similarly techniques and resources to stimulate creativity through a web site for several “generations” of gifted and talented learners were discussed by Montgomery et al (1999). Hickey et al (2000) presented a range of teaching strategies developed by teachers of literature who heard the call from students, employers, and academic administrators for more relevant learning experiences in an ever-changing world. Integrating critical theory and classroom experiences, the essays demonstrated how to foster learning, collaboration, cooperation and creative thinking. On the other hand Devereux (2002) stressed the importance of appropriate questioning in stimulating thinking.
Adey et al. 2002 studied Cognitive Acceleration though Science Education (CASE) This approach was based on the Piagetian notion progress intellectually through different stages as they experience cognitive conflict between events and their current understanding of the world.

Craft (2003) used four vignettes from group work with three to six years olds to show that problem solving engages creativity and that this quality is not monopolized by the arts. These vignettes showed children engaged in conversation with the author, contemplating the options open to them in relation to a task they have been given. In this way, the children were said to be engaging in creativity, in so far as it is defined as ‘possibility thinking’.

A more qualitative study was conducted by Veneille et al. 2003 which found that children in CASE lessons more frequently explained and demonstrated their ideas and made suggestions.

Jacobs (2004) conducted his research on the ‘writers’ workshop’ approach to literacy ion which children are given freedom over the subject for their writing. For the research the practitioners were asked certain questions. Interviews with 16 kindergarten children based on these questions, were conducted (and then transcribed) twice a month over a six-month period. The research study concluded with the remark that ‘using’ the setting of the writers’ workshop seemed to provide a meaningful and natural environment in which to nurture metacognitive thought in children’ (Jacobs 2004)

Mumford et. al. (2004) conducted quantitative meta-analysis of creativity training with a careful examination of external validity, internal validity, course content, and delivery method. The results of 70 studies confirmed prior research that creativity training is effective They concluded that there are potential benefits of creativity training programs for a variety of people, not only for gifted students. Ma’s (2006) meta-analysis of creativity training on 34 studies confirmed Torrance’s (1972a) initial investigation. Moreover, it showed older adults had more successful training effects than younger ones.

Karpova et. al. (2011) proposed study to understand how student creative thinking could be increased in a university classroom. The study demonstrated that by incorporating creativity exercises into existing courses, instructors can help students develop creative thinking —a critical aspect of one’s professional development.
More recently, Tsai (2014) investigated the effects of creativity training on adults. The results confirmed the findings of previous meta-analysis indicating that creativity training is effective on adults. The magnitude of this finding indicated creativity training is promising for increasing adults’ creative thinking.

All the above programs were found to be effective in developing thinking skills. It also emphasized that although many people once believed that we are born either with or without creative and critical thinking abilities, research has shown that these skills are teachable and learn-able. This led to a lot of research on the effectiveness of different thinking programs on the thinking skills. The research work done in the field of creativity training paved the way for the work on creative thinking so that concept map performance of secondary school students can be improved.

2.2.2 Studies related to CoRT Program

Several authors considered the CoRT as a program for teaching thinking strategies explicitly (Beyer, 1987; Hedley et. al. 1995; Starko, 1995). Starko (1995) considered the CoRT skills as tools for teaching. He focused on the first tool taught in the program called PMI (Plus, Minus, and Interesting). PMI is designed to overcome natural tendencies to continue thinking about a situation in the same direction as the original impression.

Chance (1986) in evaluating the CoRT program as a thinking program, suggested that it helps students stick closer to the topic under study, tolerate views different from theirs, generate creative ideas, and transfer the taught skills to daily life. Yet, Chance (1986) points out that these conclusions are based on opinions generated in informal research rather than empirical research. Beyer (1987) found that CoRT can be taught to all students in grades 10 through 12. CoRT seems very appropriate for use in this way because it’s in-service and materials costs are minimal. He concluded that these heuristics are not themselves cognitive operations as much as they are rules that should be followed in thinking processes. By doing so, these rules prove to be useful in creative thinking.

Pea (1987) has referred to the importance of the socio-cultural factor in the transfer of learning. He identifies that although De Bono’s CoRT program offers multiple examples, and they are all real- life situations such as planning for holidays or choosing a career, the
transfer of such thinking skills are unlikely to happen to school topics such as mathematics.
Cotton (1991) reviewed of 56 documents and found that Instruction in thinking skills promotes intellectual growth and fosters academic achievement gains. Many commercially available thinking skills instructional programs e.g. CoRT have been shown to bring about improvements in students' performance on intelligence and achievement tests.

A series of detailed investigations of the effects of CoRT in classroom practice have been completed by Edwards and Baldauf (1987) and Edwards (1991 and 1992). These studies have involved teaching the CoRT-1 program to groups of Grade 7 (approximately 12 years old) children. The CoRT-1 program is a set of ten lessons aimed at broadening student thinking through the teaching of seven specific thinking skills. Interviews with the children eleven weeks after the program revealed positive attitudes to the program and its effect on their thinking. The view was supported in general by feedback from parents.

Melchior and Edwards (1989) reported on the implementation of the CoRT-1 program in a junior high school in New York. Again anecdotal data for the success of the CoRT-1 implementation were strong. Over three years students spoke positively of the value of the CoRT-1 training, as did teachers and parents.

John Edwards (1992) reported on a series of studies investigating the direct teaching of thinking. He concluded that The CoRT (Cognitive Research Trust) program is designed to teach children a set of thinking tools, or executive thinking strategies, which they can use to overcome the limitations of their existing and relatively fixed thinking patterns.

King et. al. (1993) chose CoRT-1 thinking skill program as the instrument to mediate the impulsivity of decision making in the simulation context and found that CoRT-1 was successful up to some extent to reduce impulsivity in student decision making. Aegler (1993) determined whether a difference existed in reading comprehension test scores between the groups receiving traditional reading instructions and other with specific thinking skills. For teaching thinking skills de Bono’s CoRT Thinking Skill Program was used. The results revealed that all students experienced significant gains in reading
comprehension. Others have characterized the program simply as a popular and commercial one for teaching creativity (Cropley, 2001; Sternberg & Lubart, 1996). Ritchie and Edwards (1996) have tested the effect of CoRT program on elementary Aboriginal students in Australia. The results revealed that the implemented CoRT program enhanced the creative thinking of Aboriginal children in mainstream classrooms. They concluded that in order to maximize the application of the CoRT skills to discipline-treated learning (e.g., social studies), teachers could infuse the skills into discipline-specific learning contexts. Perkins and Prime (1996) believed that de Bono’s thinking tools can be used as an effective strategy for changing attitudes in which these tools can be used to develop and maintain mental flexibility. Schweizer (1998) tested the effectiveness of creativity training. A questionnaire was developed by the author to measure the impact of the creativity training. The questionnaire was designed to test whether the use and understanding of de Bono’s systematic tools of creative thinking can be improved by exposing students to de Bono's *Serious Creativity* text and CD. The results suggested that the creativity training was largely successful. Another study conducted by Barak (1999), studied the effect of infusing the CoRT program into teaching a technology course. The students demonstrated a deeper examination of solutions, recognized possibilities and limitations of the system and found programming solutions. Nagappan (2000) explored the implementation of thinking skills programs in schools of Malaysia. It was concluded that the teachers are better prepared in terms of their knowledge, pedagogical skills and attitude to teach languages as compared to higher order thinking skills. Wilson (2000) discussed in a paper about various thinking teaching program including CoRT and concluded that such thinking program should be infused with the curriculum to make students better thinker for future. Also, De Bono (2000) asserted that the aim of CoRT is to develop a skill in practical thinking rather than in “philosophical excursions”. He claimed that the direct application of the CoRT program will affect students’ self-concept positively, enhance their creativity, and improve scholastic aptitude scores and thinking skills.
One study which sought to apply the work of de Bono to five kindergarten grade levels in Malta (Dimech and Pace, 2003) is based on the idea that divergent and creative approaches to problem-solving can be more successful than linear reasoning. The children took part in age-appropriate exercises in creative problem-solving with confidence.

Sukor et. al. (2003) conducted a comprehensive research designed to measure the current level of critical thinking capabilities of Malaysian students through CoRT1 techniques that are capable of enhancing students’ capability in critical thinking via inquiry-based learning approach. The study explored the positive correlation with students’ thinking styles and gender as a result of exposure to the interactive multimedia courseware.

Mc Cory (2004) discovered the extent to which selected thinking tools could enhance children’s ability to think from a viewpoint other than their own and thus help improve their optional Year 4 reading and writing national test scores. The children developed a sense of ‘ownership’ of the thinking tools over the course of the study.

Fisher R. (2004) discussed main approaches to develop children’s thinking and how one might integrate a thinking skills approach in to classroom teaching. He concluded that the technique is widely used in management but little research has been published on its use in education. It encourages children to think creatively about any topic.

Assaad (2005) examined the effectiveness of transfer of CoRT 1- Breadth program skills to social studies, specifically history. It investigated the effect of explicitly teaching CoRT 1 skills on academic achievement in history. The study showed that the results of the experimental group revealed that essays assigned a high score were those in which students were able to generate enough historical information, to relate historical ideas, and to identify historical information relevant to the meaning of the skill.

Dobozy (2012) introduced a new form of generic template based on Edward de Bono’s attention-directing ideas and thinking skills, commonly known as the CoRT tools. She concluded that the development of the de Bono LAMS sequence series is an important milestone, signifying the current paradigmatic shift in higher education from a student consumer paradigm to a student-producer paradigm.
Marzidah et al. evaluated attitudes of teachers who have undergone Cognitive Research Trust thinking skills (CoRT) training towards CoRT programme. The attitudes towards CoRT thinking skills programme of teachers were favourable. Also Kessel concluded that students do indeed transfer these learned tools into other contexts with the help of CoRT thinking lessons. Hence, the findings are to an extent favorable to the CoRT program. They demonstrate transfer of the performances of students trained in CoRT. However, very few research studies have been conducted on the effectiveness of the program, which makes it an interesting subject for study. The classroom success of the CoRT thinking skills programme in increasing confidence and flexibility of student thinking, particularly in novel or unfamiliar situations, led to a desire to more closely identify the effects of the CoRT thinking skills programme on secondary school students’ concept map performance.

2.3.0 Studies related to creativity training in India

In India, the research in the field of creativity is very scanty and major emphasis has remained on construction of tests of creativity and correlation studies of creativity with self concept, personality, etc. There has been little research on the general problems of nurturing and promoting creative thinking, especially in classroom settings to find its effect on academic achievement or their day to day life. A mention of few studies is as follows: Researchers like Pillay (1978), Nair (1978), Vora (1984), Talegoankar (1984), Singh (1985), Nandanpawar, (1986), Patel (1987), and Amin (1988), tried creative thinking programmes and found them effective. Another group of researchers Pillay (1978), Miyan (1988), Yawalkar, (1985), Patel, (1988) and Jawaharlal (1990), applied brainstorming and morphological analysis as experimental treatment techniques for enhancing creativity and divergent thinking in secondary school students. Deshmukh (1979) find out experimentally, if appropriate manipulation of teaching-learning process could promote creativity. The procedure consisted of surveying of existing classroom instruction process for conditions to develop creative ability of pupils and conduct an experiment to investigate the efficiency of role playing and brainstorming techniques in the development of creativity.
Nirpharak (1980) developed a special training program and pre test- post test experiment was designed to study efficacy in developing creative appreciation. The experiment showed positive effect on experimental group on all aspects of creativity after receiving creativity training.

Researcher like Jarial, (1981), Bhaskar (1982) and Gakhar (1991) tested the utilities of a particular type of instruction materials with a group of Secondary School Students for forty to sixty days and found it to be effective.

Malhotra and Sucheta (1985) observed that brainstorming accompanied by making free use of imagination and active participation and providing criticism-less atmosphere has been reported to help in developing originality, flexibility and fluency amongst students. Malhotra and Sucheta (1990) hypothesized that if metaphorical abilities are developed among children, creativity thinking can be enhanced.

Gupta (1990) developed and validated a creativity training program and found it successful in developing various creative thinking abilities in students. The study re-affirmed the fact that creative thinking abilities of school children can be developed by deliberate methods of education and training.

Shan (1993) studied the effectiveness of certain curricular activities in the development of Creative Thinking of high school students and found these activities to be effective in comparison to the traditional methods of teaching.

In other study, Venkataraman, (1993) investigated the effect of synectics training on creativity and hemi-sphericity of higher secondary students of Tamilnadu.

But Mandal (1992) evolved an autonomous creativity cultivation programme for school students and found it not to be effective for creativity development. One such work by Bala (2000), studied the effect of instructional package upon lateral thinking and vertical thinking of the students. Findings of the study were positive in terms of effect of the instructional package on both lateral and vertical thinking of primary school children.

Sethi (2012) found the relationship of creativity with academic achievement in mathematics. In this study, it was found that high creative students scored higher mean scores as compared to low creative students. A sample of 700 students (both males and females) studying in different government and private schools were selected from
different districts of Punjab state. The study revealed that female students were more creative as compared to the male students. It was also found that students of private schools were higher on creativity scores as compared to the students of government schools.

Aggarwal (2012) found effectiveness of training module in provocative operation on lateral thinking of student-teachers. Findings of the study were positive in terms of developing lateral thinking.

More recently, Hooda (2013) found the effect of six thinking hats strategy on development of parallel thinking and general creativity in high school students. Strategy showed positive effect on parallel thinking of students and even on their intelligence.

2.3.1 Studies related to concept map as an assessment tool for creativity

Concept map is as powerful as some traditional measurement tools while it is more efficient and practical (Novak & Gowin, 1984). Research findings have also revealed that there is a high correlation between concept map and other testing measures. For example, Austin and Shore (1995) used concept maps to measure students’ understanding of physics concepts in multiple-step problem solving. In their study, 12 students aged from 17 to 21 in an elementary electricity course were asked to solve problems and draw concept maps after 12 weeks’ study. The results indicated that several quantitative indicators for assessing concept map have high correlations (0.71-0.82) with students’ performance in multiple-step problem solving. This suggested that students’ concept mapping performance is a good predictor of their performance in multiple-step problem solving.

Conclusion

From the moment Novak presented the concept mapping technique, it has been an interesting research topic for researchers from nearly every discipline (such as political science, business, medicine, nursing, biology, physics, mathematics, statistics, engineering, computing, psychology, art, and education). Even in 1991 the Journal of Research in Science Teaching devoted a special issue to concept mapping, and the Journal of Interactive Learning Research also reflected researchers' attention to this
technique as a research topic by publishing a special double issue on concept mapping in 1997. Unfortunately, to date, the field of creativity has received very little attention from concept map researchers. However, many researchers have confirmed that the concept mapping technique, whether on paper or computer, with small group or whole class situations, is beneficial in both learning and teaching. It is also useful to students irrespective of whether they have learning problems or not.

In addition, Findings emerging from the thinking skills research reviewed in this study suggested that providing instructions in thinking skills is must in rapidly changing technologically oriented world. The thinking skills whether creative or critical, are teachable and learnable. The reviews also ensured that the instruction in thinking skills promotes the intellectual growth and fastens academic achievement gains. Many commercially available research programs have been shown to bring about improvements in students performances. Further infused thinking skills instructions and separate curricula both were found to be equally effective in improving student’s performance. It was also found important to establish and maintain a positive, stimulating and encouraging classroom climate for thinking skills instruction, so that students feel free to experiment with new ideas and approaches.

From reviewing the literature, it is sufficient to say that creativity with concept mapping among secondary school students is an area sorely lacking in research. Therefore, filling a small space in the large gap that exists in knowledge of creativity among children is a major aim of the present study. More importantly, the researcher hopes that information gained from this study will benefit children through the understanding of their creative thinking. Thus, the purpose of the present study is to explore whether creativity training (the CoRT thinking lessons) can improve the concept map performance of secondary school students.

The findings of the studies reviewed above are yet conflicting as well as inconclusive. Therefore, the directional hypothesis could not be conceived from the review. In this perspective it was decided to have a null hypothesis while studying the effect of creativity training program on concept map performance of secondary school students for all the dependent variables.