CHAPTER 1
INTRODUCTION

1.1 INTRODUCTION

In the era of global environment where information and technology are changing and science is expounding new insights nearly every day, it is very difficult for the one to keep pace with the new knowledge. This era is marked by the evolution of Science and Technology and the positive and negative aspects associated with it. These influences are obvious and their application in society as well as in education is undeniable. In this prevailing era, as attention is focused on giving quality education to millions of children in the schools, a paradigm shift is found to be taking place in the basic process of education from ‘teaching to learn’ to ‘learning how to learn’ i.e. meta-learning. Now, we have not only realized the limits in traditional teaching that lead to rote learning but also started looking for better ways of ensuring meaningful learning through effective ways of teaching. It is now learnt that the knowledge is not to be seen as a thing to be acquired through transmission, but as an experience. This makes the learning to take place on individual basis. Learners create their own knowledge. They build new knowledge through active experience on the basis of their prior knowledge. This is the constructivist paradigm based on the assumption that learner construct knowledge in the social and cultural environment in which they are embedded through some meaningful interaction.

The National Curriculum Framework (NCF) 2005, prepared by the NCERT, has also proposed a shift from behaviouristic approach to constructivist approach, basically because of a paradigm shift in the theories of learning.

“In the constructivist perspective, learning is a process of the construction of knowledge. Learners actively construct their own knowledge by connecting new ideas to existing ideas on the basis of materials/activities presented to them (experience). For example, using a text or a set of pictures/visuals on a transport system coupled with discussions will allow young learners to be facilitated to construct the idea of a transport system. Initial construction (mental
representation) may be based on the idea of the road transport system, and a child from a remote rural setting may form the idea centered around the bullock cart. Learners construct mental representations (images) of external reality (transport system) through a given set of activities (experiences). The structuring and restructuring of ideas are essential features as the learners’ progress in learning.”(NCF, 2005, p 17)

Earlier, questions were used to test students’ achievement in different subject areas that were memory based. The meta-cognitive skills like reasoning, creative thinking, application of knowledge, interpretation, inference, etc. were neglected, and didn’t give any opportunity to the child to think and reason out on his own. In the words of NCF, 2005:

“We need to give our children some taste of understanding following which they would be able to learn and create their own versions of knowledge as they get to meet the world of bits, images and transactions of life”.

Traditional approach includes measurement of learners’ mastery of facts and testing of their knowledge and skills against “certain stated objectives” to describe their strength and weaknesses in a particular subject domain. The learners are judged against pre set criteria. Such tests does not provide true picture of students’ higher order thinking capabilities. (Norton and Wilbur, 1998) Therefore, it is a must to shift from rote memorization to meaningful learning because learners are expected to interpret the world in their own way based on their personal set of experiences that is the outcome of use of their higher order thinking potential.

The quality of the task also influences it’s learn ability and its value for the learner. Tasks that are too easy or too difficult, that are repetitive and mechanical, that are based on recalling the text, that do not permit self expression and questioning by the child and that solely depend upon the teacher for correction make the child a passive learner. By the passage of time the child looses the ability to express themselves or make meaning out of their experience. Instead, the tasks that are challenging and allow independent thinking, and multiple ways of being solved, encourage independence,
creativity and self discipline in learners. Thus, instead of a culture of quizzing, of answering quickly and always knowing the right answers, we need to allow learner to spend time on deeper and meaningful learning (NCF, 2005). Meaningful learning occurs when individuals “choose to relate new knowledge to relevant concepts and propositions they already know” (Novak & Gowin, 1984).

Various forms of tools of knowledge representations are applied to elicit students’ understanding, depicting conceptual changes, point alternative conceptions etc. Such tools aid in depicting students’ understanding. One such potential tool – concept map is used to capture this important aspect (Kharatmal, M., 2009).

Traditional close ended methods of assessment, such as multiple choice tests, do not adequately measure student’s learning in all spheres. These tests do not capture students’ ability to develop and carry out independent investigation nor do they measure the development of students’ conceptual understanding (Ruiz-Primo & Shavelson, 1996 a). Also, in the words of National Curriculum Framework, 2005:

“Education is concerned with preparing citizens for a meaningful and productive life, and evaluation should be a way of credible feedback on the extent to which we have been successful in imparting such an education. Seen from this prospective view, current process of evaluation, which measure and assess a limited range of mental faculties, are highly inadequate and do not provide a complete picture of an individual’s abilities or progress towards fulfilling the aims of education” (NCF, 2005).

Therefore, assessment tool should be such that it should be sensitive to the content that students are studying. Concept map as an assessment tool can be applied to classroom settings where the learning of many students needs to be assessed. Besides Novak, Ruiz Primo & Shavelson (1996 a, 1996 b) also proposed the use of concept maps and performance based assessment as alternative to the use of traditional tests.

With this background, the approach to pupil evaluation will also need to be changed in the present set up. In order to analyze and assess the changes those occur in
students’ cognitive structures as a result of instruction, a new method of learning i.e. CONCEPT MAPS is in trend these days in foreign countries. Concept maps are particularly useful as assessment tool because they can be used to *identify the misconceptions* held by the learners both prior to and after instruction (Roth, 1992). Concept maps constructed by students *can provide detailed information about their misconception* and *exact weakness*. For example, in a given context if students associate a different meaning to a concept from what a teacher want them to, then the teacher will know that the students do not differentiate the various attributes of the concept (Novak & Gowin, 1984). Moreover, concept mapping allows teachers to have "*a valuable insight into the mental models of students*" (Kinchin et al., 2000, p. 44). When concept map is used to *examine student’s integrated understanding of a topic*, it has advantages over traditional testing methods, such as multiple choice questions or fill-in-blank questions, which only examine students’ understanding of “isolated ideas” (Kinchin et al., 2000, p. 52) and thus suffer from measuring “isolated fragments” from its context (Kinchin, 2001, p. 1258). In addition, traditional testing methods may even incorrectly *judge students’ mastery of knowledge*. Novak and Gowin (1984) reported that a fourth grader was the best oral reader in the class. However, the concept map that was constructed by the student about how paper is made from trees indicated that the student only memorized the contents without much comprehension. Had traditional testing methods been used, the teacher would never know actual understanding of that student.

Till now, the studies have employed concept mapping as a learning tool in foreign countries as well as in India. But only a few of the studies in the foreign countries show that concept map have been employed as an assessment tool and none of the studies in India has employed concept maps as assessment tool. Since a concept map represents how an individual cognitively organizes information, there are no two concepts maps exactly the same. Additionally, as the individual’s knowledge and understanding develops over time, his/her concept map will also change over time. Above discussion paved the way for the investigator to utilize concept map in the present study as an assessment tool to assess creativity training changes of secondary school students along with scientific creativity test.
1.1.0 CONCEPT MAPS

Concept maps are two-dimensional graphical representations of one’s knowledge of a domain (Novak & Gowin, 1984). The idea of concept mapping (pioneered by Novak and Gowin at Cornell University) is based on constructivist epistemology as well as Ausubel’s assimilation theory of cognitive learning (Ausubel et al., 1978) with the basic assumption:

"The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly”.

The underlying basis of the theory is that meaningful (as opposed to rote) human learning occurs when new knowledge is consciously and purposively linked to an existing framework of prior knowledge. Furthermore, Ausubel et al mentioned that the mind organizes information in a hierarchical top-down fashion. Unlike meaningful learning, in rote (or memorized) learning, new concepts are added to the learner's framework in an arbitrary and verbatim way, producing a weak and unstable structure that quickly degenerates. The meaningful learning results in to conceptual change i.e. a change in the way individuals experience the world.

A concept is a regularity in objects e.g. "cow" or events e.g. "rain" designated by a label. Concept maps are visual representations of concepts and the meaningful relationships that exist among or between related concepts in the form of propositions. Thus, concept maps are a form of knowledge representation (Mintzes et al., 2001; Novak, 1990a, 1998; Plotnic, 1997). A concept map consists of:

- **Nodes**: to enclose concepts labels, so, each concept is enclosed in a box, circles, oval, or other shapes.

- **Linking lines**: to connect the nodes those are related. The links between the nodes can be one-way or two-way directional, but the linking line/s must have arrows on
either single or double-headed to point out the relationship expressed by the
linking word/s.

- **Linking word/s**: a word or phrase provides meaning to linkages by describing the
  relationship between two connected nodes.

- **Labelled lines**: a labelled line is a linking line with a linking word/s on it.

- **Propositions**: a proposition is a meaningful statement consisting of two or more
  nodes connected with labelled line/s.

- **Structure**: nodes and labelled lines must be organized in a hierarchal manner by
  placing the key/s concept and the broadest, general, most inclusive concepts at the
top of the concept map and more specific detailed concepts below, near the
bottom of the concept map. Thus more inclusive concepts subsume more specific
concepts and a concept map can be read from top to bottom.

- **Cross-links**: to show interrelationships among the nodes on different branches of
  the hierarchy.

- **Examples**: to clarify the meaning of a given concept. They are specific examples
  of events or objects and do not represent concepts. Therefore, unlike concepts,
  examples are not enclosed in a box, circles, oval, or other shapes

- The Concept Map may pertain to some situation or event that we are trying to
  understand through the organization of relevant knowledge, thus providing the
  context for the Concept Map. Thus, Concept Maps are often constructed with
  reference to some particular question we seek to answer, which is called a *focus
  question*.

  Concept maps have been used for over 25 years in research and classroom
  practice to reveal and assess the structure and complexity of knowledge held by
  students in the sciences and other disciplines (Novak and Gowin, 1984).
Occasionally, concept map has been misinterpreted with mind maps, knowledge maps, graphic/visual organizers, and semantic webs. However, Cañas et al., (2003) distinguished concept maps from other mapping systems by their theoretical basis in Ausubel’s Assimilation Learning theory and constructivist epistemology, their semi-hierarchical organization, the use of unconstrained and meaningful linking phrases, and the way concepts are defined. This can be well understood by observing the characteristics of concept maps.

1.1.1 CHARACTERISTIC OF CONCEPT MAPS

Concept maps have specific characteristics that distinguish them from other knowledge representation tools. Not every graph with text in its nodes is a concept map. Following are the key characteristics of concept maps:

**Propositional Structure**

Concept maps express explicitly the most relevant relationships between a set of concepts. This relationship is depicted by means of the linking phrases forming propositions. The same linking words are part of the proposition. When constructing a concept map, one needs to be careful that every two concepts together with their linking phrases form a unit of meaning, a claim, a short sentence. Thus a concept map consists of a graphical representation of a set of propositions about a topic. Propositions should not be confused with prepositions, which are a grammatical form such as "to", "by", "above", "of", etc. In a concept map, each concept consists of the minimum number of words needed to express the object or event, and linking words are also as concise as possible and usually include a verb. There is no predefined list of linking words.

**Hierarchical Structure**

Within any domain of knowledge, there is hierarchy of concepts, where the most general concepts are at the "top" of the hierarchy and the more specific, less general concepts are arranged hierarchically below. Concept maps tend to be represented in a graphically hierarchical fashion following this conceptual hierarchy. Because of this, concept maps tend to be read from the top, progressing down towards the bottom. Note
that this doesn't mean that a concept map needs to have a graphically hierarchical structure: a concept map about the water cycle could be cyclic, while there is a still conceptual hierarchy of precedence or cause and effect in the concept map. Neither does it mean that concept maps need to have only one "root" concept -- there can be more than one. However, it has been found that when learning to build concept maps, keeping the concept maps hierarchal with a single root makes it easier for the learner to grasp how concept maps are constructed.

**Focus Question**

A good way to delineate the context for a concept map is to define a Focus Question, that is a question that clearly specifies the problem or issue the concept map should help to resolve. Every concept map responds to a focus question, and a good focus question can lead to a much richer concept map. When learning to construct concept maps, learners tend to deviate from the focus question and build a concept map that may be (somewhat) related to the domain, but which does not answer the question. In a sense, the map built probably answers another focus question, and so the focus question of the map should be changed to reflect this. In the case of a school-learning environment, it may be important to have the learner go back and construct a concept map that responds the original focus question.

**Cross-Links**

Another important characteristic of concept maps is the inclusion of cross-links. These are relationships or links between concepts in different segments or domains of the concept map. Cross-links help one see how a concept in one domain of knowledge represented on the map is related to a concept in another domain shown on the map. In the creation of new knowledge, cross-links often represent creative leaps on the part of the knowledge producer. There are two features of concept maps that are important in the facilitation of creative thinking: the hierarchical structure that is represented in a good map and the ability to search for and characterize new cross-links.

**Theoretical Foundation**
Concept maps have a strong psychological and epistemological foundation, based on Ausubel's Assimilation Theory (Ausubel, 1968, 2000) and Novak's Theory of Learning, which explain that people learn new things by using their current knowledge and, to a greater or lesser degree, seeking ways to integrate new knowledge and related knowledge already known. When learning meaningfully, the integration of new concepts into our cognitive knowledge structure takes place through linking this new knowledge to concepts we already understand. Thus a concept map is a graphical representation of these relationships between concepts in our cognitive structure.

Above cited characteristics make concept maps somewhat unique from other traditional tests of assessment. But the question arises how to prepare these concept maps. What things one should keep in mind while preparing concept maps? What process one should follow to prepare a perfect concept map? The same has been dealt in detail in next section.

1.1.2 CONCEPT MAPPING PROCESS

Various investigators have provided a variety of steps in concept mapping process. These are summarized as below:

Novak (2000) who is the pioneer of concept maps has summarized the concept mapping procedure as:

(a) Select domain: start from familiar domain of knowledge and set up a context, such as “a segment of text, a laboratory activity, or a particular problem or question that one is trying to understand”;
(b) Identify the key concepts and rank them from the most general and inclusive to the more specific and least general;
(c) Construct a preliminary concept map;
(d) Establish links between concepts based on their relationship; and (e) revise the concept map.

In addition to the basic steps, Novak, Jonassen and Kinchin has provided some tips that can facilitate a concept mapping process:
(a) Use simple words or phrases rather than “sentences in the boxes” to represent concepts since “sentences in the boxes” indicates that there is a relationship statement in the box at the subordinate level (Novak, 2000);

(b) Try to identify if there is a relationship between each pair of concepts (Jonassen, 1996) but remain selective while constructing links (Novak, 2000);

(c) Be “precise and succinct” while describing relationships between concepts and avoid using linking phrase such as “is connected to”, “is related to”, or “involves” because they do not identify the nature of relationships between concepts (Jonassen, 1996; Novak, 2000);

(d) Avoid using chain maps (Kinchin et al., 2000); and (e) keep the meaning of links consistent across a map (Jonassen, 1996).

Besides the knowledge of concept mapping steps, investigators (Kinchin et al., 2000; Novak & Gowin, 1984) believe that an individual’s knowledge and understanding of a topic, which is influenced by his/her “experience, belief and biases” (Novak, 2000), and learners’ perspective may also influence the final maps that they build Jonassen (1996).

According to Trochim (2009) the steps of concept mapping process for enhancing creativity in an organization involves six steps that can take place in a single day or can be spread out over weeks or months depending on the situation (see Figure 1.1).
Fig 1.1 Six steps of the concept mapping process  
**Source: Trochim (2009) Mapping for Organizational Creativity.**

The process begins with the ‘Prepare Project step’ continue through generate ideas, structure ideas, compute maps, interpret maps and finally utilize maps for enhancing creativity in an organization.

Indian investigator Dhaaka (2012) has also specified the steps (phases) of concept mapping process. These are:

*Phase I: Presentation of Abstraction:* First, the students are presented with a definition or a generalization. Since a generalization arises from common characteristics of various concepts. Secondly, the students are asked to identify various concepts and sub-concepts. Thirdly, to enlist the concepts and lastly, they are asked to provide new and unique examples to judge their understanding of these concepts.

*Phases II: Propositional Phase:* The teacher guides the learners to arrange the concepts hierarchically in a deductive manner, with the broader concepts placed at the top followed by less inclusive concepts. These various concepts are linked by lines and these lines are supplemented by words/phrases which indicate meaningful relationship among various concepts. Thus the whole concept map is viewed as a network of concepts.

*Phase III: Application:* Then the students apply their knowledge by citing new examples and reflecting on the present examples

*Phase IV: Closure:* Closure is a point at which the students come to the formal conclusions of the lessons. At the closing stage, the students summarize major ideas involved in the process.

According to Ahuja (2013), the procedure of concept mapping begins with a domain of knowledge that is very familiar to the learner for constructing the map. Since concept map structures are dependent on the context in which they will be used, it is best to identify a segment of a text, a laboratory activity, or a particular domain or a question that one is trying to understand. This creates a context that will help to determine the hierarchical structure of the concept map. It is also helpful to select a limited domain of
knowledge for the concept maps. Once a domain has been selected; the next step is to identify the key concepts that apply to this domain. These concepts should be listed. From the listed concepts a rank order is established from the most general, inclusive concept to the most specific, least general concept. Although, this rank order may be only approximate, it helps to begin the process of map construction. After the hierarchical arrangement of concepts, cross links are sort/searched. These links between different domains are related to one another, hence the concepts. After this, the suitable word(s), phrases etc. should be placed between he linked concepts which serve as propositions. Finally, the map should be revised and thus a “final” map is prepared.

From the above discussion, it is very much clear that concept mapping process cannot be followed in single manner. One can start or choose the major concept out of the given list of concepts according to one’s own perception and then can proceed by choosing and linking the further concepts. From this view point, we can understand that concept maps are not only the way of assessing one’s knowledge but also the misconception held by him about a topic and many more. It means that that the concept mapping have a variety of applications. These are discussed in next section.

1.1.3 CONCEPT MAPPING AND ITS APPLICATIONS

On the basis of decades’ of research in concept mapping, Novak and Gowin (1984) found that concept mapping activities can not only enhance students’ cognitive performance and motor skills but also boost their motivation in learning. They claim that “achievement in nearly every area of human endeavor would probably be enhanced if the relevant concepts and how they function were understood and used to interpret events or objects”. Although these were originally developed in the United States, now-a-days are used worldwide and in many different areas of education as learning tools, evaluation tools, tools for textbook analysis, and tools for identifying students” alternative concepts (Chang, 2007). In view of Chiu (2008) concept mapping can be applied to all aspects of education, including as instructional tool, assessment tool, knowledge eliciting and capturing tool, and curriculum planning tool, and a meta-learning tool used to extend
students” capacity to learn independently. Various purposes for which concept maps can be used are as follows:

1. As Instructional Tool

Concept mapping engages students in active and meaningful learning processes. Following are the different ways in which concept maps as instructional tool is beneficial:

- **For coherence and reorganizing knowledge:** Concept mapping helps students reorganize knowledge and achieve comprehensive understanding of subject topics. Because learners have to understand the meaning of information, including concepts or ideas and relationships between them, and then reorganize their understanding to reflect the underlying knowledge structure. During the construction of concept maps, the student focuses on the relationships among concepts and how to combine and connect them. This renders the concept map an effective tool to analyze the coherence of concepts in the students” mind (Novak & Gowin 1984)

- **Making thinking openly expressed:** Generally, students acquire knowledge through a series of lectures over a period time. If not explicitly required, they do not think about relationships between concepts. To create a concept map, however, students have to think about relationships between concepts and ideas, understand the “underlying structure of the idea they are studying” (Jonassen, 1999) and express their understanding openly through a concept map.

- **Identifying misconceptions:** As an individual expresses his/her understanding about a concept map openly, it can serve to point out any conceptual misconceptions the person may have concerning the knowledge structure. This allows identifying the alternative educational approaches to address those misconceptions. (Kinchin, 1998).
• **Deep information processing:** During preparation of concept map, students need to identify and classify concepts, clarify relationships between them, and synthesize their understanding into a connected whole (Kinchin et al., 2000). This process requires them to elaborate and organize information in meaningful ways, which cannot be realized through simply memorizing facts without understanding their meaning and underlying associations. This leads to deep information processing that promotes information retention, retrieval, and application to new contexts (Ausubel & Robinson, 1969).

• **Exploring structural knowledge:** The concept map shows the overall framework of the concepts that is moving in the student’s mind. So, in complex topics where students display a fragmentary understanding and are unable to integrate all the components to form a meaningful overview, concept maps help in the development and representation of well-organized, domain specific knowledge. Thus, Concept mapping process is the process to explore structural knowledge

• **Facilitating reflection:** Kinchin, Hay, and Adams (2000) believe that concept mapping facilitate reflection by providing “explicit point of focus”. Mastering the construction of concept maps will help students acquire higher order thinking skills that help them achieve higher on problem solving questions (Jonassen, 1997).

2. **As Knowledge Eliciting and Capturing Tool**

Kharatmal M. (2009) suggested that concept maps can be used for capturing and eliciting individual’s knowledge because it reflects relationships among concepts that exist in an individual’s long-term memory.

3. **As Curriculum Planning Tool**

Concept maps can be used by the teachers to plan curriculum (Novak, 2000). With the help of concept maps, the teachers will be able to look in to important contents and will not be left untaught. In addition, the organization of concepts often suggests an “optimal sequencing of instructional material” and “make the instruction ‘conceptually transparent’ to students”.

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4. As Assessment Tool

Studies show that concept maps can externalize and reflect students’ understanding of subject matter contents. Thus, it can be used to assess students’ knowledge structure as well as its change as the result of learning. In addition, Concept maps not only measure the aspects of learning that conventional tests measure but also measure the other aspects of learning that are difficult to measure with conventional tests. The observable changes evident in student created concept maps represent the unseen changes that occur as the students assimilate and accommodate new information in to their existing cognitive structures (Vazalwar & Padhi, 2009).

To conclude, concept map covers all the “spectrum of educational applications” including as (a) instructional tool; (b) assessment tool; (c) curriculum planning tool; and (d) knowledge eliciting and capturing tool (Jonassen, 1996; Novak & Gowin, 1984). From the above points it can be observed that concept maps can be used as a way to access prior knowledge, determine misconceptions, provide a study guide and serve as an ongoing assessment tool. From the paragraphs written in the succeeding pages, this point will be very much clear that concept maps lead to meaningful learning and follow constructivist epistemology. And as a metacognitive tool, these can be a strong link in education for the students to connect with knowledge of subject matter and strengthen understandings of pedagogy through reflective practice.

1.2.0 CONCEPT MAP AND AUSUBEL’S MEANINGFUL LEARNING THEORY

Creating new knowledge is, on the part of the creator, a form of meaningful learning. It involves at times recognition of new regularities in events or objects; the invention of new concepts or extension of old concepts; recognition of new relationships (propositions) between concepts; and, in the most creative leaps, major restructuring of conceptual frameworks to see new higher order relationships. These processes can be viewed as part of the process of assimilative learning, involving addition (subsumption) of new concepts, progressive differentiation of existing concepts, super ordinate learning (on occasion), and significant new integrative reconciliations between concept frameworks.
Ausubel proposed the idea of meaningful learning in contrast with rote learning. He believes that meaningful learning occurs when students make sense of new information by relating and incorporating it to what they have already known and form various relationships between them, such as “derivative, elaborative, correlative, supportive, qualifying or representation relationships” (Ausubel, 1963).

According to Ausubel (Ausubel, 1963; Ausubel & Robinson, 1969), meaningful learning requires three conditions: (a) the learning material itself has logical meaning, that is, it is non-arbitrarily connected to a cognitive structure; (b) the learner should have an existing cognitive structure, which the relevant ideas can relate to; (c) the learner must have the intention to relate the new idea to his/her existing knowledge structure. Lack of any of the three conditions may cause rote learning (Ausubel & Robinson, 1969). However, rote learning and meaningful learning only differ in the degree that these conditions are met. When the meaningful learning conditions are less met, the degree of rote learning increases. Compared with rote learning, meaningful learning has the advantage of less learning effort, longer retention time, and greater applicable potential to new contexts. It also facilitates the formation of more integrated view about knowledge in students (Ausubel, 1963).

A learning tool that has the potential to activate students’ mental models regarding complex and abstract scientific concepts and consequently lead to deep learning is the Concept Map (Novak & Wandersee, 1991). Meaningful learning is the theoretical basis of concept mapping (Novak, 2000). A concept map is a tool that grew out of the cognitive learning work of Ausubel (1963) who described meaningful learning as the arrangement of non-arbitrary relations among concepts in the learner’s mind. The influence of students’ prior knowledge on subsequent meaningful learning is emphasized by Ausubel’s cognitive learning theory which states that learning takes place by the assimilation of new concepts and propositions into existing concepts and propositional frameworks held by the student. So, when a person consciously and explicitly links new knowledge to relevant concepts or propositions, he/she already is a meaningful learner. However, when new knowledge is arbitrarily incorporated into the knowledge structure held by the student, rote learning results (Novak, 2006).
The basic Novakian concept map illustrate a hierarchy of concepts where more specific and less inclusive concepts are linked together by valid and meaningful propositions and therefore are subsumed under the broader, more inclusive concepts. Links between concepts are shown by the hierarchical structure in which the lower concepts are subsumed beneath those of the higher levels, and the super ordinate concepts are more general than subsumed concepts. Two or more concepts linked together by words create a proposition. The propositions, along with arrows indicating the direction of the relationship help to develop the connections between linked concepts more precisely. For example, the figure 1.2 below shows a concept map that demonstrates the knowledge structure required for understanding the concept of ‘seasons’:

![Concept Map on ‘Seasons’](From the technical report represented by Novak (2006))

This can be elaborated by the fact that concept maps rely on four fundamental qualities for meaningful learning: hierarchical structure, progressive differentiation, integrative reconciliation and super-ordinate learning (Novak & Gowin, 1984). More precisely the fundamental qualities can be described as follows:
- **Subsumption**: In the course of meaningful learning, new information is linked with concepts in cognitive structure. Usually this linkage occurs when more specific, less inclusive concepts are linked to more general existing concepts in cognitive structure (Novak, 2010). New information often is relatable to and subsumable under more general, more inclusive concepts. Thus, it is the process of integration of the new information into the relevant existing knowledge (Novak and Gowin, 1984).

- **Progressive differentiation**: As meaningful learning proceeds, development and elaboration of subsuming concepts necessarily occurs (Novak, 2010). Meaningful learning is a continuous process wherein new concepts gain greater meaning as new relationships (propositional links) are acquired (Novak and Gowin, 1984). Thus, as meaningful learning progresses the meaning of a concept increases and become clearer.

- **Super-ordinate learning**: A more general new concept relates to the meaning of two or more related and less inclusive ideas (Novak and Gowin, 1984).

- **Integrative reconciliation**: Subsumption and progressive differentiation lead to more than quantitative addition of knowledge to conceptual framework. Each of the concepts in the relevant structure is modified in the meaning to some extent (Novak, 2010). The learner “recognizes new relationships (linkages) between related sets of concepts or propositions” (Novak and Gowin, 1984). Since the new relationships are formed between various previously isolated concepts or ideas, it is likely that the new learning breaks the isolation of concepts, displaces misconceptions, and opens explanation of similarities and differences between related concepts or ideas (Ausubel, 1968; Ausubel et al., 1978; Novak, 1977; 1990a; Novak and Gowin, 1984; Wandersee, 1990).

Novak and Gowin (1984) also based their concept map scoring technique on these three Ausubelian notions: progressive differentiation, integrative reconciliation and hierarchical cognitive structure. Novak and Gowin also thought that progressive differentiation and integrative reconciliation determine the hierarchical structure of
concept maps. During concept map creation, progressive differentiation and integrative reconciliation cause general, inclusive concepts to appear near the top of the map. Specific concepts are subsumed beneath inclusive concepts.

To conclude, a concept map will reflect an individual’s knowledge structure in a given topic, subject, domain or area under discussion. More importantly, concept mapping is a technique for visualizing concepts and propositions; it possibly will provide a schematic summary of learning that has occurred after a learning task has been completed (Novak and Gowin, 1984; Novak, 1998) and leads to meaningful learning. However, the relation between concept mapping and meaningful learning can be more deeply understood if both these terms are discussed along with Constructivist epistemology.

1.3.0 CONCEPT MAPPING, CONSTRUCTIVIST EPISTEMOLOGY AND MEANINGFUL LEARNING

Humans construct knowledge rather than discover it. After a long use of discovery approach for teaching and learning, it became apparent that there were limitations with the approach. The identified limitations and criticisms against discovery learning paved the way for a shift in research efforts from discovery learning to constructivism.

For the constructivist, knowledge is created rather than discovered. Even those who have been critical of the constructivist view have acknowledged its success in generating a significant body of empirical data. This approach has contributed to knowledge and understanding of difficulties in the learning of new things; enabling the development of some innovative teaching methods and creating a greater awareness of the central importance of the learner (Osborne, 1996). Constructivism emphasizes that education is a creative human endeavor which is historically and culturally conditioned and that its knowledge claims are not absolute.

The notion that learning is influenced by prior experiences and ideas led to the development of what has become the dominant view of learning in education today-
constructivism. Constructivist view of learning holds that people construct their own meanings from what they experience, rather than acquiring knowledge from other sources. The impact and development of this view led to the development of different strategies now employed in the teaching and learning of science. Specific examples among constructivist approaches include concept mapping, cooperative learning and learning cycle. In case of concept mapping, the theoretical framework is consistent with cognitive psychology and constructivist epistemology. The use of concept mapping is often linked to the 'constructivist' view of learning as a concept map makes a good starting point for constructivist teaching. It has been usefully summarized by Novak (1993) that from birth to senescence or death, individuals construct and reconstruct the meaning of events and objects they observe.

Meaningful learning occurs when individuals "choose to relate new knowledge to relevant concepts and propositions they already know" (Novak & Gowin, 1984). This is constructivist perspective of learning, where learning is an active process in which the learner is constantly creating and revising his or her internal representation of knowledge when new concepts are linked to familiar concepts existing in the learner’s cognitive structure and can be applied to all subject matter. (Duffy & Jonassen, 1992). Meaningful learning of super ordinate concepts also gives new meaning to relevant subordinate concepts and propositions, which facilitates integrative reconciliation of concepts.

Thus from the constructivist point of view it can be concluded that concept mapping technique mirrors the constructivist definition. Concept mapping helps the investigatios in designing the curriculum in such a way that enables them to set learning experiences for the learners i.e. developing their understanding or meaningful learning. To conclude, concept maps and meaningful learning are the two sides of same coin. Also, it is a well known fact that higher levels of meaningful learning lead to creativity and metacognitive abilities. Therefore, it becomes very much necessary to discuss concept mapping along with metacognition so that it will become easy for an individual to understand that concept mapping, in itself, is a metacognitive ability as well as a creative activity.
1.4.0 CONCEPT MAPPING AND METACOGNITION

Metacognition: Monitoring the thinking process; being aware of one's thinking and reflecting on what one knows; knowledge about one's own cognitive processes (Darling-Hammond & Bransford, 2005).

Metacognitive strategy: An activity or technique used to generate metacognitive reflection and strengthen metacognitive skills.

There is a great deal written on the subject of metacognition; there are also numerous definitions. Most agree that it has to do with knowledge about cognition, awareness, and control. Monitoring the thinking process, being aware of one's thinking, and reflecting on what one knows are all a part of what is understood as metacognition. Metacognition is “thinking about thinking”. Flavell (1976) defines metacognition as “one’s knowledge concerning one’s own cognitive process and products or anything related to them.” The definition classifies two aspects of metacognition: knowledge about cognition, and regulation of cognition. Knowledge about cognition concerns knowledge about one’s own cognitive resources, and regulation of cognition concerns self-regulatory mechanisms used by an active learner during ongoing attempts to solve problems. Metacognitive view holds that successful transfer occurs when the problem solver is able to recognize the requirements of the new problem; select previously learned specific and general skills that apply to the new problem, and monitor their application in solving the new problem. Metacognitive skills are usually conceptualized as an interrelated set of competencies for learning and thinking, and include many of the skills required for active learning, critical thinking, reflective judgment, problem solving, and decision-making.

Recent research identifies metacognition as an important factor affecting learning (Bransford et al., 2000; van Driel & de Jong, 2001; Zohar & Schwartz, 2005). The area of learning indicates the importance of the learner taking an active part in the learning process or developing an understanding of what is learned. Since understanding is an important aspect of meaningful learning, people must be able to assess their own understanding. Also, meaningful learning involves being able to think about how new knowledge fits into existing concepts, this process includes monitoring the learning
experiences and using feedback about one's progress. The key assumption underlying the idea of meaningful learning is that, if the new information is learned meaningfully, it can be better comprehended and better applied in a wide variety of new contexts or problems. In the terminology of Novak (1998), if learners learn meaningfully, the transferability of knowledge is high. For this very purpose, metacognitive strategies or tools can be taught and should be incorporated into the subject matter students are learning.

Concept maps were developed by Novak and the members of his research group at Cornell University in 1972, in an attempt to understand changes in young students’ knowledge of science (Novak & Musonda, 1991) and to monitor how students learn and model their own understanding from the material presented in class (Cliburn, 1990; Mason, 1992; Moreira, 1979; West, Farmer, & Wolff, 1991). This means that a concept map is a meta-learning tool. In the course of their research program on young students learning science, Novak and his research group recognized that concept maps help in showing the interrelatedness of the group of concepts held by the learner. Concept mapping also has been considered as a metacognitive strategy that allows learners to learn in a very highly meaningful fashion (Novak, 1991, 1993; Novak and Cañas, 2006a, 2006b; Novak and Gowin, 1984).

Concept maps provide a means for students to organize and represent knowledge. Concept mapping is claimed to engage a high degree of metacognitive involvement (Novak, 1990b; Jegede, Alaiyemola & Okebukola, 1990) because the learners are aware of and are active in their own knowledge construction. This knowledge becomes organized around the important concepts in order to develop meaningful patterns of information. Thus, Concept map, as a tool, helps the learners to organize their cognitive frameworks into more integrated patterns. Concept map has its theoretical strength in meaningful learning to empower learners with the ability to apply something learned in one situation to another. The practical strength of concept map lies in facilitating effectiveness as a metacognitive strategy for complex learning tasks and for summarization of information.
Concept maps help students learn about their knowledge structure and the process of knowledge construction. In this way concept maps also help the students learn how to learn (meta-learning). This strategy is also metacognitive in nature in the sense that it provides ongoing reflection on the process as well as the relationships among concepts. To summarize, Concept mapping is a metacognitive strategy intended to reinforce understandings of concepts and their relationships in a graphic, visual manner. It requires the learners to operate at all six levels; knowledge, comprehension, application, analysis, evaluation and creation (synthesis) of Bloom’s educational objectives of cognitive domain. All the six cognitive abilities or the levels of cognitive domain are also required in a creative act. This reflection leads to an idea that concept mapping is a creative activity. However, this reflection requires confirmation from the discussion of concept mapping as creative activity.

1.5.0 CREATIVITY AND CONCEPT MAPPING AS A CREATIVE ACTIVITY

Creativity is a phenomenon described variedly by the investigators. The investigators assume that cognitive abilities are central to creativity. However it is the pioneer work of Guilford and Torrance which has been followed by the investigators all over the world to define the term creativity and identify it among individuals from school children through adult to the aged. According to Torrance creative thinking takes place in the process of sensing difficulty, problems, gaps in the information, missing elements; making guesses of formulated hypothesis about their deficiencies; testing their guesses; revising and retesting them; finally in communicating the results.

Novak and Cañas highlighted in their study that, "there are two features of concept maps that are important in the facilitation of creative thinking: the hierarchical structure that is represented in a good map and the ability to search for and characterize new cross-links" (2006a, p, 2). Hierarchical structure of concept maps is determined by Progressive differentiation and integrative reconciliation. These two also determine the number and quality of links (new cross links) in a concept map. Progressive differentiation refers to the thinking that concepts are never fully learned and that propositional links are continually added to them as learning occurs. Integrative
reconciliation is a conscious reasoning process that facilitates the discovery of relationships between concepts. Newly discovered links may be unique to their author as integrative reconciliation is a creative process. Integrative reconciliation also has a reflective component that can increase the quality of understanding and identify relationships that are inappropriate. From this viewpoint, it can be established that whenever an individual observes his map again and again, he finds some new relations between the concepts that strengthen the hierarchical structure of his concept map. These new relations (cross-links) can be termed as creativity.

In the same way Novak and Gowin (1990) noted that the act of mapping is a creative activity when they say that the learner must exert effort to clarify meanings, by identifying important concepts, relationships, and structure within a specified domain of knowledge. Concept maps actively involve students in the learning process, allowing them to be in charge of their own learning. The skill involved in preparing a concept map enhances the efficiency of the student’s active learning process. Concept maps provide a unique graphical view of how students organize, connect, and synthesize information. The activity fosters reflection on one’s knowledge and understanding, providing a kind of feedback that helps students monitor their learning and, focus attention on their learning needs. Goldstein (2001) also supported Novak and Gowin’s argument and concluded that Concept Map helps to focus the “divergent process and provide structure to the inherently organic nature of the creative process”.

Jenssen (1998) is in line for his view that creating a concept map of a particular domain makes learning an active process rather than a passive one because it helps in the visualization of conceptual frameworks and stimulates prior knowledge by making it explicit and requiring the learner to pay attention to the relationship between concepts. Concept mapping as a nurturing tool facilitates the nurturing of creativity among the students in problem-solving situations that is, in generating the creative solutions of the problems (Ahuja, 2007). In his view, as a nurturing tool concept maps facilitates to inculcate creativity by enabling the students to use novel concepts for drawing a concept map, incorporate relevant propositions and link one example with more than one relevant concept. The last aspect measures the diversification of the thinking as the greater the
number of examples linked with more than one relevant concept greater is the divergent thinking employed by the student. This means creating a concept map calls for creativity when one organizes the structure of previously selected concepts and connect them by remarks to indicate the new type of relation between them.

In view of Ausubel, creativity is the individual's ability to build hierarchical conceptual structures and to make unique associations across concepts at the higher levels in his/her conceptual structures (Novak, 2010). From this view point, creativity is a very high level of meaningful learning which leads to success in finding new solutions to problems (Novak and Cañas, 2006b). In the same way concept mapping is a metacognitive strategy that helps learner to have higher level of meaningful learning. Thus, it can be said that concept mapping is a creative activity.

From the various studies on creativity, it is summarized that creativity might arise when an individual thinks in another direction other than the traditional one. This new thinking is not a discovery rather from individual’s past experiences which provide a basis for perception of a problem, looking for the new solutions, restructuring the coming new idea and adding to the previous experience. In the similar manner, while preparing a concept map, the learner firstly attends to the focus question i.e. perception of the problem to be solved. Then he searches for the concepts related to his prior knowledge. Actually at this stage, the learner is looking for the solution to the given problem. When learner comes across the new concepts to be linked, he recalls for his previous knowledge i.e. the previous experience. The learner gets new meaning for the older concepts (progressive differentiation) when he links new concepts to the previous one. So, at this stage he may add or delete some older links and may add some more links (cross-links) to the previous concepts (integrative reconciliation). This is restructuring of coming new idea and adding to the previous experience. Thus, in creating a concept map ,an individual draws his/her map upon his/her relevant prior knowledge and also structures concepts using his/her own perspective rather than someone else’s perception. Since the process of creating a concept map empowers the learner to take charge of his/her own learning, concept map might help individuals to develop more personal awareness of themselves as learners and their own knowledge. This awareness of how much control
the learner has over his/her own learning may increase the internal control and lead to
deeper levels of cognitive engagement which can result in a creative way of thinking and
behavior. Therefore, based on the evidence in the literature mentioned, it might be
reasonable to argue that concept map is related to creativity.

The above discussion leads to the conclusion that concept mapping is a creative
activity because of inclusion of higher order thinking skills like analysis and evaluation of
concepts and creation (synthesis) of new links, cross links and propositions. This lead the
investigator to confirm the same by administering scientific creativity test along with
concept map performance test and find out the significance of correlation between the
two. Moreover, it is a well known fact these days that creativity can be enhanced through
creativity training program. Therefore, this view paved the way for investigator to find
out that if creativity training is provided to the students, then concept map of every
individual student should change over time. And it will be visible through the complexity
of his /her concept map which is of prime importance for the investigator for her
research. There are various approaches by which creativity can be developed among the
students. These are discussed in succeeding paragraphs.

1.6.0 VARIOUS APPROACHES FOR DEVELOPING CREATIVITY

Psychologist and educationists have tried number of ways to develop creativity. An
analysis of research studies reveals that there may be three approaches to develop
creative thinking among school children in classroom situation (Gupta P.K. 2004). These
are:

(a) Providing creative climate.
(b) Using creative teaching methods.
(c) Training creativity directly.

The details of these as given by Gupta P.K. (2004) are as follows:

(a) Providing creative climate:

It has been shown (Parnes, 1967) that creativity can be developed by providing a
climate which is conducive to creativity. In such climate, children are given freedom to
express their ideas without any fear. Their unusual questions and imaginative ideas are respected by the teacher. Deshmukh (1977) has listed four types of activities namely: searching, organizing, originating and communication for creating conducive environment.

(b) Using creative teaching methods:

By creative teaching is meant teaching a concept, relation or skill through a technique that involves the student’s creative thinking abilities (Gorman, 1968). In such type of teaching, the teacher teaches the content matter in a way so as to encourage student’s original thinking to promote their creativity. They are encouraged to manipulate ideas and objects in different ways or to list the parts of an object and then to think different ways to change each part, and similar activities. Parnes (1967) has listed number of techniques to develop and strengthen the creative abilities of an individual but the main ones are as given below:

- **Attribute Listing**: Created in 1954 by Crawford. In this technique students are asked to enumerate and limit the characteristics of an object to the basic then the students begin to make a series of changes to each characteristic, without any restriction of their freedom.

- **Check-List**: Created in 1957 by Osborn. This technique depends on posing a group of questions including a wide range of information (e.g. new uses, change, adaptation, magnifying, minimizing, modification, re-arrangement, and relating). Each question requires a specific change in an object, thing, or idea.

- **Forced Relationship**: Created in 1961 by Gordon. The aim of this technique is to produce new thoughts by forming a relationship between two or more things or ideas, where no relationship in reality exists between them.

- **Brainstorming**: Created in 1963 by Osborn. This technique was constructed for use with groups of six to twelve students, but it may also be used with individuals. This technique aimed to generate a long list of possible creative problem solving solutions.
- **Synectics:** Created in 1961 by Gordon. This technique is a complex one which is founded on a principle with two parts: making the strange familiar; and the familiar strange. The first part includes an analytic process. The second part means perceiving a common object in a way in which it is not usually seen by using a variety of mechanisms based on analogy.

- **Open-ended Activities:** This teaching method is used to remove the fear of failing that “one” right answer. Open-ended activities which have no right or wrong answers provide for multiple possibilities and risk taking that lead to creativity (Hertzog, 1997, 1998).

Still, there are many more techniques that got attention in the recent years in foreign countries. Some of the methods like Analogy, Random stimulation, Trigger session and brain writing, Bionics have been most commonly used in Indian classrooms along with brainstorming technique and synectics.

(c) **Training Creativity Directly:**

Recently, attempts have been made to train pupils’ creativity directly. Here children are taught directly about how to think. In this approach, children are given instructions on the nature of creative process and creative thinking abilities. They are given practice and training in creative thinking skills. This technique involves use of work books, idea books, audio-visual materials e.g. Sound and Images by Cunningham and Torrance (1965) and packaged programmes.

In recent years, a large variety of packaged programmes are being used to train creative thinking in school children. These programmes contain exercises based on the assumption that creative thinking can be strengthening by such exercises. More importantly, in view of the fact that a greater advantage can be achieved by using all the above teaching methods and techniques, many creativity training programmes are commercially available (e.g. Talents Unlimited TP, the Purdue Creativity Program PCP, the Productive Thinking Program PTP, Future Problem Solving FPS, Creative Problem Solving CPS and the Cognitive Research Trust CoRT). These programmes include...
activities to teach cognitive skills that lead to creative thinking. Problem recognition, problem definition, generation of possible solutions, testing solutions, and selection of the best solution are some of the skills that creativity training programmes are designed to teach either in isolation or infused in the curriculum.

The foregoing discussion on various approaches for developing creativity among students leads to the conclusion that these three approaches can be employed to develop creative thinking in children. Most, if not all, the above teaching methods and techniques in first two approaches were developed and considered to be useful and practical tools in aiding creative abilities such as elaboration, fluency, flexibility, and originality. However, both of these methods stress upon creating a congenial environment. The base behind these methods is that an individual can enhance or improve upon their creative potential when provided with congenial environment. Both of these methods have their specific requirements for being applied in classroom and require special arrangements. But there is no requirement of room and special arrangements for developing creativity among students in the third approach i.e. training creativity directly.

Thus, the third approach i.e. *training creativity directly* seems to be right approach in the present circumstances as it can be employed without bothering to change the present curricular and administrative set up, without demanding modifications of classroom variables and without any material aid that demands financial burden on administration. In the present study CoRT Thinking Lessons have been employed for the creativity training purpose because all the factors in the above written paragraphs are found in CoRT Thinking Lessons. Moreover, there is no need to bother for creating or changing the present environmental conditions. There is no requirement of special class rooms, costly gadgets, and financial burden on the part of students, investigator and administrator. The detail of CoRT Thinking Lessons is given in succeeding paragraphs.

### 1.6.1 CoRT (COGNITIVE RESEARCH TRUST) THINKING LESSONS

CoRT is an acronym for Cognitive Research Trust that De Bono established at Cambridge, England. The CoRT program was first established in 1973 and then it was copied on a CD-Rom in 2000. It is an instructional program on thinking skills that is used
by several million school children in many different countries and cultures. There are six sections viz. CoRT I, II, III, IV, V, VI in the program. Each section is comprised of ten lessons. Therefore, there are sixty lessons in total. Taken together, all these lessons prepare a unit that covers a considerable range of themes relevant to thinking. An overall view of CoRT Thinking Lessons includes the following sections in general:

- CoRT 1, entitled Breadth, emphasizes thinking about a situation in many different ways that a person might ordinarily neglect.
- CoRT 2, entitled Organization, offers ten lessons designed to help the student direct attention effectively and systematically to a situation, without loss of focus.
- CoRT 3, Interaction, is concerned with matters of adequate evidence and argument (De Bono, 2000).
- CoRT 4, Creativity, offers a number of strategies for generating ideas one might otherwise not think of; it also devotes some attention to the editing and evaluation of ideas (De Bono, 1984).
- CoRT 5, Information and Feeling, is concerned with a variety of themes; some involve affective factors that impinge on thinking, while others rehearse themes taken up in the earlier units.
- CoRT 6, Action, presents a general framework for attacking problems. It can be used to knit the strategies introduced in the previous lessons together.

Directed thinking, is what the CoRT is all about. The central subject matter is supported by a series of techniques having specific tools in which one has to direct his thinking. With directed thinking there is less drift, thinking is more purposeful and the whole idea can be explored.

The differences between individuals thinking styles and considering thinking as skills which can be taught and improved were the basis on which de Bono designed the CoRT. In addition, the assumption of the CoRT is that poor thinking is caused by deficiency in perception.

The following are the features and benefits of the CoRT thinking:
- The CoRT lessons provide a framework where the emphasis is placed directly on thinking.

- Pupils are encouraged to think, and are given credit for their thinking.

- Pupils get opportunities to think in groups, in order to put their ideas across to interact with the ideas of others.

- CoRT offers a selection of specific and deliberate thinking skills.

- Pupils are encouraged to view thinking as a skill that can be learned and practiced, pupils can practice and see their improvement.

- The improvement is in confidence, focus, fluency, and application.

- Pupils feel in control of their thinking, rather than drifting in a sea of emotion and confusion

- CoRT is the learning of specific thinking tools that can be transferred to other situations.

- Moreover, Formal training is not a requirement to teach the CoRT thinking lesson.

De Bono, 2000 has described many thinking tools and techniques in these lessons to help the learners to practice thinking as a skill. A glance of the most important of them is:

1. AGO

AGO stands for Aims, Goals, Objectives. Since deliberate thinking is actually the manifestation of deliberate use of Will Power, it is important that the thinker should be well aware of the aims, goals and objectives. In other words, a sense of direction is required if one is to use his thinking effectively.

2. CAF
CAF stands Consider All Factors. It reminds us that all factors or parameters of a problem should be considered to analyze it. This thinking operation is essentially related to action, decision, planning, judgment and coming to a conclusion. By doing so, one can avoid the error of partialism in thinking.

3. PMI

PMI is the abbreviation for Plus, Minus, Interesting. When making decisions, this technique is very useful. First write down all the minus (i.e. negative) aspects. Lastly, write down the interesting ideas or suggestions or aspects of the same. Now it is easy to arrive at the best suitable solution of the issue or problem at hand. The PMI is a way of treating ideas, suggestions and proposals, bypassing the emotional reaction to an idea.

4. OPV

OPV means Other People’s Vies. In this technique the thinker thinks from the perspective of the different people involved in or affected by the decision or solution. For example, a change in syllabus mainly affects the students, teachers, management and parents either directly or indirectly. So, before implementing a new syllabus, we should think from the perspective of all these people. This is especially important when the decision is enacted upon and through other people.

5. APC

APC is the short form for Alternatives, Possibilities, and Choices. In this technique, the thinker generates as much alternatives, possibilities and choices for the solution of the problem. It is an attempt to focus attention directly on exploring all the alternatives or choices or possibilities-beyond the obvious ones. The best suitable one can then be selected by applying PMI or OPV. De Bono’s (1982) credits this method for brainstorming alternatives for explanations, hypotheses, perceptions problems, reviews, designs, decisions, course of action and forecasting. Objections to this process are time wastage and indecisions due to abundance of alternatives.

6. C&S
This is the process of looking ahead to see the consequences of some actions, plans, decision, rule, invention etc. it is a short form of consequences and sequel.

7. Alternatives and the Concept Fan

This method extracts the concept alternatives. Alternatives run onto The Concept Fan De Bono’s (1996) which is the process of moving from an idea to a concept then becoming the starting base for other ideas, producing a flow of alternative ideas.

8. The Stepping Stone

It is the most provocative technique (De Bono, 1996) and can lead to new ideas. De Bono 1982 gives following two phases:

- The intentional setting of provocation or stepping stone.
- The effective use of the provocation to create practical new solutions.

9. The Escape/Creative Pause

Here the main direction of thinking is identified and avoided. The most obvious answers or solution to a problem are blocked intentionally so as to make way for new ideas.

10. Challenge

It is human nature to think of better alternatives only when the situations are deemed inadequate thus limiting creativity and innovations (Mumford, Connelly & Gaddis 2003). This technique is based on the willingness to explore the reasoning why things are done and whether there are any alternatives.

One of peculiar feature of CoRT thinking lessons is that De Bono has provided a definition to the tool to be taught. Various examples have been provided so that the investigator was able to understand the complete definition of the thinking tool. The procedure for development of lesson with the help of tool has been outlined. Instructions are provided for making the students work in groups on practice problems after which the
class discussion on the ‘process’ and ‘principles’ of thinking tool employed takes place. After this the students are made to work individually on the thinking tool employed. Finally, homework projects are presented to the students to practice the tool at home.

De Bono observes that, in general, CoRT 1 should be taught first, and the other units need not to be used in any particular order. Each unit stands on its own and contributes something very different. Therefore, CoRT Thinking Lessons No. I, IV, VI except the whole package of six lessons have been employed in the present study to provide creativity training to the students of IX & X grade students and not to overburden students with unnecessary description of the tools which are not required in the study. Thus, the investigator hoped that the participants’ ability to integrate information related to a key concept will increase as a result of the creativity training and therefore they will produce more complex concept map.

1.7.0 Significance of the Study

In the present scenario when a glance is taken on the board results of any school, it is found that the achievement of students is getting low day by day. Teachers are teaching and students are learning, even, the students are taking tuitions by paying extra charges to the tutors; still the results are not up to the mark. It was also found out by the investigator herself during orientation program that the students cannot answer even to simple questions. What are the reasons for such poor academic achievements? This question has given investigator a thinking point.

Many new teaching methods and techniques are administered effectively in abroad for bringing meaningful learning to the students. Concept mapping technique is one out of them suitable in Indian context. Concept mapping technique of teaching seems less expensive, interesting and easy to use. Where other methods need much technical knowledge and gadgets, students can do it with the help of paper and pencil.

Most of the research in the field of concept mapping as learning, instructional and assessment tool has been done at international level. The work done so far is at elementary level or disadvantaged children. The ongoing study is significant as it aims to
investigate the effect of creativity training program using concept maps as assessment tool on secondary school students, not only to gather information about the quantitative changes but also for qualitative changes in their concept maps.

The study is being experimented and investigated through evaluation of the pupils’ tests scores, content analysis and interviews on the concept map performance test. Therefore, the investigator found that the information gained from this study will not only add some knowledge to the field but will also lead to further investigation.

1.7.1 Rationale of the study

Scientific advancements and technological advancements have led to knowledge explosion. Yet the schools and universities employ traditional teaching methods that provide only knowledge which is required by beginner but does not develop wisdom i.e. high order thinking skills. Thus, it is not an easy task for the students to keep pace with new knowledge. The students of today live in the world of tomorrow where the things are totally different. In such circumstances, the students require high order thinking skills i.e. problem recognition, finding new solutions so that they can become effective learners. Consequently, it becomes the duty of educators to realize the importance of teaching thinking skills to students. However, only a few studies have been taken-up in India to study the effectiveness of creativity training programme and that on development of creative thinking: Nirpharake (1980) developed and tried out a training programme in creative appreciation. Bhaskar (1988) found significant gain in development of creative score by teaching through specially designed instructional material developed by him.

In regard to creativity in education, today's teachers can nurture creativity by providing their students with an adequate knowledge through meaningful learning instead of rote learning. Knowledge and thinking skills are essential to nurture creativity and allow students to express their creative potential. Of even greater importance for the current study is that the literature is consistent in suggesting that all people are creative to some extent and that creativity can be taught by training programmes such as the CoRT thinking lessons which will be employed in this study to enhance creativity among secondary school students.
Furthermore, it is well known fact that concept map has been widely recommended and used in a variety of ways in science education in advanced countries such as UK, USA, or Japan. But it is still a new method and not adapted by science teachers in India. The reason could be the problems in developing Novak's style concept maps in India as caused by linguistic differences between multi-linguistic country like ours and English. This challenge paved the way of investigator to adapt and employ Novakian style concept map in Indian settings.

While a lot of research has been done in the field of development of creative thinking through specially designed teaching strategies and instructional programmes, there is a dearth of the researches in the field of development of creative thinking through creativity training programme and specifically assessed through concept map performance test. That is why; an attempt has been made to see the effect of creativity training programme on concept map performance of secondary school students.

To sum up, there is dearth of research in the area of creativity and concept mapping. The concept maps represent the meaningful learning by the students and the way the students organize the knowledge. And if creativity training is given to the students, the creative thinking will enhance and the concept map performance of students will improve. That is why an attempt has been made to see the effect of creativity training programme upon concept map performance of students.

1.8.2 Statement of the Problem

In the context of the above rationale, the problem can precisely be stated as follows:

“The Effect of Creativity Training Programme on Concept Map Performance of Secondary School Students”

1.8.3 Operational Definitions of the Key terms

Various terms used in the statement of the problem are defined operationally below:

a) Creativity Training Program:
This is a group of educational activities designed to increase fluency, flexibility, elaboration and originality. It also includes exercises to bring new, different and unexpected response to a situation. As a result, creative thinking of one is improved. CoRT Thinking Lessons are one such programme prepared by Edward de Bono (2000) that enhances the creativity of an individual. The same concept has been applied in the present study.

b) Concept:
Concept is an idea about something that is formed mentally by combining its characteristics; it is generally derived through specific instances and usually formed from a number of simpler elements. Concepts could be considered the building blocks of knowledge or the basic unit of knowledge (Schunk, 2004). The same concept has been applied in the present study.

c) Concept map:
Visual graphic organizer designed to display concepts and the connections between them. Typically, concepts are displayed in the nodes or shapes, while relationships between them are shown with links, often titled with verbs (Novak & Gowin, 1984). The same concept has been applied in the present study.

d) Concept Map Performance:
Concept map is a visual representation of the concepts in a meaningful way. A concept map reflects individuals knowledge structure on a given topic or area. Additionally, as individual’s knowledge and understanding develops over time, his/her concept map will also change. Concept maps are used as instructional tool, learning tool as well as assessment tool. In the present study concept maps has been employed as assessment tool.
e) **Secondary School Students:**

The age period between 10-14 yrs is when children enjoy thinking unusually most of all. They enjoy using their minds and having different ideas. Secondary school students are in such age limit. The same conception about the students has been applied in the present study.

1.7.4 **The Objectives of the Study:**

The overall aim of the current study is to explore the question about whether the creative ability of children can be enhanced by creativity training. The other goal of the study is to inform our understanding of the impact of creativity training on the complexity of concept maps among children. Specifically, the objectives have been delineated as under:

1. To provide orientation to the secondary school students about concept mapping and creativity training programme.

2. To develop and standardize the criterion concept maps for evaluating the creative thinking of secondary school students.

3. To develop lesson plans for creativity training approach and expositional teaching approach.

4. To find out the effect of creativity training programme on the proposition component of concept map secondary school students.

5. To find out the effect of creativity training programme on hierarchical component of concept map secondary school students.

6. To find out the effect of creativity training programme on cross-link component of concept map of secondary school students.

7. To find out the effect of creativity training programme on example component of concept map of secondary school students.
8. To study the effect of the creativity training programme on overall concept map performance of students.

9. To find out the effect of creativity training program on scientific creativity of secondary school students.

10. To find out relationship between scientific creativity and concept mapping.

11. To find out the depth of understanding of ‘concepts’ in secondary school students.

12. To find out the effect of creativity training program on structural changes and learning quality of secondary school students.

13. To find out the effect of creativity training program on use of expert terms in concept map performance test of secondary school students.

14. To find out the effect of creativity training program on conceptual richness and individuality of understanding of secondary school students.

1.7.5 Hypothesis of the Present Study

Although there are a lot of research evidences to show the effectiveness of training modules and self instructional programs and teaching strategy (Singh (1985), Gill (1990), Talegaonkar (1984), Patel (1987) etc. over the traditional methods even in field of creativity, divergent thinking, investigator could find no directional evidence of research in creative thinking with concept mapping technique. So in the absence of the same and in order to achieve the objectives of the study, null hypotheses has been framed as they are the only testable form of hypothesis, Following is the hypothesis framed:

“There is no significant effect of Creativity Training Programme on Concept Map Performance of Secondary School Students”

1.7.6 Delimitations of the study

The study has its delimitations with respect to title, sample selected, experimentation process and treatment applied. Apart from this, other delimitations of the study are:
• The study is delimited to only De Bono’s CoRT Thinking Lessons strategy to develop creativity among students. There could be some other effective methods also to develop creativity.

• As already mentioned the study has adopted only concept mapping technique as evaluation tool as given by Novak. The basic components of concept mapping are proposition, example, hierarchy and cross links.

• The experiment continued for nearly two months separately for each class.

• The sample was delimited to private schools located in an urban area.

• Various extraneous variables might have affected the results. The variables that the investigator could not think of, or the variables which were beyond the control of the investigator, have not been included in the study.

• The study is also delimited to student variable. The students of varying aptitude, with different culture, ideologies and background have not been taken care of. This variable has neither been controlled nor matched for different groups of student.