CHAPTER – I
INTRODUCTION

1.1.0 INTRODUCTION

Mathematics is the back bone of all subjects. So it is very important for mathematics teachers to teach their students with the most appropriate strategy which results in the students to have perfect knowledge of the subject. The teaching strategies with the other factors affect the achievement of the students. In this study, which is experimental in nature, concept mapping was used as teaching strategy in teaching of mathematics. The effect of concept mapping was checked that whether the concept formation in the students will effect mathematics achievement or not, whether the concept formation through concept mapping will increase the mathematical creativity or not, whether the concept formation through concept mapping will effect the mathematics achievement of students having mathematics anxiety or not. This study concluded with answer to many questions which prevails in the mind when we talk about effect of concept mapping in mathematics.

In this chapter the details related to theories of learning; concept; concept maps; mathematics; mathematics achievement; concept mapping and achievement; creativity; mathematical creativity; achievement and mathematical creativity; concept mapping and creativity; anxiety; mathematics anxiety; concept mapping, achievement and creativity as factor of mathematics anxiety; emergence of the problem; statement of the problem; objectives; hypothesis and delimitations of the study in separate captions have been given.

1.2.0 THEORIES OF LEARNING

Learning has played significant role in cultures around the world and has been the part of formal study particularly since the European Renaissance of the 14th – 17th centuries (Aspinwall, 1912).

Over past 125 years the studies of learning have been approached from a variety of angles, some of the most important learning theories are listed below:-
a) Behavioural learning theory: - This theory focuses on observable changes in outward behaviour. In this theory new behaviours are learned and reinforcement strengthens the responses. In classroom the instructions for behaviour learning theories is teacher centred.

b) Cognitive learning theory: - This theory focuses on the internal mental process that how they change and how they affect external change. In this theory knowledge is learned and reinforcement is feedback. In classroom the instructions for cognitive learning theories is student centred.

c) Social learning theory: - The social learning theory grew out of cognitivism. Learning takes place through observation and sensory experiences. In the classroom, the instruction for this theory is collaborative learning and group work.

d) Social constructivism learning theory: - This theory also grew out of cognitivism and was framed around meta-cognition. In this theory knowledge is actively constructed. In classroom the instructions for social constructivism learning theory is doing experimental activities and also by collaborative and co-operable learning.

e) Multiple Intelligence learning theory: - This theory grew out of constructivism and was framed around meta-cognition. This theory enables students to leverage their strengths and purposefully target their weaknesses. In classroom the instructions in multiple intelligence learning theory is student centred and delivery of instructions can be done via multiple mediums.

f) Brain based learning theory: - This theory also grew out of neuroscience and constructivism. The twelve governing principles of this theory are :- (1) Brain is a parallel processes. (2) Whole body learning. (3) A search for meaning. (4) Patterning. (5) Emotions are critical. (6) Processing of part and whole. (7) Focused attention. (8) Conscious and unconscious processes. (9) Several types of memory. (10) Embedded learning sticks. (11) Challenge and threat. (12) Every brain is unique. In classroom the instructions for brain based learning theory is group learning, opportunities for self expression and making personal connection to content.
g) Humanist learning theory: - In this theory learning is dependent upon meeting a hierarchy of needs i.e. physiological, psychological and intellectual. This theory consider learner as a whole person.

These various approaches to the studies of learning have emerged into theories of learning, theories of instruction, theories of instructional design, and methods of teaching

(Bower and Hilgard, 1981; Driscoll, 2000; Gredler, 2009; Mowrer and Klein, 2001; Olson and Hergenhahn, 2009; Reigeluth, 1999; and Saettler, 1990).

The above approaches and their resulting theories have made an important contribution toward an eminent understanding of what it means to learn and the procedure by which learning takes place. Each theory is based on different beliefs, but each theory has given a unique and valuable point of view. With respect to all these learning theories still there is need for additional work toward an improved design of learning which overcomes the gap between theory and practice (Christensen and Osguthorpe, 2004).

Thus to overcome the gap between theory and practice, only fifty percent of instructional framer use theories while framing instructional-strategies. But those who practices the multiple learning theories on methods and strategies frames good instructional strategy (Christensen & Osguthorpe, 2004). Thus the theory that supports the process of framing the instructional strategies is Subsumption theory (David P Ausubel-1962) which is discussed below:-

1.2.1 SUBSUMPTION THEORY (DAVID P. AUSUBEL – 1962)

Subsumption Theory was given by an American Psychologist David Paul Ausubel (1918 – 2008). David Paul Ausubel was influenced by the work of Piaget. In the Subsumption Theory, David Paul Ausubel suggests that our mind subsumes the information in hierarchical way. The new information is incorporated with the previous information which the person already have. Thus previous knowledge is given absolute importance in this theory. According to the Subsumption theory teachers are instructed to teach previous knowledge first rather than the new knowledge which help in the formation of subsume.
The Subsumption theory works on two major principles:

a) The most important concept of a subject be given first and then moderately differentiated in terms of its particulars and specificity.

b) The instructional strategies should attempt to consolidate new information with previously presented information through their resemblance and cross-linking of new and old concept.

The purposes of the Subsumption theory are given below:

a) Supports to present new concept, lesson or unit.

b) Supports to compile major concept in new lesson or unit.

c) Uses the student’s previous knowledge.

d) To show the comparison between previous attained concept and new concept.

e) Supports to structure the new information or concept.

f) Supports to teach complex concept that are similar to knowledge gained previously.

Ausubel designed four processes of Subsumption Theory:

a) Derivative subsumption

b) Correlative subsumption

c) Super ordinate learning

d) Combinational learning

These four processes of Subsumption Theory are explained one by one below:

a) Derivative subsumption: - In this new concept can be derived from the existing framework. Knowledge is linked to other concepts to create new conclusions. For example: - Suppose the student has acquired a basic concept of quadrilateral i.e. it has four sides, four angles and two diagonals. When he learns about the types of quadrilaterals that he has never learned before conforms to previous understanding of quadrilaterals. His new knowledge about types of quadrilateral is attached to his concepts quadrilateral without
substantially altering the concept in any way. So he learned about the types of quadrilateral through the process of derivative subsumption.

b) Correlative subsumption: - In this new knowledge or concept are extensions of what is already known. For example: - when a student knows about the new kind of quadrilateral i.e. trapezium and in trapezium when the student is given knowledge about isosceles trapezium; means student have learned new kind of isosceles trapezium through the process of correlative subsumption. Therefore this is more valuable learning as compared to derivative subsumption since it upgrade the higher level concepts.

c) Super ordinate learning: - In this students can give number of examples of the concepts but does not know the concept itself until it is taught. For example:- when the students are told to draw the different figures of quadrilateral they may draw square, rectangle trapezium or parallelogram but they may not know their properties until it is taught to them. This is called super ordinate learning.

d) Combinational learning: - All learning processes associates’ new information that “connects” to a hierarchy at a level that is either above or below previously gained knowledge. This learning describes about the new concept which is derived from another concept at the same level. For example: - When a student is taught that when all four sides of quadrilateral are equal it is called rhombus. Now this knowledge is related about that when any one angle of rhombus is 90° it is called square. Both of these figures i.e. rhombus and square are different but comes under same heading that both are parallelogram.

According to theory ‘Advance organizers’ provide concepts and principles to the students directly in an organized manner. ‘Advance Organizers’ basically means to arrange the information as the information is proceeded to the next complex level.

Advance organizers: - An advance organizer is the strategy used to relate previous knowledge to new concepts. This is the part of Ausubel’s subsumption theory that ‘with stand that meaningful learning and long lasting retention of material is a
function of the stability of existing concepts or ideas. Advance organizer can be classified into expository teaching strategy or comparative teaching strategy.

Expository teaching strategy is used while presenting new concept. This is used in the beginning of lesson. It produces many surrounding generalizations and the detailed concepts are discussed later. For example: - as teacher discusses the types of quadrilateral like trapezium, parallelogram, rhombus, square and rectangle and the detailed are discussed later.

Comparative teaching strategy is used when the new concept are developed to the learner. In this teaching strategy comparison of new concepts with the knowledge already known is done by explaining the similarities between two kinds and concluding about the concept that is to be learnt. For example: - the teacher shows the similarities and differentiates among different types of quadrilateral in detail.

Thus Ausubel’s subsumption theory exercises with individuals that how they gain large amount of meaningful learning from verbal or textual presentations in school environment. Therefore the learning is based upon the kinds of super ordinate and combinational processes that occur during the formation of knowledge or concept.

In 1978 Ausubel was formally referring to his theory as assimilation theory. In context with his theory, Ausubel distinguished between two types of learning, i.e. rote learning and meaningful learning (Ausubel et al, 1978)

Rote learning is learning but not high level learning and has implications for recall and transferability.

David Ausubel’s Assimilation Learning Theory concentrates on ‘Meaningful Learning’. during this method, new data is expounded to an existing acceptable side of the individual’s data framework. This part of his theory matches with the concepts of short and long run memory in an intellectual scientific discipline. His theory integrates the cognitive, affectional and body process. The table 1.2.1 outlines the differences between meaningful learning and rote learning:-
### Table 1.2.1 Differences between meaningful learning and rote learning

<table>
<thead>
<tr>
<th>Meaningful Learning</th>
<th>Rote learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-arbitrary, non-verbatim substantive incorporation of new knowledge</td>
<td>Arbitrary, verbatim incorporation of new knowledge</td>
</tr>
<tr>
<td>Deliberate effort to link new knowledge with other higher order concepts</td>
<td>No effort to link new knowledge with other higher order concepts</td>
</tr>
<tr>
<td>Learning related to experiences</td>
<td>Learning unrelated to experiences</td>
</tr>
<tr>
<td>Affective commitment to relate new knowledge to prior learning</td>
<td>No affective commitment to relate new knowledge to prior learning</td>
</tr>
<tr>
<td>Knowledge is retained much longer</td>
<td>Generally knowledge cannot be recalled after hours or days</td>
</tr>
<tr>
<td>Added capacity for subsequent learning of related materials</td>
<td>No added capacity, in fact may inhibit learning, for subsequent learning of related materials.</td>
</tr>
<tr>
<td>Can be applied in a variety of new problems or contexts (transferable)</td>
<td>Transferability to new problems or contexts is minimal</td>
</tr>
</tbody>
</table>

Adapted from Hassard J (2003) and Shunck D (2004)
http://www.csudh.edu/dearhabermas/advorgbk02.htm

### 1.3.0 CONCEPT

The word concept is originated from the Latin word *conceptum* which means ‘something conceived’. The literary meaning of word concept is an idea of something formed by mentally combining all its characteristics or particulars.

A concept is made of set of specific objects, symbols or events which share their common characteristics and can be reconstructed by a particular name or symbols (Tennyson and Park, 1980)

Concept is an opinion, an idea or a mental image. It is the combination of many components like attributes, examples, definitions, establishing relationship etc. A concept is assumed to be a set of specific objects, symbols or events which compares common characteristics and can be performed by a particular name or
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symbols (Tennyson and Park, 1980). The concept systemizes information and generalizes ideas. Thus, concepts and processes are inter-related and interdependent.

Hence concept is the basic unit of all type of learning. Human being from infancy to old age, learn new concepts and use old concepts in new situation of their daily life. Individual differs in their level of concepts formation based on their age, intelligence and experience, for example, a child of four years have different concept of plant than a biology teacher have. Thus the word concept is used to designate both mental constructs of individual and also identifiable public entities that comprise part of substance of various disciplines. In simple term we may define that a concept is an idea or understanding of what a thing is. We can also define a concept as ordered information about the properties of one or more things to be differentiated from and also related to other things or classes of things. Logically, a concept refers to phenomenon in a given field that is grouped together because of their common characteristics (Novak and Gowin, 1984).

1.3.1 ATTRIBUTES OF CONCEPTS

Bourne (1970) and Johnson (2010) has emphasized the attributes of a concept in learning process as:

a) Learnability: - There is great difference in learnability of concepts in the sense that some concepts are easily learned than others by individuals who share similar cultural experiences and language. For example the concepts, which have easily perceptible instances as cat, dog, cow and tree, are more readily learned than the concepts without perceptible instances as atom and eternity.

b) Usability: - Concept varies in their use in day-to-day life. Some concepts are used more than others hence forming principles and solving problems. For an instance, mathematical concepts of sales tax, VAT and GST are used more than the concepts of matrices and determinants.

c) Validity: - The concept is valid to the extent that experts agree on its meaning and definition. Some concepts, which have been well defined according to taxonomic systems with physics, chemistry and botany, have greater validity than so many concepts in the behaviour science which have not yet been well-defined and standardized.
d) Generality: - There are many concepts that are arranged in hierarchical order of taxonomy system. Within the same taxonomy the higher the concepts, the more general it is in terms of the number of subclasses or subordinate concepts it includes.

e) Structure: - Bourne defines that any public concept defined in terms of attributes has a structure, a relatedness of defining attributes.

The concept attainment level is based on the age, experience and intelligence, for example, if it is said “think of a ball”, the concept of “ball” will create many ideas in your mind with respect to age, experience and intelligence. A child will think that ball is a thing to play in the ground like playing football volleyball, basket ball, throw ball etc but with respect to age and experience ball can attain the concept of sphere with its different formulae like volume of sphere, surface area of sphere etc.

The word concept is used to designate both mental construct of individual and also identifiable public entities that comprise part of substance of various disciplines. For example a five year old child have different concept of box than a mathematics teacher have as cuboids or cube. Thus concept is defined as ordered information about the properties of one or more things to be differentiated from and also related to other things or classes of things.

1.4.0 CONCEPT MAPS

The concept maps are two-dimensional representations of concept and their interconnections which intend to explore the knowledge. (Jonassen et al.1993). A concept map is the method of presenting relationships between ideas and images. As a road map represents the locations of different places, and a circuit diagram of an electrical appliance represents its workings and eases the path, similar function is of concept map.

Concepts maps are sketched in boxes and circles which are linked with each other by labeled arrows in a downward-branching hierarchical manner. When a concept map is organized in a hierarchical structure, the most important and most comprehensive concepts should be in the beginning of the concept map, with progressively more specific arranged below them (Novak & Gowin, 1984).
"Concept maps are graphical tools for organizing and representing knowledge. They include concepts, usually enclosed in circles or boxes of some type, and relationships between concepts indicated by a connecting line linking two concepts. Words on the line referred to as linking words or linking phrases, specify the relationship between the two concepts. We define concept as a perceived regularity in events or objects, or records of events or objects, designated by a label.”(Novak & Canas, 2008)

A concept map is a graphical representation consists of nodes and labeled lines. The nodes correspond to important terms (standing for concepts). The lines denote a relation between a pair of nodes (concepts). Concept maps leads to develop logical thinking and reflective skills by revealing connections and so it enhances meaningful learning. Concept maps facilitate sense-making and meaningful learning on the part of individuals.

Concept maps were developed by Novak in 1972 in the research program at Cornell. In this research program he sought to follow and understand the changes in children’s knowledge of science (Novak and Musonda, 1991). During his study he interviewed with many children, and found it difficult to identify specific changes in the children’s understanding of concepts in science by examination of interview transcripts. This was based on the learning psychology of David Ausubel (Ausubel, 1963; Ausubel et al., 1978). The basic idea in Ausubel’s cognitive psychology is that learning takes place by the assimilation of new concepts and rectifying the existing one(concept) and self designed frameworks is held by the learner. This self designed structure as held by a learner is also referred to as the individual’s cognitive structure. Therefore in the need to find a better way to represent children’s conceptual understanding, the idea of concept map was aroused. Thus a new tool of concept maps was born not only for use in research but also for many other uses (Novak and Canas, 2006).

Thus concept map is a type of graphic organizer used to help students organize and represent knowledge of a subject. Concept maps start with a main idea (or concept) and then branch out to exhibit how that main idea can be broken down into specific topics. The figure 1.4.1 gives the brief idea of concept maps given by Joseph D Novak.
1.4.1 HISTORY OF CONCEPT MAPS

A concept map was first originated at Cornell University in 1972 by Novak. Afterwards Van Kirk, Stewart and Rowell in 1979 claimed in ‘The American Biology Teacher’ that they are the first originators of concept maps. But in their concept maps there were no links and no propositions. After some time, in the same journal Novak published two articles in which he gave the reference of Stewart, Van Kirk & Rowell (1979). He also gave examples of concept maps, but the links were still unnamed with linking phrases. However, Novak (1981) introduced the linking phrases and meaningful propositions in his concepts. Hence this form of Novakian concept maps has been spread globally. Thus in reality, Novak and Gowin (1984) were predominant in spreading the concept maps with linking arrows and linking phrases all over (Palmer 1998).

Mostly all articles published in research journals describes the use of concept mapping refer to Novak and Gowin (1984). They defined concept maps as follows:-

1) Concept maps are circled concepts with links connecting them in the form of arrows.
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2) The links are phrased in order to create meaningful statements are called as linking phrases.

3) The ideal concept map has branches or so called links.

4) Links from the top concepts interlinks with other concepts which are subtopics. It’s only when links are horizontal or is read upwards that arrows are used. This formatting style for concept maps is presented as his trademark (Novak, 1998).

Novak in 1998 has applied “Concept Map™” as a trademark of his style in concept mapping. However his research partners and students did not followed the rules made by him for concept mapping. Moreover Novak himself does not follow his own rules (Novak, 2002). Also Wandersee (2000) disapproved one of the figures in Novak’s book because the concept map which he made on rhizo botany fails to follow the Novakian Standard Concept Mapping Format.

Safayeni et al. (2005) conferred idea regarding cyclic concept maps that are stratified. This ends up in presentation of concept maps in any manner that ought to be justified. This is because according to modern science, the world is a system and everything in the world is connected. That is why a concept map can be interpreted as a provisional theory of a part of the world. Hierarchies or circles may sometimes be natural and reasonable, but sometimes a network can be an even better option than circles or Hierarchies.

Ausubel made a real attempt in to present instruction or the knowledge in the proper concept map form. This method would also be used to organize one's ideas on paper in a speedy and in simple manner. In Ausubel’s subsumption theory, he confirmed that “the utmost important factor that affects learning is what that previous knowledge that learner has” (Ausubel, 1968). A main process in subsumption theory is the relatedness of new material to ideas in the existing cognitive structures. Ausubel proposed the use of advance organizer as an important instructional mode. He laid more stress on advance organizers that these are different from generalizations and briefs. Organizers work as a “subsuming bridge” between new learning material and previous knowledge and ideas (Ausubel, 1963).

Professor Joseph D. Novak elaborated the Ausubel theories. Novak concluded that “Meaningful learning involves the assimilation of new concepts and proposition
into existing cognitive structures”, but Novak practiced Ausubel theories into concept map structure which are made up of central nodes (concepts) and links (linking phrases and comments).

1.4.2 DEFINITIONS OF CONCEPT MAPS

A concept map is a type of kind of image, i.e. a graphical representation of knowledge. More literally, concept mapping is artistry to visualize relationships between different concepts. Concepts are drawn as nodes as boxes or circles and their relationships are drawn with arrows between concerned concepts. These arrows are normally labelled to express the kind of relationship between them.

- Concept maps are the graphical representation of a person's (student's) knowledge of an area. (Alpert & Grueneberg, 2001).
- The setup of major concepts from a text into a visual setup. Lines are drawn between associated concepts, and relationships between the connected concepts are named by linking phrases. These maps reveal the structural style within the material and supply the large image.
- Thus concept mapping is the technique for visualizing the relationships between totally different ideas. A concept map could be a diagram showing the connections in between ideas. Ideas are connected with tagged arrows, during a downward-branching ranked framework. The relationships between ideas are expressed in linking phrases, e.g., "is similar to", "is congruent to", "is divided by," or "are equal".

1.4.3 ATTRIBUTES OF CONCEPT MAPS

One of the components of the concept is its attributes followed by rule. Attributes are the features of a stimulus that specifies that stimulus is a positive instance of the concept or not and rule is a statement that specifies which attributes must be present or absent for stimulus to qualify as a positive instance of the concept. In behavioral terms, when a concept is learned, two processes generalization and discrimination contrast how we respond to a stimulus.

In generalization we generalize a certain response like the name of the object and all object comes under it of the conceptual class based on their common attributes
and in discrimination we discriminate between stimuli which is the member of the conceptual class and those that don’t because they lack one or more of the defining attributes. For example we talk about the word “quadrilateral” and there are different types of quadrilateral like rectangle, square, parallelogram, rhombus etc. and further they are discriminated by their different attributes with different names.

The attributes of a concept maps given by Ian et al. 2010, in learning process depends upon structure, hierarchy, additions, deletions and links is given in the table 1.4.1

Table: 1.4.1. Attributes of concept in learning process (Ian et al. 2010)

<table>
<thead>
<tr>
<th></th>
<th>STRUCTURE</th>
<th></th>
<th>HIERARCHY</th>
<th></th>
<th>ADDITIONS</th>
<th></th>
<th>DELETIONS</th>
<th></th>
<th>LINKS</th>
<th></th>
<th>In general</th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>Spoke</td>
<td>Chain</td>
<td>Network</td>
<td></td>
<td>Single level</td>
<td>As many levels as concepts (but often these are unjustified)</td>
<td>Several justified levels</td>
<td></td>
<td>Links are often simple</td>
<td>Links are often compound (making sense only when the map is read as whole)</td>
<td>Links are often rich and complex showing deep understanding</td>
</tr>
<tr>
<td>2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>This type of structures indicates ‘learning readiness’</td>
</tr>
</tbody>
</table>

1.4.4 CHARACTERISTICS OF CONCEPT MAPS

Tools like concept maps can be used to encourage creative thinking of students by teacher. Concept maps are constructed basically on the learning theories of cognitive psychologists, particularly Ausubel's Assimilation theory. A concept map helps to represent ideas in such a way that they reflect an individual's cognitive
structure. Some of the characteristics of concept maps given by Novak and Canas (2006) are:

1. **Concept map is a 2-Dimensional node link:** A concept map is a 2-dimensional node-link representation that depicts the most important concepts and relationships.

2. **Concept map are represented in hierarchical manner:** Concepts are represented in a hierarchical manner with the most important, most broad concepts at the top of the map and the more particular, less broad concepts arranged beneath. The hierarchical structure for a particular area of knowledge also depends on the context in which that knowledge is being applied or considered. Consequently it is best to construct Concept Maps with reference to some specific question we look to answer, which we have called a focus question. The Concept Map may relate to some situation or event that we are trying to understand through the organization of relevant learning, thus providing the settings for the Concept Map.

3. **Inclusion of crosslink’s in concept maps:** There is inclusion of “cross links” in concept maps. These make definite connections between or among concepts in various regions within the Concept Map. Cross-links indicate how a concept in one area of knowledge represented on the map is related to a concept in another area shown on the map. In the formation of new knowledge, cross-links frequently represent creative steps on the part of the knowledge producer.

4. **Inclusion of specific examples in concept maps:** The last part of the structure of Concept Maps is the including specific examples of events or objects. These can help to explain the meaning of a given concept. Normally these are not represented in ovals or boxes, since they are specific events or objects and do not represent concepts.

5. **Concept maps promote creative thinking:** Concept maps promote creative thinking. For this there are two features of concept maps that are important in the facilitation of creative thinking:
   a) the way in which hierarchical structure of the map is represented
   b) Searching for new cross links between the maps.


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From the above discussion it is concluded that:-

a) Concepts are sketched in a hierarchical manner with the most important and general concepts at the top and the more precise, less general concepts at below of the concept map. The hierarchical structure for a particular sphere of knowledge also depends on the situation in which that knowledge is being applied or considered. Therefore, it is best to construct the concept maps with reference to some particular question we need to answer. The concept map may relate to some situation or event that we are trying to understand through the organization of relevant knowledge, thus providing the frame for the Concept Map.

b) There is infusion of “cross-link” in concept maps. These cress-links directs the relationships between or among concepts in different regions within the concept map. Cross-links show how a concept in one area of knowledge represented on the map is related to a concept in another area. In the formation of new knowledge, cross-links often represent creative leaps on the part of the knowledge producer.

c) A final view of the structure of Concept Maps is introducing specific examples of events. These can help to understand the meaning of a given concept. These examples are not included in ovals and boxes, since they are specific events and do not represent concepts.

1.4.5 ELEMENTS OF AN IMPROVED CONCEPT MAPS.

Some of the common and different points which are given by Ahlberg (2001) between improved concept maps and traditional Novakian concept maps are given below:-

a) In Novakian concept maps the main elements of thinking and learning are sometimes inside the frames like circles or square boxes and sometime not but in improve concept maps all concepts are always presented inside frames.

b) In Novakian concept maps mainly very short verbal labels were used for concepts and sometimes for presenting clear meaning of concepts many words were also used in labelling the concepts which was against its own fixtures
and in an improved concept map there is no limit for words in labelling the concept map accurately.

c) In Improved concept maps pictures, videos, sounds, can be connected to concept maps but in Novakian concept maps it cannot be done like this.

d) In Novakian concept maps stress is laid only on Ausubel’s learning theory but in improved concept maps Ahlberg concluded that concept maps can be used for any type of learning theory and everything that is spoken or to be written can be converted into concept maps and all good concept maps can be converted into simple reading or writing.

1.4.6 PSYCHOLOGICAL FOUNDATIONS OF CONCEPT MAPS

In life span the origin of first concept map by children is from the time of birth to three years, when they identify the uniformities in the world and around them. The concepts begin to identify language labels or symbols for these uniformities (Macnamara, 1982). In the early stage, learning of concepts is primarily inventing the learning process, where each individual learns and differentiate the patterns or uniformities in the objects and recognizes that the same uniformities which are labelled by older persons with words or symbols. This is a remarkable skill that is part of the developmental culture of all normal human beings. Once the age of three years is attained then new concepts and supportable learning is fixed by language and new meanings are obtained by asking many different questions and getting description of relationships between old concepts and propositions and new concepts and propositions. So this time period is very important for all infants because this is only the period when there is strong attainment of concepts.

In addition to this, there is distinction between the discoveries of learning process, where the attributes of concepts are determined independently by the learner, and there is reception of the learning process. The aspects of concepts are defined using their language and transferred to the learner. With respect to this part Ausubel gave some differences between meaningful learning and rote learning, which are already discussed earlier.
1.4.7 EPISTEMOLOGICAL FOUNDATIONS OF CONCEPT MAPS

As indicated before, concept map was defined as patterns which were designated by labels. It is generalised that meaningful learning process which was described above is the same process which is used by researchers and mathematicians, or specialists in any order, to develop new information. Novak has contended that new information creation is just a generally abnormal state of important learning achieved by people who have sorted out learning structure in the specific region of learning, furthermore a strong enthusiastic responsibility to persist in finding new implications (Novak, 1977, 1993, 1998). Epistemology is that branch of philosophy that deals with the way of learning and new information creation. There is an essential relationship between the psychologies of learning, as we comprehend it today. The developing agreement among thinkers and epistemologists that new information creation is a helpful procedure includes both our insight and our feelings to make new. Learners attempting to make great concept maps are themselves occupied with an inventive procedure, and this can challenge, particularly to learners who have spent the vast majority of their life learning through repetition. Rote learning contributes almost no to our knowledge structure, and along these lines can't underlie imaginative speculation or novel critical thinking.

As characterized above, concepts and propositions are the building blocks for learning in any space. For example we can utilize the similarity that concepts resemble the particles of matter and recommendations resemble the atoms of matter. There are just around 100 various types of atoms and these make up a limitless number of various types of molecules. As there are currently around 4, 60,000 words in the English dialect (the greater part of which are concept labels), and these can be joined to frame an interminable number of prepositions. Although most mixes of words may be meaningless, there is still the likelihood of making a limitless number of legitimate and significant recommendations. Writers and poets will never come up short on new thoughts to express in new ways. The inventive individuals will keep on creating new concepts and new learning. Making new strategies for recording occasions for the most part opens up new doors for new knowledge creation. For instance, the production of the concept mapping strategy for recording subject's understandings has driven new chances to concentrate on the procedure of learning and new knowledge creation.
1.4.8 USES OF CONCEPT MAPS

Concept maps are used in different ways in the teaching of the different subjects, like in mathematics at all levels ranging from elementary school to secondary school. (Novak and Gowin, 1984; Novak, 1990; Malone and Dekkers, 1984): Concept maps can be used in the following situations

a) **Concept maps help to organize information on a topic**

A concept map classifies knowledge into categories and sub-categories so that it can be easily remembered and retrieved. The hierarchical structure of concept maps conforms to the general assumption that the cognitive representation of knowledge is structured in order (Tergan, 1986).

b) **Concept maps facilitate meaningful learning**

Concept maps aid in organizing and understanding new subject matter. Each concept map has a unique appearance and a strong visual appeal. Thus information may be memorized and recalled faster and structured information becomes long living.

c) **Concept maps are effective tool for identifying students’ knowledge structures.**

This helps the teacher to plan lessons by taking into account what a learner knows at that time. A student himself understands his own knowledge organization. Perhaps wrong connections in a student’s knowledge become visible to the teacher and they can be corrected by him at the right time.

d) **Concept maps may serve as a memory aid**

Concept map being a pictorial representation may be grasped at once, and due to its unique appearance, it is committed well to one’s memory and recalled faster.

![Maps of Real Numbers in oval structure serves as memory aid.](image)

Figure 1.4.2 Maps of Real Numbers in oval structure serves as memory aid.
c) **Concept maps can be used as design of instructional strategy**

Teachers found that concept maps were useful tools for teaching as an instructional strategy. Moreover, teachers were not only assisted in planning instruction, but also during the plan of concept maps their own understanding of the subject matter was increased (Novak, 1998).

Concept mapping is a method used to demonstrate the knowledge in the form of structure. Since the knowledge is expressed in semantic therefore concept maps are sometimes called as semantic networks. Instead of describing all concepts and relations within the kinds of text, one could prefer to draw a map indicating concepts and relations in an exceeding graph or network.

A concept map is an innovative approach to planning and organizing ideas. A concept map is a way to arrange and manipulate material in a visual manner to assist the organization, comprehension, and retention of material. Concept maps can be used to plot ideas and to formulate concepts that are to be understood. In practice some student’s takes notes in the form of concept maps, while some use it to preview a chapter before reading. So concept maps are used in different ways and for different purpose.

**1.4.9 GOALS IN THE USE OF CONCEPT MAPS**

One of the essential goals in the use of concept maps is to encourage meaningful learning. With this goal the following points should be focused:-

a) The learner must have significant background knowledge.

b) Material which is to be learned should be thoughtfully clear and should be presented with dialect and examples that will relate with the learner's prior knowledge.

c) The learner must settle on the decision to learn meaningfully. Memorizing concept definitions should be avoided and implications of new meaning to the prior knowledge of the students should be completed by motivating them to learn something new. The making of concept maps helps to the consolidation of new meanings into earlier knowledge.
1.5.0 MATHEMATICS ACHIEVEMENT

Mathematics is essential not only in the education of scientists’, engineers and financial specialist but also in the education of each working citizen. If the working people are good in mathematics so the good result will be in field of science and technology. For the people to be good in mathematics, they should learn mathematics in their schools in perfect way, which results to good mathematics achievement in their school levels. Regarding these needs of mathematics achievement the national educational programs and evaluation standard for school mathematics aims the need for all students to create mathematics proficiency. The NCTM’s gave four points for all students that the students:-

- Understand mathematics to value mathematics.
- To become self-confident in their ability to do mathematics.
- Become mathematics problem solvers and figure out how to communicate mathematically
- Understand mathematics to reason mathematically.

This is possible only when in the classroom the teacher use good teaching strategies according to the needs of mathematics under certain conditions.

According to Douglas and Kristin (2000) teaching strategies and methods are worth careful consideration as teacher strives to improve their teaching practices and resulting in improvement of student’s achievement which is as follows:

1. **Opportunity to learn**: - The level of student’s opportunity to learn mathematics directly depends upon mathematical achievement. OTL in students was the first international mathematics study where teacher were asked to rate the extent of student exposure to particular mathematics concepts and skills. Strong coordination was found between student’s opportunity to learn and student’s achievement in mathematics (Husen, 1967).

2. **Focus on meaning**: - Lot of work is done by Brownell in research, on the effect of teaching for meaning and understanding. According to Brownell (1945) focusing instruction on the meaningful development of important mathematical ideas and concepts increase the level of student learning’s.
3. **Attaining different concepts while solving problems**: Research suggests that a student who creates conceptual understanding early perform best and on formal knowledge later. Students with good conceptual understanding can perform effectively on near-transfer task. Students with low degree of conceptual understanding needs more exercise in order to gain formal knowledge.

4. **Chance for both intervention and practice**: Giving students both an opportunity to discover and invent new information and a chance to practice what they have learned enhances the students’ achievement in mathematics. Therefore when student discovers different mathematical thoughts and create their own mathematical procedures then they have more conceptual understanding of mathematical ideas.

5. **Chance to student for discovering methods and practises**: Student mathematical achievement altogether enhanced when teacher know about students that how students construct their knowledge and are familiar with the natural solution that the students use when they solve the problem and the teacher uses this knowledge while planning and conducting instruction in mathematics.

6. **Small group learning**: Using small groups of student to work on activities, concept, problems and assignment can increase student’s mathematics achievement.

7. **Class discussions**: Class discussions can be effective when it is used for sharing and explaining different solutions which the individual students have solved the problems by themselves. It allows the student to see many ways of examining a situation and the variety of appropriate and acceptable solution. Wood (1999) found that discussion of students in class works best when discussion expectations are clearly understood. Student ought to be expected to judge each other’s plan and reasoning in a manner that is not important.

### 1.5.1 FACTORS INFLUENCING MATHEMATICS ACHIEVEMENT:

There are several factors influencing student’s achievement in mathematics some of these factors are student personal attitude towards mathematics, classroom climate, mathematical anxiety and teacher attribution as lack of experienced mathematics teachers, teaching practises and teaching methods.
For the purpose of understanding the factors associated with mathematics achievement, Tuncay and Omur (2009) have concentrated on numerous factors are listed below.

1. **Demographic factors:** Different demographic factors are related to mathematics achievement. Gender, socio-economic status/Financial status and parental' academic levels are the factors which affects the mathematics achievement.

   (a) **Gender:** The literature on gender difference that male tends to better on mathematics tests that involve problem solving and female tends to do better in computation; provide evidences that gender issue impact achievement in mathematics. Hence it is very important to pay attention to the gender differences while designing the mathematics instructions.

   (b) **Socio economic status/Financial status:** Socio-economic status or financial status is determined to be predictive of mathematical achievement. Parents with higher socio-economic status are more involved in their children’s education than the parent lower socio-economic status. The greater involvement results in development of optimistic attitudes of children towards school, classes and enrichment of their academic achievement. It is said that low socio-economic status contrarily influence academic achievement to some extent because the parents may not help their children for getting various educational material and assets and creates a non-comforting atmosphere at home. (Majoribank, 1996; Jeynes, 2002). This is because the socio economic status of student is a common factor that determines academic achievement.

   (c) **Parents’ academic level:** Parents academic level plays an important role in the academic achievement of their children. If the parents are educated then they can tell the importance of studies with respect to the different subjects. If once their children understood the importance of the subject hence resulting in the achievement. Parent’s education level also creates the home environment that affects children’s learning and achievement.

2. **Instructional Factors:** Various instructional factors are known to be related to mathematics achievement. Curriculum, instructional strategies and techniques, teacher proficiency in mathematics education, school context and facilities are factors which affects the mathematics achievement.
(a) **Curriculum**: Many mathematics curricula over emphasize memorization of facts and under emphasize understanding and application of these facts to discover, make connection, and to test mathematics concepts. Remembrance must be raised to conceptualization, application and critical thinking for students to effectively apply what they learn. Research suggests that curriculum that considers students to be incapable of meeting a cognitive activities, example: complex reasoning ought to be replaced with the one that sees students who are fit for higher order thinking and reasoning when upheld with necessary and relevant knowledge and activities (Branford et al, 1994; Schowble et al, 1995; Warren and Roseberry, 1996). Research has also uncovered the roof that curricula in which students’ knowledge and skills develops is fundamentally associated with their learning and therefore achievement, (Brown and Campione, 1994; Lchrer & Chazzan, 1998).

(b) **Instructional strategies and techniques**: Being effective in mathematics includes the ability to understand current state of knowledge, expands on it, improves, and makes the change or decision on the face of conflicts. To do this requires critical thinking, abstracting, inventing and proving (Romberg, 1983). These are fundamental cognitive operation that students need to create and utilize it in mathematics classes. Consequently only instructional strategies and techniques that provide students with learning situations which makes them create and apply higher order operations which are critical for mathematics achievement. Thus instructional strategies shape the advancement of student’s learning and achievement.

(c) **Teacher proficiency in math education**: Numerous studies report that teacher knows and accepts that mathematics is directly associated with their instructional choice and methodology (Brophy, 1990). Geliert (1999) additionally reported that “in mathematics education research, it seems to be unchallenged that the teacher’s logics of mathematics affect on the students mathematics achievement which results to affect the framework of mathematics classes”. Therefore mathematics teachers need aptitude and knowledge to apply instructional choices in his teaching of mathematics in classroom.

Teacher competency in the area of mathematics is closely linked to the student thinking, understanding and learning in mathematics education. It is clear that student achievement in mathematics education requires teacher to have a firm understanding
of the subject area and the rationales that aids mathematics education as well as careful understanding of different kinds of instructional achieves that promotes students achievement (Ball, 1993). Competent mathematics teacher provide a road map to guide student to an organized understanding of mathematics concept, which increases the learning, critical thinking and finally mathematical achievement.

(d) **School context and facilities:** - School context and facilities could be an important factor in student’s achievement. In fact, distinguishing the factors related to the school environment has become a research focus among educational practitioners. For example, research reveals that student achievement is connected with a safe and orderly school climate (Reyonds et al., 1996). Researchers also found a negative impact on student achievement where inadequacies of school elements or components such as temperature, lighting and age exits. In a study by Harner (1974), temperature above 23°C (74°F) a diversely affected mathematics skills. As far as the condition of school building, Cash (1993) discovered student achievement scores in standard buildings. Furthermore, Rivera et al. (1995) concluded multiple regression statistical analysis to inspect the relation between stuffed school buildings and student achievement. The findings signified that a high population of students had a negatively effects the students' achievement.

3. **Individual factors:** - Various individual factors are known to be related to mathematics achievement. Self directed learning, arithmetic ability, motivation or concentration, mathematics anxiety are factors which affects the mathematics achievement.

(a) **Self directed learning:** - Self directed learning could be one of the factors in students which affect mathematics achievement. Mathematics learning requires a deep understanding of mathematical concept, the ability to make connections among them and produce effective solution to ill-structured domains. There is no exact method in which student can practice mathematics properly and this is possible only if students play their assigned role in their learning process. Self directed learning has an important place in effective mathematics learning. Self directed students can take the initiative in their learning by determining their necessities, formulating objectives, distinguishing assets for learning and assessing or checking learning outcomes (Knowles 1975). The teacher role is to involve with students by helping to organise
and assist them as they take the initiative in their own self directed explorations, instead of directly adopting the learning autocratically. (Stormmen and Lincoln 1992)

(b) **Arithmetic Ability:** - Arithmetic ability is also another factor that affects mathematics achievement of students. Arithmetic ability includes the skills such as controlling the mathematical knowledge and concepts in ways that transform their meaning and implications. It permits the students to interpret, examine, synthesize, generalize, or hypothesize the facts and concepts of mathematics. Students having high arithmetic ability can take part in tasks such as solving complex problem, finding new implications and understanding, and arriving at logical conclusions.

Arithmetic ability was found to be one of the factors on students’ mathematics achievement in various studies. For example, in a study by Kaeley (1993), arithmetic ability gave the highest correlation coefficient with mathematics achievement. Also, student achievement scores were found to be most emphatically anticipated by level of ability (Schiefele & Csikszentmihalyi, 1995). Researchers additionally found that the relationship of gender issues and arithmetic ability on math achievement. For example, Mills (1997) conducted a study to investigate longitudinal data gathered over 10 years with as aim at asking whether personality traits were related to gender differences in long-term achievement in mathematics in math for young women. However, the level of math ability did not seem to be a factor of long-term math achievement for young men.

(d) **Encouragement and motivation:** - In mathematics education students should extremely encouraged and motivated. This is on account that mathematics student requires reasoning, making interpretation and solving problem. The challenge of mathematics learning for today’s education is that it requires tasteful study, concentration, encouragement and motivation. To meet these difficulties, learners must be engaged and motivated to progress. Broussard and Garrison (2004) examined the relationship between classroom motivation and academic achievement in primary-school-aged children (122-first grade and 129-third grade participants). Predictable with past studies, they found that for a higher level of mastery, motivation was related to higher mathematics grades.

The teacher’s role in students’ motivation to learn ought not to be disparaged. In helping student to become motivated learner and makers of mathematical
knowledge effectively, the teachers’ primary instructional task is to develop a learning environment where students can take part in mathematical thinking activities and consider mathematics as something requiring-evaluation, guess, speculation, confirmation, and reflection (Carr, 1996).

(d). **Mathematics Anxiety**: - Mathematics anxiety is the fear of mathematics when student deals with mathematics. It is nothing but a type of phobia that student feels that he will not be able to do the sums or to solve the problems related to his syllabus. Here the teacher plays an important role to get rid of mathematical anxiety from students. It is only with the motivation, strategies which the teacher adopts to explain the topics in the mathematics.

### 1.6.0 CONCEPT MAPPING AND ACHIEVEMENT

Kaur (2012) in her study concluded that group taught through concept mapping show better performance as compared to the traditional method. The study concludes that concept mapping has a positive effect on achievement. Rani (2011) in her study also concluded that there is significant effect of strategies i.e. concept mapping over conventional method. Thus concept mapping shows significant effect on achievement of students. The introduce of concept mapping as a component of teaching and learning strategy increase the achievement of students in their learning process as comparative to the process of teaching learning through traditional method.

### 1.7.0 CREATIVITY

Creativity may be defined in many ways. It is usually defined as kind of person, product, or process. It may also be defined in terms of environmental conditions. Rhodes (1961) has referred to these four kinds of definitions as the “Four P’s of creativity (Person, Process, Press and Products). In attempting to combine these four approaches, Rhodes has defined the word “creativity” as a noun naming the phenomenon in which a person communicates a new concept.

#### 1.7.1 LEVELS OF CREATIVITY

Taylor (1959) has sought to reconcile some of the apparent differences in opinion concerning creativity by suggesting that we think of creativity in terms of various levels. He suggested the following five levels:
1. Expressive creativity: Autonomous expression where abilities, originality, and the nature of the item are unimportant, as in unconstrained drawing of children.

2. Productive creativity: Artistic or exploratory products where there is a propensity to limit and control free play and create systems for delivering completed products.

3. Inventive creativity: Inventors, explorers and discoverers where ingenuity is displayed with materials, methods, and techniques.

4. Innovative creativity: Improvement through modifications involving conceptualizing skill.

5. Emergentive creativity: An entirely new principle or assumption around which new school flourish.

Taylor points out that many people have this fifth level in mind when they discuss about creativity. Since fifth level of creative behaviour is so rare, the lower levels have usually been involved in most of the investigations concerning creative behaviour. Taylor also objects to the frequent confusion of creativity and prevalent interpretations of traditional logic, scientific method, and intelligence. He maintains that fantasy associations and relaxation for unconscious play are so essential for creativity thought that creativity cannot be subjected to the same interpretations as logic and scientific method. Inventive creativity, Taylor’s third level of creativity, has perhaps been subjected to more systematic definition and specification of criteria than any other levels.

1.7.2 NATURE OF CREATIVITY

There is little conceptual clarity and agreement among the investigators as to the nature of creativity. Different people have different views regarding the nature of creativity.

According to the artist, “creativity is the ability to evoke an emotional need which is conducive to creativity”.

To an architect, “creativity is the ability to produce new forms and new approaches and new materials in the functional design.”
As per mathematicians, “creativity is the capability to solve mathematical problems which are useful in creating combination and that provide knowledge of mathematical laws and principles.”

As per scientists, “creativity is the ability to explore ways of extending the frontiers of knowledge”

Torrance (1966) conceives creative thinking as “a method of being sensitive to the problem, deficiencies, gaps in information, missing components so on, distinguishing the difficulties, finding out solutions, making hypotheses, testing and retesting the hypotheses and presumably modifying them and at last communicating the results.”

To sum up, creativity is a process; this process is a goal oriented which leads to the production of something new idea. In other way it is a specifics way of handling in formations.

Further, there is variation in creativity of the individual. Environment has a great influence on the development of creativity. Similarly gender, socio-economic status of the parents, family size, urban-rural differences, problem solving abilities, intelligence, interest and anxiety levels of individual have lot of influence on the development of creativity, including mathematical creativity and achievement in mathematics.

1.8.0 MATHEMATICAL CREATIVITY

Creativity is a resource for human beings. Of all the abilities that man has, which recognise him from the creature life like animals life, creativity is undoubtedly the unique. About five or six decades back, creativity was attributed toward heavenly source and was termed as “spark of genius”. However, today it is attributed to psychic working of individuals. Creativity is a potentiality, which impacts human movement in all circles of life. Creativity has been recognized as a precious source of emergence, improvement and survival of man’s culture through ages. Most of the changes and advancements in society as well as other fields tell us nothing but the story of man’s endeavour to create. Man’s creative potentialities are unimaginable. Creativity has defined in many ways, based on Chambers 21st century dictionary, creativity means being inventive or innovative. Torrance (1966) defined creativity, as a process of sensing gaps or missing components, shaping thoughts or speculations concerning hypothesis, testing these theories and imparting the outcomes. Mathematical creativity is one of the most established composed controls of human knowledge, with a
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persistent line of improvement crossing 5000 years and each major society. National Policy on Education (1986) has envisaged that “Mathematics should be visualized as the vehicle of communication to train a child to think creatively, to reason, to articulate and to analyze logically. It should be treated as a concomitant to any subject involving analysis and synthesis”. Mathematically creative students were identified by their ability of learning and understanding of mathematical ideas quickly; working systematically and accurately; high level of analytical skills; logical thinking; quick identifying ability and application of self knowledge to new or unfamiliar contexts.

1.8.1 DEFINITIONS OF MATHEMATICAL CREATIVITY

An examination of the literature has tried to outline mathematical creativity and found that the shortage of an approved definition for mathematical creativity which hindered research efforts (Ford and Harris 1992; Treffinger et al, 1971). Treffinger et al (2002) acknowledged that there are many ways to specific creative thinking and located over one hundred up to date definitions.

Runco (1993) describes creativity as a multifarious develop which incorporates each divergent and intellection, finding the matter and thinking critically regarding it, expressive style, inherent motivation, a questioning angle, and confidence.

Haylock (1987) outlined many of the attempts to define mathematical creativity. One of the perspectives is that mathematical creativity includes the ability to see new connections among strategies and areas of application and to relationship between possibly unrelated ideas”

Krutetskii (1976), a Russian Psychologist describes mathematical creativity in the context of problem formation (problem finding), innovations, emancipation, and originality.

Singh (1988) described mathematical creativity as the procedure of formulating hypotheses concerning circumstances and effect in mathematical events, testing and retesting these hypotheses and making changes and finally imparting the outcomes.

Studies related to mathematical creativity (Balka, 1974, Jensen, 1973; Singh, 1988) have tried to measure mathematical creativity either in terms of flexibility, fluency and originality of a student’s answer to problems presented or in terms of the formation of mathematical problems from situational data.
1.8.2 DEVELOPMENT OF MATHEMATICAL CREATIVITY

Mathematical creativity is hard to develop if one is restricted to rule-based applications without identifying the essence of the problem to be solved. Described by leaders in the National Council of Teachers of Mathematics (NCTM) (2000) students should be empowered confidently to take part in complex mathematical task, draw an information from a wide range of mathematical topics, sometimes attending the same problem from different mathematical point of views or exploring the mathematics in different ways until they find methods that enable them to make progress. (NCTM, 2000) For many adults, this vision is not at all like the mathematics classrooms they remember from their youth where time was spent learning from the master.

In this setting, the teacher demonstrated the lesson with examples and then the students practiced with similar problems (Pehkonen, 1997). For students, the concept of mathematics is of “a digestive process rather than a creative one” (Dreyfus & Eisenberg, 1996).

Romberg and Kaput (1999) in their study described three-section lesson: checking homework, presentation given by teacher on new material and practice done by students. The problems in the experiment were constructed in such a way that a single correct answer existed (Shimada, 1997). A second group was given the conditions on which the first group’s exercises was based and were asked to develop the problem with answer that is to be solved by using calculations. The open-ended nature of the task given to the second group did not restrain them to a set number of problems. The second group created more questions and equal number of answers as compared to the first group. Balka (1974) provided participants with mathematical situations from which they were to develop problems. Base for measuring mathematical creativity was flexibility, fluency and originality of the problems that the participants constructed. By working with these types of mathematical situations, students are encouraged to use their knowledge flexibly in new applications. Thus by considering the above discussion researchers can try to develop mathematical creativity with the help of different methods specially teaching mathematics by different teaching strategies.
1.9.0 ACHIEVEMENT AND MATHEMATICAL CREATIVITY

The basis of mathematics is thinking creatively, not just getting the right answer (Dreyfus & Eisenberg, 1966). Hong and Aqui (2004) studied the difference between academically gifted students who attained high grades in school math, and the creatively talented in mathematics and those students with a high concern, dynamic and expert in math but not necessarily high achievers. They found significant differences in cognitive strategies used between the two groups with the creatively talented are more cognitively creative. This is not to say that students cannot be both academically gifted and creatively talented in mathematics. Although they were studying differences, their study did not contain students with strong points in both areas. Traditional tests to identify the mathematically gifted do not identify or measure creativity (Kim et al., 2003) but often reward accuracy and speed. These tests identify students who do well in school mathematics (Hong and Aqui, 2004) and are computationally fluent, but neglect the creatively talented in mathematics. The definition of mathematical creativity varies and depends upon the identification tools used and also the program offered. Notwithstanding the definition used, finding students inventive in arithmetic could also be a challenge for every professional and social. Generally, ability in mathematics is thought through performance in the class, test scores and teacher recommendations. Researchers suggest that a high level of achievement in class arithmetic is not a necessary ingredient for high levels of achievement in arithmetic. Sternberg (1996) summarized conversations with the variety of mathematicians once he wrote: performance in mathematics courses, up to the college and even early graduate levels typically don't effectively predict who can succeed as a mathematician. The prediction failure occurs due to the fact that in math, as in most other fields, one can get away with good analytical but weak creative thinking until one reaches the highest levels of mathematics. Mayer and Hegarty’s (1996) research focused on problem understanding. They found that student difficulties in mathematics lie with understanding and representation of the problem, not in the execution of computational tasks. In an environment where computation is the basis of assessment, high achievement is possible without mathematical understanding. Pehkonen (1997) discussed the balance between knowledge/logic and creativity. In colleges and schools wherever education is one-sided action knowledge and logic, students develop the left hemisphere of the brain, however, neglect the
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right. For achievement on the far side traditional college mathematics, a balance between the right and left hemispheres is required. Nonetheless, several students leave college and schools with the right side, the inventive aspect, of the brain undeveloped. The research finding of Pehkonen (1997) and Hong and Aqui (2004) suggests an apparent detachment between school mathematics and mathematical accomplishments. Not only are the identified mathematically gifted being neglected, there is a significant probability that some talented students are overlooked by current practices in school. The division of mathematical talent into the academically gifted and creatively talented is important in the consideration of talent development (Hong and Aqui’s 2004). The academically gifted student may excel in the classroom by demonstrating high achievement, or schoolhouse giftedness, which is valued in traditional educational settings. According to Renzulli (1998), these students’ abilities remain relatively stable over time. Those academically gifted in mathematics are able to acquire the skills and methodologies taught often at a much more rapid pace than less able students and perform well on standardized testing. The academically talented sometimes demonstrate their mastery of the utilitarian aspects of mathematics, however, neither speed nor accuracy in computation or the analytical ability to use familiar ways to identified issues are measures of inventive mathematical talent. Hadamard (1945) represented people he labels “numerical calculators” as “prodigious calculators – often quite uneducated men – who will very quickly build very complicated numerical calculation. Such talent is, in reality, distinct from mathematical ability”. Therefore in an associate environment that values talent and speed, it's attainable to be academically talented however lacks Mathematical creativity. Whereas the speed of data process is very important in testing situations during which students’ mathematical thinking is assessed using standardized tests, it's less important when a mathematician spends months or maybe years exploring a spread of mathematical ways to resolve ill-defined issues (Sternberg, 1996). Current tests of the number or numerical facility emphasize speed with stress imposed by severe cut-off dates and answerableness on the accuracy of the solutions (Carroll, 1996). However, the future generation of mathematicians should be shown the “wellsprings of mathematics; creativity, imagination, associated an appreciation of the beauty of the subject” (Whitcombe, 1988). In an analysis of psychological feature ability theory and the supporting psychological tests and factor analysis, Carroll noted
that despite six to seven decades of work, the relationships between the distinct skills measured by psychology tests and performance in mathematics remains unclear.

1.10.0 CONCEPT MAPPING AND CREATIVITY

Illa (2006) in his study concluded that the students who used the concept mapping strategy obtained higher scores in the physics creative test than who did not. Hsu and Chang (2011) also studied the relationship between computer based concept mapping and creative performance. The results of the content analysis and expert evolution showed that computer based concept mapping benefits students’ creative and thinking abilities. The students taught through concept mapping shows higher gain scores in their creative test scores and shows more creative performance than the students taught with traditional method. Thus concept mapping has significant effect on students’ creative performance as comparative to the process of teaching learning through traditional method.

1.11.0 ANXIETY

Anxiety is most common psychological phenomenon of our time. Anxiety is a central problem in this age of speed and tension and it seems as one of the major mental health problem of today.

The twentieth century is referred as “the century of fear” by the French author, Albert Camus (Spielberger, 1972), and as the age of anxiety by Auden (1947). With the growth in the mental health profession of behavioral science, it is ordered that anxiety has huge impact on human life. Almost every human attempt seems to be affected by anxiety (Swatantra Jain, 1995). Though the present century has been termed as an era of anxiety but fear and anxiety are as old as the history of mankind.

In Spielferger & Rickman’s (1990) views “the concept of fear was clearly represented in ancient Egyptian hieroglyphics. It was also observed in Greek and Roman literature as a powerful motivator of behavior. Pascal in the 17th century and Kierkegaard in the 19th century, in their views, recognized the historical roots of scientific conception of fear and anxiety. Darwin (1965) examined fear to be an essential and adaptive nature of both humans and animals evolved over countless
generations through a process of natural selection. According to Darwin, fear varies in intensity - “from mild fear or surprise to an extreme agony or terror.”

Presently anxiety becomes a focus of study for psychologists. Its importance for practice of theory had been recognized and examined with the framework of psychologists which have had an extensive impact upon psychology as well as upon psychiatry.

The concept of anxiety as a research variable has taken place both within and without the framework of psychoanalytic theory. How so ever, different schools of psychology may be having different views about the definition and origin of anxiety but they undisputedly agree that anxiety after a minimal limit disturbs the overall human behavior as is clear from explanation of anxiety in the American handbook of Psychiatry:-

“…….. subjectively experienced uneasiness, apprehension, anticipation of danger, doom, disintegration and going to pieces, the source of which is unknown by the individual and toward which he feels helpless, with a characteristic somatic pattern. This somatic pattern shows evidence of increased tension in the skeletal muscles (stiffness, tremors, weakness, unsteadiness of voice, etc.); the cardiovascular system (palpitation, blushing or pallor, faintness, rapid pulse and increased blood pressure etc.). There may also be other manifestations such as cold / wet extremities, rapid or irregular breathing, and frequency of urination and sleep disturbance……..”

The above mentioned explanation of anxiety shows that it upsets its possessor by rendering him incapable of normal behavior.

Webster (1947) defined anxiety as, “A painful uneasiness of mind over an impending or anticipated ill”. While APA, 1952 considers anxiety as: “A danger signal felt and perceived by the conscious portion of the personality. It is developed by a menace from within the personality. With or without stimulation from external situation”

All the above points of view make it clear that anxiety is a state of mind, not something which can be directly found or discovered in the brain, heart or any other part of the body. It is feeling state, clearly different from other emotional states. Sometimes there is great confusion between the usage of the terms anxiety and fear as they are alternately used. Many psychologist view that fear must be separated from anxiety.
Various theorists have suggested that the term anxiety, reserved for fear from a source that is unknown to the troubled individual. It happens ‘without stimulation from external situations’ when an individual is aware of a threatening object or situation (Lewitt 1968).

1.11.1 COMPONENTS OF ANXIETY

The three component of anxiety are Behavioral component, Cognitive component and Physiological component which are mapped on figure 1.11.1.

These three components are discussed one by one under their headings:-

1) **Behavioral component**: - The Behavioral component is activated with the aim of reacting to a situation and re-establishing on the condition of well-being. Here there are two possibilities i.e. coping with the problem directly or simply avoiding it. In the first case, if an individual is challenged by an unexpected situation he is not prepared for it. He will possibly react by analyzing the problem and preparing a suitable solution. In the case of avoidance however, he will tend to put off resisting with the problem, there by achieving immediate relief , but this can give rise to feelings of guilt and may damage self-esteem. This will then increase the risk that such situations will take place again in the future.

The behavioral component of anxiety can include reduced performance due to the anxiety. If someone is focused on his worries or physiological symptoms, he might find himself distracted and so concerned with what’s going on in his mind and his body that he feels removed from the outside world.
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Another behavioral feature of anxiety is Avoidance. Avoiding what is anxious about generally makes the anxiety subside in the short term. If someone is anxious about socializing or flying, or public speaking, or leaving the home then by ignoring those situations leads him anxious for the time being. However, avoidance winds up strictly what one can do and negatively affecting day to day life and when anxious person do and if they are forced to face one of those situations, the anxiety returns stronger than ever.

2) **Cognitive component:** - the cognitive component is constituted by a series of mental process that have the purpose of assessing oneself. These processes includes:-
   a) To evaluate reality in an unrealistic and unreasonable way. (“if I can’t do this, I’m failure”)
   b) Self-efficacy and the belittling of one’s potential or limit e.g. believing we cannot perform a certain task.
   c) Catastrophizing i.e. overestimating the external situation, anxious person feel so astonished or overwhelmed by events as if he was facing a major disaster.
   d) Perfectionism: - the tendency to continuously delaying an issue, problem or evaluation on the part of others until some future moment for when we feel we are perfectly prepared.

3) **Physiological component:** - A physiological basis that prepares the individual for action, the main physiological modifications are : -
   a) Increase in muscular tension, with a continuance increase in blood flow to the muscles (so as to be able to react immediately with a flight or fight responses if necessary.)
   b) Tachycardia (nasty heartbeat, with distinguishable acceleration of the heart rate), which has the motive of pumping a greater quantity of blood to different parts of the body that have been enacted and an increase in blood pressure.
   c) Hyperventilation: - It an increase in respiratory frequency beyond control. This may lead to weakness and in serious cases, to cloudy vision and a dynamic decrease in one’s capacity to understand the situation
   d) An increase in the organism’s sensibility towards external agents.
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1.11.2 TYPES OF ANXIETY: -

There are different types of anxiety which are discussed below:

1.11.2.1 Existential anxiety: -

Existential anxiety gives an account to a sense of worry, frightful or panic that may appear from the deep thought of life’s biggest questions, such as “Who am I?” or “Why am I here?” Existential view in psychology and philosophy explains that these thoughts lead necessarily to the realization that everybody has the freedom and responsibility to find importance in life. Although this realization is barely distressing, many existential view this form of anxiety as healthy and productive.

Five dimensions of existential anxiety are given below: -

1. Free – hovering ‘terror’
2. No clear cause or source, we don’t know why we are afraid and from where it comes from and is everywhere and nowhere.
3. Permanent or ever renewed inner state of being does not pass away.
4. Pervades our whole being; unlimited menace, touches every things.
5. Nothing we do will overcome anxiety; psychological techniques are useless, (Park, 2015)

1.11.2.2 Test anxiety

Test anxiety is the discomfort, fear, or nervousness felt by students who have trepidation of failing an exam. The students suffers from test anxiety may undergo any of the following:- the connection of grades with individual worth, fear of humiliation by a teacher, fear of alienation from parents of companions, stress of time. Sweating, dizziness, migraines, hustling heartbeats, queasiness, squirming, and drumming on a desk are all normal. An optimal level of excitement is necessary to best finish a task, for example in an examination when the anxiety or level of arousal exceeds that optimum; it results in a decline in performance.

Test anxiety is one of the weakest factors in schools and other places where testing is performed. Among secondary school and college students, it is a typical and conceivably difficult problem. Twenty percent of test anxious students leave school before completing their secondary study because of repeated failure (Wachelka & Katz, 1999).
High test anxiety has been found to be associated with low self-esteem, poor reading and low mathematics achievement, failing grades, disruptive classroom behavior, negative attitudes toward school, and feelings of nervousness and dread that stem from an intense fear of failure. Evidence suggested that high degrees of test anxiety correlate with; lower self – esteem (Wachelka & Katz, 1999). For some people however this fear can become so intense that it actually interferes with their actual perform well on a test.

1.11.2.1 Cause of test anxiety

For many students, it can be a combination of things. Bad study habits, poor past test performance and an underlying anxiety problem can all contribute to test anxiety. Causes of test anxiety are given below:-

a) Biological causes of test anxiety: - In stressful situations, such as before and during an exam, the body releases a hormone called adrenaline. This helps to prepare the body to deal with what is about to happen and is commonly referred to as the “fighter flight” response. Essentially, this response prepares you to either stay and deal with the stress or escape the situation entirely. In lot of cases, the adrenaline rush is actually a good thing. It helps to prepare you to deal effectively with stressful situations, ensuring that you are alert and ready.

b) Mental causes of test anxiety: - Expectations of students are one of the major mental factors which play an important role in test anxiety in addition to biological causes of anxiety. For example, if a student believes that he will perform poorly on an exam, he is far more likely to become anxious before and during a test. Test anxiety can also become a vicious cycle. After experiencing anxiety during one exam, students may become so fearful about it happening again that they actually become even more anxious.

1.11.2.3 State anxiety

According to Spielberg (1972) state anxiety expresses short time emotional state or condition of the human organism. This condition of human organism is characterized by subjective, consciously perceived feeling of tension and apprehension which heightened automatic nervous system activity.
State anxiety is low in non-stressful conditions. Mostly the people with this type anxiety only exhibit it in specific conditions. It means that ‘state’ anxiety is the anxiety state we experience when something causes us to feel appropriate and temporary anxious and this anxiety then retreats until we feel normal again.

1.11.2.3.1 Causes of state anxiety:

Causes of state anxiety for different reasons are given below:-

- a) Fear of leaving the test blank or the disability to perform in testing situations can develop state anxiety.
- b) Lack of preparation is another factor that contributes in state anxiety.
- c) Poor time management, poor study habits, and lack of organization can lead to a student feeling overwhelmed.
- d) Student who is forced to cram at the last minute will feel less confident about the material covered than those have been able to follow a structured plan for studying.
- e) State anxiety also develops genetically.
- f) Lack of confidence, fear of failure, and other negative thought processes may also contribute to state anxiety.
- g) The pressure to perform well on exam is a great motivator unless it is so extreme that it becomes irrational.

1.11.2.4 Trait anxiety

Trait anxiety follows stability in a certain way to respond with anxiety in the intuition of threatening situation. It is strictly related to the personality trait of neuroticism. An individual with high trait anxiety is ready to feel the immense range of situation as dangerous or threatening and responds to such situations with increased state anxiety.

Trait anxiety is the ‘preset’ level of anxiety experienced by an individual who has a tendency to be more anxious and to react less appropriate to anxiety provoking stimuli. Trait anxiety is a relatively stable aspect of the personality. Individuals those who have trait anxiety are likely to have an attitude of reflecting their approach to
certain conditions as frightening. The anxious sensitive style of these individuals will eventually become common, extending to and affecting other areas of experience and in result finally becoming a characteristic of the personality. Individuals who show more developed anxiety trait are much more likely to reacting to large number of stimuli and will tend to worry also in situations which for most individuals would not represent a source of threat.

1.11.2.4.1 Trait anxiety is constrained to state anxiety

Trait anxiety is contrasted to state anxiety, as trait anxiety is the temporary, uncomfortable experience that occurs when a person feels threatened by a situation. Trait anxiety is the potential or tendency to experience state anxiety. A person can be either high or low in trait anxiety depending on how often they tend to experience state anxiety. A person high in trait anxiety experience state anxiety more often.

State anxiety refers temporary emotional response which involves feelings of fear and tension and Trait anxiety refers to a permanent characteristic of a person that can be used to explain a person’s behavioral flexibilities, and determines the likelihood of a person that he will experience anxiety in stressful situations. For example, some people spend considerable time on a particular action or behavior such as continuously checking to see if the door is locked.

Thus the difference between trait and state anxiety has not been identify or established for decades, on the grounds that both types of anxiety make individuals more receptive to negative information, to the determine of positive or neutral information.

1.11.2.5 Stranger or social anxiety

Stranger or Social anxiety is a term which is mostly used for social phobia, which has been defined by psychiatrists, psychologists, and other mental health professionals through DSM - IV criteria in the Diagnostic and statistical manual of the American Psychiatric Association.

Social anxiety disorder first develops in mid teens and early adulthood. Sometimes adolescent or children may also develop the disorder. Adolescents or children who become the subject of vicious teasing in middle school understandably can come to fear social situations with peers. Detract parenting and other
psychosocial factors may also influence to the disorder. Males tend to develop the disorder somewhat less than females.

Social anxiety in children doesn’t mean that it is a phobia. Somewhat it is a developmentally appropriate fear by kids and preschool children of those who are not parent or family members. In adult, an excessive fear of other people is not a developmentally common stage; such type of anxiety is called social anxiety.

There is broad range in term of impact and focus of the phobia in Social anxiety disorder. Apprehension of public speaking is apparently a prevailing social phobia. The more specific fears such as not feeling comfortable eating in front of other, changing at the changing room of pool or gym, using public restrooms, may have a fear of talking to the opposite sex or possibly speaking to authority figures. For other, fears may be multiple or occur in many situations. Fears may extend to how one sits, avoiding other’s eyes and social interaction or events may cause anticipatory anxiety for days or even weeks.

According to American psychiatric association (1994) social anxiety is the number one most common anxiety disorder and is also the third most common mental disorder in the U.S. An estimated 19.2 million Americans suffer from social anxiety disorder and it can occur at any time but most often it on sets in adolescence in women than in men. It is much easier to spot social anxiety in adult because they tend to shy away from any social situation and keep to themselves away. Common adult forms of social anxiety include shyness, performance anxiety, public speaking anxiety, stage fright, etc. All of those may also assume clinical forms, i.e. become anxiety disorder Edelman (2007).

- Social anxiety and Inheritance: Genetic roots of physical and mental health suggest that if one parent has a mental health disorder such as social phobia, the child has a slightly higher chance of having an anxiety disorder.

- Social Anxiety and Nervous system: Another possible cause of social anxiety is the nervous system. Certain areas of the brain, such as a small, almond-shaped area called the amygdale, can be more active in individuals with social phobia.

- Social anxiety and life Experiences: Another possible cause of social anxiety is life experiences. Negative experiences in life, and the way one handles and react to them, can also lead to the development of social anxiety.
If an individual believes that if most social situations are going to be uncomfortable for him then he is naturally going to try to avoid them. This causes one to miss the chance to find out that one may be completely wrong about automatic negative assumptions. If one enjoys singing but fears the judgment of other, he or she may never be able to discover the quality of his or her voice due to constant avoidance and as a result, often gets ignored or neglected by others due to their social awkwardness as a result or not being able to emotionally carry themselves normally in social situation.

Staying away from the situations for fear of other’s judgment will strengthen negative notions and prevent one from going into situations where he or she might actually enjoy himself or herself. As this pattern starts to interfere with overall functioning, the warning signs of social anxiety can become more credible.

1.11.3 SYMPTOMS OF ANXIETY AMONG STUDENTS

The symptoms of anxiety among students are given under the headings- emotional symptom of anxiety, physical symptoms of anxiety, and behavioral symptoms of anxiety which are discussed below:-

a) Emotional symptoms of Anxiety: - In this, there is too much self-consciousness and anxiety in everyday social situations. Especially talking about students before examination there is an intense worry for days, weeks, or even month. The other symptoms are the extreme fear of being watched or judged by others especially people you don’t know.

b) Physical symptoms of Anxiety:- In this, shortness of breath, red face, upset stomach, nausea, trembling or shaking voice, high heart beat or tightness in chest sweating, feeling dizziness is seen.

c) Behavioral symptoms of Anxiety: - In this, an individual avoids social situation to a degree that limits his/her activities or disrupts his/her life. Individual suffering with anxiety stay quiet or hiding in the background in order to escape notice and embarrassment. Individuals are in need to always bring a buddy along with you wherever you go.
1.11.4 Treatments for anxiety

There are five types of therapy that have been used successfully to treat the symptoms of anxiety disorder and include:

1) Behavior therapy,
2) Cognitive – behavioral therapy,
3) Psychodynamic psychotherapy,
4) Drug therapy, and
5) Biofeedback therapy.

1) Behavior therapy: - This therapy uses resting techniques and put into view to the feared objects or situations in very planned, gradual manner so that the individual can learn to control the anxious situations or responses.

2) Cognitive behavioral therapy (CBT) helps a person understand their patterns of thinking so they can react differently to situations that cause their anxiety. Cognitive behavioral therapy teaches a person to anticipate and prepare for the situation and bodily sensations that may trigger their anxiety.

3) Psychodynamic psychotherapy is based on the concept that symptoms result from unconscious mental conflict a person is experiencing. For the person to experience relief from the anxiety symptoms, the meaning of the unconscious mental conflict must be uncovered, preferably by consulting with a qualified mental health professional in a clinical setting on a regular basis.

4) Drug therapy can be a convenient, effective method in treating the symptoms of anxiety. The goal of drug therapy is to resolve the symptoms by restoring chemical imbalances in the brain that lead to symptoms.

According to Marks et al. (1998) it is necessary to treat the anxiety because the individual may continue to have serious attacks for years. The anxiety disorder can seriously interfere with a person’s relationship with their family, friends, and co-workers too. Individual’s life may become severely restricted because the individual may start to avoid certain situations where their fear will cause them to experience a panic attack.

In extreme cases, people with untreated panic disorder grow afraid to leave the house, such a condition known as agoraphobia. The individual may become severely depressed and find it difficult to be productive at school and work. The individual may begin to have thoughts about suicide.
1.12.0 MATHHEMATICS ANXIETY

Mathematics is one among the foremost necessary subject among all in institutions. This subject was established to provide a competent one who is in a position to use information of mathematics in day to day life effectively and responsibly in finding issues and creating choices. Weaknesses among students in learning this subject particularly will have a control on the efforts of assorted sectors. Mathematics anxiety could also be a psychological dimension of learning that is necessary for educators to spot. Sherman and Wither, (2003) and Jackson and Leffingwell (1999) done the research work in primary schools and Mohamed and Tarmizi (2010) in the secondary level. Research work done by them has shown that mathematics achievement in students is influenced by psychological factors like mathematics anxiety. Inside the mathematical context, it looks that many students who are weak in this subject worry whereas creating an effort to use arithmetic skills to unravel issues (Mohamed and Tarmizi, 2010; Arem, 2003). The findings of Marsh and Tapia (2002) indicate that students with low levels of mathematics anxiety feel a lot of excited, a lot of assured and extremely impelled to find out mathematics compared to students who have high anxiety levels. Mathematics anxiety is loosely considered as feelings of worry, avoidance, and dread when handling any scenario concerning mathematics. Tobias (1995) outlined mathematics anxiety as a sense of tension and anxiety that seems once somebody is engaged in the manipulation of figures to unravel mathematical issues in each academic and daily-life situations. It’s straightforward to forget mathematics equations and to lose confidence once that is experiencing mathematics anxiety. Mathematics anxiety is found to be related to beliefs. The analysis of Tobias discovered that there are several female students at the university level who change their major subjects to avoid mathematics. This went on not as a result of these girls has a lower intellectual level than men, however, due to the assumption issue among female students in mathematics. Female students reported that they were not able to understand and solve mathematical problems that they had previously studied. Mathematics anxiety was defined as the level of discomfort that occurs among students in response to situations involving mathematical tasks, which is seen as a threat to their self-ability (Trujillo and
Hadfield, 1999). It is described as a construct that involves cognitive and affective behaviours. This construct is related to personality type, negative attitudes toward mathematics, mathematics avoidance, mathematics background, teaching behaviour, achievement levels, lack of confidence and negative experiences in school (Harper and Daane, 1998). Mathematics anxiety is a repeatable methodology that is supported data gathered by people from their surroundings (Puteh, 2002). This data is accumulated and becomes the personal experience of individuals that finally informs their beliefs toward mathematics. These beliefs turn out behavioral things to flee mathematics. According to Puteh, teachers, peers, and parents are liable for triggering anxiety among students of mathematics. If students perceive that mathematics is difficult throughout their early life then the mathematics anxiety is going to be triggered. Because of the presence of mathematics anxiety, such students can try to flee from any situation that involves mathematics. This may strengthen their belief that they are ineffective and lack the information to have interaction in mathematics and that they will still lose confidence in their maths skills as a result. If these students continue their course of study in mathematics then possibly failure may occur because of their prescribed belief system. According to Arem (2009), Mathematics Associate in nursing, anxiety is an emotional, mental and physical activity associated with the mathematical thinking and problem-solving method and ensuing from uncomfortable past experiences associated with mathematics.

Feelings and experiences like this can any have an effect on a student’s ability to learn mathematics. Students who have experienced disappointment within their mathematical skills can have the problem believing in their skills in the future. The contributed factors to mathematics anxiety are bitter experiences in mathematics, social pressure and therefore the expectation of attaining outstanding results, the need to stand out, myths concerning the study of mathematics, social group gender stereotypes and negative self-talk (Arem 2009). These factors bring about to feelings of deep shame for the student experiencing mathematics anxiety within the classroom setting. Students with mathematics anxiety can usually appear preoccupied with something else to avoid meeting face-to-face with their teachers. They are afraid to appear up in school and quickly panic when their name is named(Arem 2009). They
are also afraid to raise their hands and when the teacher is waiting for an answer from them, they become even more afraid.

Mathematics anxiety or fear of mathematics is entirely normal. Mathematics anxiety is quite similar to stage trepidation. Why does someone suffer stage trepidation, apprehension of something going wrong in front of a group, apprehension of forgetting the lines, apprehension of being judged poorly, apprehension of going completely blank? Mathematics anxiety arouses up fear of some type. The trepidation that one won't be able to do the mathematics or it's too hard or fear of failure which often stems from having a lack of confidence. Generally, mathematics anxiety is the fear about doing the mathematics right, our minds experiences blank and we think we'll fail and obviously disappoints and mind becomes anxious. Added pressure of having time bound mathematics tests and exams also results in the levels of anxiety grow for many students.

1.12.1 SYMPTOMS OF MATHEMATICS ANXIETY

Being an effective mathematics teacher one has to know the symptoms of mathematics anxiety. Mathematics anxiety can be exhibited in many different ways. A student may judge that he or she is unable to do mathematics problems before endeavouring the problem or even before the teacher describes the problem. A student may have a bad viewpoint about mathematics. In mathematics class student might be apprehensive and not able to sit still or concentrate on the lecture. Math anxious students may fear even to attend mathematics class. The bigger apprehension for student is to answer teacher's question wrongly in mathematics class than other subject classes. They additionally tend to compare their evaluations with their peers progressively and worry more over how their peers will respond to them in the event when they give a wrong reply in mathematics class. They fear taking more advanced mathematics classes (Hsiu-Zu, 2000). Students with mathematics anxiety may feel humiliated, upset, disappointed, and fearful (Buxton, 1981). Not only with respect to these external symptoms, teacher should also try to know his students as best he can so he can tell if any of the students have these negative frame of mind about mathematics. The teacher does this by monitoring the students’ outward expressions
and non-verbal communications, among other indicators. Students may encounter mathematics anxiety because they have never got good marks in mathematics tests in mathematics class. This can be due to poor instructions also. If the teacher does not teach effectively in class, the normal student will most likely not do well in his class. Additionally, the student may have taken less number of mathematics classes which results him to be unprepared for the class he is in. This could particularly be a problem in schools where teachers are unequivocally demoralizing their students against getting good marks. There false supposition that mathematical ability is natural and only certain people will ever have the ability to succeed in mathematics (Perina, 2002). The teacher needs to fight these false suppositions as he sees that his students trust them. After understanding the outcomes of being anxious about mathematics, it helps the mathematics teacher to prevail the mathematics anxiety from their students. Mathematics anxiety critically blocks the students' working memory (Perina, 2002). A student with mathematics anxiety has included trouble working a problem.

Students with mathematics anxiety also have test and social anxiety as well (Perina, 2002). Again, students with mathematics anxiety are less hopeful to continue working on problems if they fail to understand in their first attempt. Mathematics anxiety begins at various ages for various people. Some students may undergo mathematics anxiety in third or fourth grade (Jackson & Leffingwell, 1999). It’s the students only that how they handle the tough data in order to learn hastening or to prevent mathematics anxiety. This has a considerable measure to do with how they try to understand the problem. Do they study the textbook or their notes from class, or they simply surrender the moment that they don’t know what to do? The essence of mathematics anxiety is thought to occur in middle school when students undergo increasing social pressures (Perina, 2002).

Thus we can conclude that there are two types of symptoms of mathematics anxiety which are categorised as Physical symptoms and Psychological symptoms and are listed as in table 1.12.1
Table 1.12.1 Physical and Psychological symptoms of mathematics Anxiety

<table>
<thead>
<tr>
<th>Physical Symptoms of Mathematics Anxiety</th>
<th>Psychological Symptoms of Mathematics Anxiety</th>
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<tbody>
<tr>
<td>• Squeamish stomach.</td>
<td>• negative talk with itself</td>
</tr>
<tr>
<td>• clammy hands and feet</td>
<td>• frighten</td>
</tr>
<tr>
<td>• increased or irregular heartbeat</td>
<td>• uneasiness</td>
</tr>
<tr>
<td>• muscle tension, clenched fists</td>
<td>• desire to quit the situation</td>
</tr>
<tr>
<td>• tight shoulders</td>
<td>• a feeling of inability</td>
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<tr>
<td></td>
<td>• mental complications</td>
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<td></td>
<td>• feelings of failure</td>
</tr>
<tr>
<td></td>
<td>• extreme tension</td>
</tr>
<tr>
<td></td>
<td>• inability to recall material studied</td>
</tr>
</tbody>
</table>

1.12.2 CAUSES OF MATHEMATICS ANXIETY

The mathematics teacher at any grade challenges serious obstacles to teaching his students mathematics and one of the biggest obstacles for him is to teach those students who have mathematics anxiety. Mathematics anxiety is described as different type of fear for mathematics that can step-in with manipulating numbers and finding mathematical problems within a variety of everyday life and academic aspects (Buckley & Ribordy, 1982). Fear can be seen as turbulence in the mind of some students suffering with mathematics anxiety. The mind may also pause and the student may undergo physical tension and inflexibility (Buxton, 1981). It has been estimated that sixty six percent of grownups hate and fear mathematics (Furner & Duffy, 2002). These negative feelings toward mathematics influence the student’s capacity to perform well. This negative feeling towards mathematics makes the mathematics teacher's job of teaching his students to succeed in and acknowledge mathematics extremely difficult, but not impossible. Having knowledge about math anxiety would be of great use to mathematics teacher while teaching his students. The National Council of Teachers of Mathematics developed standards in 1989 for the curriculum and evaluation of mathematics at all grade levels. These standards express five general objectives for all students:- (1) that they learn to rate mathematics, (2) to become sure in their capability to do it, (3) to become mathematical problem-solvers, (4) to figure out how to convey mathematically and (5) to figure out how to reason
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Mathematically, (National Council of Teachers of Mathematics, 1989,). Math anxiety in students would particularly block the quality they put on mathematics and their assurance that they can do mathematics. Some students dislike mathematics simply for the reason that they are afraid of it and don't feel like they can comprehend the concepts. Same students who have mathematics anxiety do not try as hard to understand and finish their homework as students who do not have. The students who have an apprehension of mathematics accept that in the event that they don't comprehend the homework in first time when and they will never comprehend it. They set themselves up for disappointment before they even endeavour to succeed. Knowing this, teacher faces numerous questions i.e. at what age does math tension start, what causes mathematics anxiety, and so many.

Mathematics anxiety is due to poor test grades, inadequacy to attempt and finish difficult assignments, negative motivation of parents, and also because of mathematics teacher too. Parents and teachers that are fear of mathematics pass that on to their wards and students (Furner and Duffy, 2002). Under these circumstances when their parents do not do well in mathematics well results the same for their children and their children does not take it as an important subject and on the other hand when the parents of students who have love for mathematics will reflects the positive image on their children to hinder the mathematics anxiety. If teacher does not give importance to mathematics, his students surely can't be expected to value mathematics either. There are number of things that a mathematics teacher can do which will incite his students to hate mathematics. The teacher might be seen as not taking care of students because he is involuntarily to give additional help to students who need it. The teacher may get furious or frustrated when his students do not understand the problems. The teacher may likewise have unreasonable desires of his students. Explaining the textbook problems one by one can turn students off from learning mathematics. Giving heavy homework every day and force the students to solve them in the only which in which his teacher gave and rejecting the other correct methods, and giving mathematics problems as punishment for misbehaviour results the students to dislike mathematics (Furner and Duffy, 2002).

Another important cause of mathematics anxiety is the teaching approach of "explain practice- cram" (Steele and Alfred, 1998). The mathematics teacher should be innovative in his teaching strategies, so students do not lose their interest (Pyne et al.,
In this study, teacher taught elementary mathematics to college students who did not achieve the basic concepts to be enrolled in a course they required. The researchers found that these students are filled with negative feelings towards mathematics. Therefore, to overcome this negativity towards mathematics, they decided to concentrate on adopting different teaching strategies, methods of evaluation, and support sessions. They supported an innovative approach of teaching mathematics to their students because they wanted their students to be good in mathematics instead of being passive listeners. Teachers provoked the students to make their own choices about what type of practice they required in mathematics. Many teachers advance the false thought that females cannot carry out more effectively as compared to males in mathematics (Jackson and Leffingwell, 1999). They believe that boys are more capable of succeeding in mathematics than girls. Teachers who promote this thought results in girls to leave the concepts or sums in mathematics without even attempting them. Sometimes teachers are keen to help male students than females, and sometimes teachers even tell students in mathematics class that girls need not to learn mathematics. The mathematics teacher needs to give measure up to chance to both male and female students to succeed in his mathematics classes. The teacher should support, rather than discourage females to take mathematics classes. Likewise, certain circumstances have a tendency to bring out mathematics anxiety. Knowing these circumstances permits the teacher to attempt to reduce them. The primary situation that realizes this negative feeling is the presence of an authority figure (Buxton, 1981). The teacher is seen as making judgments about right and wrong; which puts lot of pressure on the student. In spite of the fact it is not conceivable for the teacher to allow their students to sit unbothered in mathematics class. Teacher can discover new ways to make their presence less frightening. Mostly students have a misinterpretation that they should be able to do mathematics quickly; this stresses on speed resulting in nervousness. This view of mathematics gave birth to speed drills that occur regularly in elementary schools. Teachers should give stress on the reasons behind speed drills and distinguish their goal from the goal of homework and tests. Students should be demonstrated that mathematics requires concentrated and continuous consideration and many times mathematics needs time to do it accurately. Another way time influences the student is the point at which student knows he will have a test or be given homework later on. This delay causes
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trepidation to set in. There is a continuous approach of an unwanted event which one knows that he can't make distance from it, so he begins to panic. When a mathematics test is declared, students begin to fear it. This extended anxiety raises fear and apprehension. The student joins the apprehension of not succeeding on the test, the instability of having the capacity to do the problem, and the direness to complete it on time - all of which cause anxiety. Individuals don't care to allow their fears and deficiencies to other individuals, so they fear going to class where they might be requested that do the problem or sum on the board before other students (Buxton, 1981).

Thus on the basis of above discussion we can conclude that mathematics anxiety can be related to:

• Dealings of parents, teachers or other individuals in the learning environment
• Some particular incident in a student’s mathematics history which was terrifying or humiliating.
• Weak self-concept caused by previous record of failure

Teaching strategies which stresses:

• Time bounds
• The right reply
• Accuracy with speed in getting the answer
• Competition among students
• Working in disengagement
• cramming rather than understanding

Student state of mind:

• Dropped stitch concept
• Doubt of instinct or capacity
• Negative self-talk
• Surrendering before truly starting
• Fears and sentiments of getting fail
1.13.0 CONCEPT MAPPING, ACHIEVEMENT AND CREATIVITY AS A FACTOR OF MATHEMATICS ANXIETY:

Olugbemiro et al. (1990) in their study concluded that use of concept mapping is helpful in meaningful learning. They concluded that concept mapping is significantly more effective than traditional method and reduces the anxiety among students. Johnny (2008) studied the relationship between Mathematical creativity and Mathematical anxiety. The relation between Anxiety in Mathematics and Mathematical creativity was found be real and low. Thus it is found that performance of the students taught through concept mapping shows significant increases in gain scores of achievement and creativity and factor related to anxiety found that performance of student in mathematics is perched by math anxiety i.e. higher the anxiety in mathematics poorer is the performance and lesser the mathematic anxiety, better is the performance, Ramirez et al (2013).

1.14.0 EMERGENCE OF THE PROBLEM

Learning process is generally complex but it is not unpredictable. Learning has played significant role in cultures around the world and has been the part of formal study particularly since Renaissance of the 14th-17thcenturies (Aspinwall, 1992). In class room teaching-learning process, learning totally depends upon the teaching strategies adopted by the teacher. From different instructional strategies like teaching through lecture-discussion method, teaching through concept mapping, teaching through CAI etc; teaching through concept mapping boosts the achievement of the individuals. Concept mapping has its roots in education. Like other strategies teaching through concept mapping depend upon it how it is used, for which subject it is used and under which conditions it is used. In a review of the educational effectiveness of the concept mapping (Horton et al., 1993) concluded that concept mapping have educational benefits. According to Allen, Kompella & Hoffman (1993) that by constructing concept maps, the areas that appear trivial may be dropped from the course. The important themes can be discovered and emphasized. The teacher can understand how students may see or organize knowledge differently from them, which help the teacher to relate their teaching to students and to challenge their ways of thinking. The mapping process can help to identify concepts that are way to more than one discipline, which help the teacher to move beyond traditional disciplinary
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The teacher can visually explain the conceptual relationship used for achieving objectives in any course. The teacher can facilitate efforts to re-conceptualize course content. The teacher can use concept maps to provide a basis for discussion among students and to summarize course concepts. Concept maps support holistic style of learning, by teaching with the help of concept mapping in class room teaching increases the ability to provide meaningfulness to the students by integrating concepts. Concept maps can increase potential to see multiple ways of constructing meaning for students. Student generated concept maps can also help to make student thinking visible. They can gain an appreciation of just how they understand a concept by viewing their visual representation of a concept. Thus considering all the points given by Allen, Kompella & Hoffman (1993) the present study further investigates the effect of concept mapping as one of the teaching strategy.

According to Douglas and Kristin (2000) teaching strategies and methods are worth careful consideration as teacher strives to improve their teaching practices and resulting in improvement of the students achievement. The individual opportunity to learn mathematics depends upon mathematical achievement. ‘Opportunity to learn’ (OTL) was the first international study by Husen (1967). In this study strong coordination was found between the students’ opportunity to learn and students’ achievement in mathematics. Along with OTL Tuncay and Omar (2009) gave several factors like curriculum, instructional strategies and techniques, teachers proficiency in math education, school context and facilities, self directed learning arithmetic ability, encouragement & motivation and Anxiety which effects the achievement of the students. Thus considering all the points the present study investigates the effect of concept mapping on mathematics achievement of the individual.

According to Rhodes (1961) the creativity is referred with four P’s i.e. Person, Process, Press and Product. Rhodes (1961) also defined the word creativity as the phenomenon in which person communicates a new concept. But for the students the concept of mathematics is of “a digestive process rather than a creative one” (Dreyfus & Elsenberg, 1996). Thus in the teaching learning process, the teaching strategy can play a vital role in nurturing the creativity among students along the achievement of the particular subject. Thus the present investigates the effect of teaching strategy i.e. concept mapping on the achievement and on the creativity in particular subject i.e. in mathematics.
Mathematics anxiety is a major issue that the students and teacher are facing in the present scenario. The mathematics teacher particularly need to check the causes and effects of math anxiety as well as to help students to overcome it. There are many indications of the math anxiety including unwillingness to solve mathematics problem and trepidation of mathematics classes. Mathematics anxiety blocks student’s working memory (Perina, 2002). It happens in various ages of various people for various reasons. The main reason of the math anxiety is the teacher himself. Students tend to internalize their teacher’s interest and passion for teaching mathematics. (Jackson and Leffigwell, 1999). As if a teacher has a bad approach about mathematics, his students most probably will too. Mathematics teacher can take many steps to overcome math anxiety including revising basic mathematics skills, by giving detailed information to the students about mathematical language, mathematical signs and by providing proper support for their students (Schwartz, 2000). The more a teacher comprehends mathematics anxiety the more he will have the capacity to anticipate it and help students to overcome it. Thus the present study further investigates the effect of concept mapping strategy in mathematics in relation to mathematics anxiety in students.

Thus on the whole the purpose of the present study is to investigate the effect of concept mapping as teaching strategy on the mathematics achievement, its effect on mathematical creativity in relation to anxiety on mathematics.

1.15.0 STATEMENT OF THE PROBLEM

The problem under investigation is entitled as:

EFFECT OF CONCEPT MAPPING STRATEGY IN MATHEMATICS ON ACHIEVEMENT AND MATHEMATICAL CREATIVITY IN RELATION TO ANXIETY IN MATHEMATICS

1.16.0 OPERATIONAL DEFINITIONS

1) Concept mapping

Concept mapping refers to representing the concepts of mathematics topics enclosed in circles and boxes and the relationship indicated by connecting lines linking two concepts and phrases in the lines specify the relationship between the concepts.
2) **Achievement**

Achievement refers to success or proficiency attained in mathematics subject which will be assessed with achievement test in mathematics.

3) **Mathematical creativity**

Mathematical creativity refers to items pertain to overcome fixation, problem posing and problem solving/ testing solutions, as divergent production of semantics units, symbolic units, semantics classes, symbolic classes, symbolic relations, figural systems, symbolic systems, figural transformations, figural implications and symbolic implications.

4) **Mathematics anxiety**

Mathematics anxiety refers to learned phenomena on account that an individual has negative cognito-affective reactions (worry-fear/tension/physiological reactions etc.) towards mathematics.

1.17.0 **OBJECTIVES**

1. To study the effect of instructional strategy on mathematics achievement of IX grade students.
2. To study the effect of gender on mathematics achievement of IX grade students.
3. To study the interaction effect of instructional strategy (concept mapping / conventional method) and gender on mathematics achievement of IX grade students.
4. To study the effect of mathematics anxiety on mathematics achievement of IX grade students.
5. To study the interaction effect of instructional strategy (concept mapping/conventional method) and mathematics anxiety on mathematics achievement of IX grade students.
6. To study the effect of instructional strategy on mathematical creativity of IX grade students.
7. To study the effect of gender on mathematical creativity of IX grade students.
8. To study the interaction effect of instructional strategy (concept mapping / conventional method) and gender on mathematical creativity of IX grade students.

9. To study the effect of mathematics anxiety on mathematical creativity of IX grade students.

10. To study the interaction effect of instructional strategy (concept mapping/conventional method) and mathematics anxiety on mathematical creativity of IX grade students.

1.18.0 HYPOTHESIS

H 1(a). There is no significant difference in the adjusted means scores of Mathematics Achievement of Experimental and Control Groups by considering Pre- Mathematics Achievement as covariate

H 1(b). There is no significant difference in the adjusted means scores of Mathematics Achievement of male and female students by considering Pre- Mathematics Achievement as covariate

H 1(c). There is no significant effect of Interaction between Treatment and Gender on Mathematics achievement of students by considering Pre- Mathematics Achievement as covariate

H 1(d). There is no significant effect of Mathematics Anxiety on Mathematics Achievement of students by considering Pre-Mathematics Achievement as covariate

H 1(e). There is no significant effect of Interaction between Treatment and Anxiety on Mathematics achievement of students by considering Pre-Mathematics Achievement as covariate

H 2(a). There is no significant difference in the adjusted means scores of Mathematical Creativity of Experimental and Control Groups by considering Pre- Mathematical Creativity as covariate

H 2(b). There is no significant difference in the adjusted means scores of Mathematical Creativity of male and female students by considering Pre- Mathematical Creativity as covariate
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H 2(c). There is no significant effect of Interaction between Treatment and Gender on Mathematical Creativity of students by considering Pre-Mathematical Creativity as covariate

H 2(d). There is no significant effect of Mathematics Anxiety on Mathematical Creativity of students by considering Pre-Mathematical creativity as covariate

H 2(e). There is no significant effect of Interaction between Treatment and Anxiety on Mathematical Creativity of students by considering Pre-Mathematical Creativity as covariate

**1.19.0 DELIMITATIONS**

1. The study will delimit to schools affiliated with Punjab School Educational Board.

2. The study will delimit to IX grade students.

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