EFFECT OF DIGITAL CONCEPT MAPPING ON ACHIEVEMENT IN SOCIAL SCIENCE AND CREATIVE THINKING ABILITY OF HIGH SCHOOL STUDENTS

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CHAPTER – I

INTRODUCTION AND CONCEPTUAL FRAMEWORK

Education is the most powerful weapon that can be used for the transformation of the world- Nelson Mandela.

Education is the key to success for any nation. In a competency based world of today education is crucial to the entire developmental process of a country. The quality of the nation depends on the quality of education imparted to its citizens. The aim of education is to provide desirable changes in pupils for the all-round development of his personality. The need of twenty first century is not the sole development of academic skills in learners, but to help them grow into mature ones, so that they can cope with different situations in life.

Education is the basic condition for the development of the 'whole man' and vital instrument for accelerating the well-being and prosperity of all, in every direction. Education is a complex idea. Educators have defined education in many ways.

Education means the manifestation of the divine perfection, already existing in many – Vivekananda

By education, I mean an allround drawing out of the best in the child and man, body, mind and spirit – Gandhiji

Education is the process of living through a continuous reconstruction of experiences. It is the development of all these capacities in the individual which will enable him to control his environment and fulfil his possibilities – John Dewey

The function of education is multidimensional within the school system and outside it. Therefore, scholars, thinkers and educationists differ about the nature of these functions. According to John Dewey, 'the function of education is to help the growing of a helpless young animal into happy, moral and efficient human being.' Daniel Webster says that, 'the function of education is to discipline feelings, to control emotion, to stimulate motivation and to develop religious sentiments.' (Dash, 2012)

Education begins at birth and continues throughout life till death. Like that, from the cradle to the grave, a human individual under goes continuous changes in physique, intellect and emotion. The dictionary of education defines education as, 'the aggregate of all the processes by which a person develops ability, attitudes and other forms of behaviour of practical value in the society in which he lives; the social process by which people are subjected to the influence of selected and controlled environment so that they may obtain social competence and optimum individual development.'

The vision of education emphasizes a holistic, interdisciplinary approach to develop the knowledge and skills needed for a sustainable future as well as changes in values, behaviour and lifestyles. This requires us to reorient education systems, policies and practices in order to empower every one, to make decisions and act in culturally appropriate and locally relevant ways to redress the problems that threaten our common future. In this way people of all ages can become empowered to develop and evaluate alternative visions of a sustainable future. (Panigrahi, 2003)

1.1.0 TEACHING OF SOCIAL SCIENCE

Teaching of social science is an integral component of general education up to secondary stage of school education because it helps the students to understand the society and the world in which they view. Social Science is a close and appropriate integration of the materials and learning experiences of History, Geography, Civics, Political Science, Economics etc. that helps in providing information about all essentials related to human society with regard to its organization and working during different periods belonging to its past and present and prediction about its future. It deals with the activities of individual as a member of the group. Social Science provides necessary knowledge, skills, attitudes, interests and values to children to become responsible and effective citizens of their country.

The Social Sciences are those subjects that relate to the origin, organization and development of human society especially to man in his association with other man (Bining and Bining, 1952). Moffatt (1950) defines the social sciences as "the compilation of all present knowledge concerning man and society that has been obtained through scholarly research and investigation". The new Encyclopaedia Britannica gives the scope of social sciences as "The Social Sciences, which deal with human behavior in its social and cultural aspects, include the following disciplines: Economics, Political Science, Sociology, Social and Cultural Anthropology, Social Psychology, Social and Economic Geography; and those areas of Education that deal with the social context of learning and the relation of the school to the social order. History is regarded by many of its practitioners as a Social Science and certain areas of historical study today are almost indistinguishable from work done in the Social Sciences (Aggarwal, 2006).

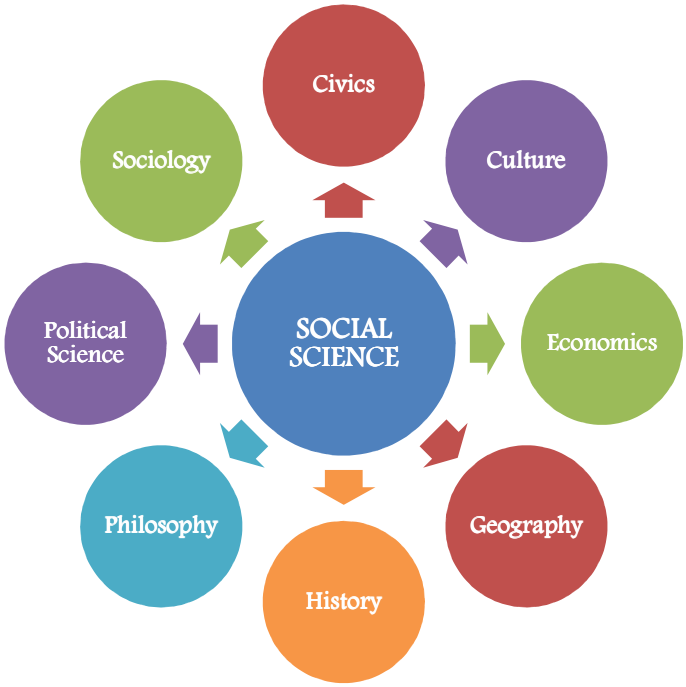


Figure: 1.1 Components of Social Science

Teaching of social science helps children to develop an insight into human relationships, social values and attitudes and also helps them appreciate other cultures along with our rich cultural heritage. This leads the children towards the highest aim of teaching social science "International Understanding". Besides these the teaching of social science is considered important for self-development of the students and for becoming effective and contributing members of society. Thus the most important point to be kept in view in the teaching of social science is to encompass the vast frontiers of the subject matter in such a way as to deepen the understanding of the child on the social, physical and cultural world around him, develop an insight into human relationships, values and attitudes and appropriate skills. According to Vashist (2004) "the social sciences dealing exclusively with man's problems, becomes essential in any programme of education which aims to preserve known values and to achieve new heights of social relationships".

1.1.1 Importance of Teaching Social Science in Schools

The subject Social Science deals with the study of the society and human relationships. Its study while on one hand helps in the desired knowledge and understanding of the society and the human relationships, it also on the other hand, fulfills the responsibilities of preparing the youngsters for contributing towards the progress and well-being of the society and nation. In this way the teaching of Social Science, if adopted according to the structure and needs of a society, must surely prove to be quite effective and useful in the realization of its objectives. Moreover, whatever may be the nature and composition of a society, one has a dire need of getting oneself acquainted with and adjusted in the existing pattern of a society, and the realization of this important need can be successfully met with the teaching and learning of Social Science in schools. The need of its study may be more prominently felt in the cases of those countries which follow the democratic principles in the organization and functioning of their country and hence have a prime responsibility of preparing young generation for exercising their functions as efficient and effective citizens of a democratic country (Mangal and Mangal, 2008).

The National Council for Educational Research and Training (NCERT) has outlined the need for the inclusion of Social Sciences in these words. “The study of Social Sciences as component of general education is of critical importance in facilitating the learner’s growth into a well informed and responsible citizen. It should aim at developing in him an understanding of his physical and social environment, both immediate and remote, in terms of time and space and an appropriation of the cultural heritage of India and various cultures of the world. The study of the Social Sciences should also aim at enabling him to see the present in the perspective of past developments (Aggarwal, 2006).

The importance of teaching Social Science in secondary schools is summarised under the following heads. (Mangal and Mangal, 2008)

1. **Training for effective citizenship**

   Every citizen should have a proper understanding of their rights, duties and privileges. The study of Social Science provides the needed education to the younger generation for growing into effective and efficient citizens of a democratic country. Bining and Bining (1952) emphasize "The most prominent of the objectives in secondary school is the training of pupils for effective citizenship. The materials of the Social Science provide the basis for making the world of today intelligible to the pupils, for training them in certain skills and habits and for inculcating attitudes and ideals that will enable students to take their places as efficient and effective members of the democratic society."

2. **All round development of the personality**

   Teaching of Social Science pay a proper attention towards the all-round development of the personality of the growing citizens of a country. Teaching of Social Science enables the students to develop qualities like intellectual conscience, tolerance, self-reliance, love of truth, unbiased attitude etc. Development of these qualities helps in the development of well-balanced personality.

3. **Development of democratic values**

   A democratic society is bound to pay equal treatment to all of its members without any discrimination in respect of caste, colour, sex , religion , socio – economic status etc. In this regards , it is quite proper for our country in getting wedded with the principles of equity, equality, fraternity, justice for all, socialism,

secularism, and feelings of peaceful co-existence, love and cooperation among its citizens. The inculcation of such values among the citizens is, however, a very challenging task. It can only be possible if serious attempts are made to inculcate them from the very tender age among our children by some or the other formal as well as informal system of education. The teaching and learning of Social Science plays a major role in this direction. It can provide substantial help in the development of all these democratic values among the students.

4. Development of broad mindedness

Every nation feels proud of its patriotic citizens and in a way tries to find ways and means for the development of the feelings of nationality among its children from the very beginning. No doubt, education can play a big role in this direction. However, the subject material and learning experiences related to social science can help a lot in this task. Its emphasis on knowing the men, society, environmental surroundings with a central focus on the human relationships may certainly help in the cultivation of the habits, interests, attitudes and feelings related to broad – mindedness, mutual love and respect for the feelings, faiths and choices of others, self-sacrifice, tolerance of opinions, group loyalty and patriotism in the youngsters from the early elementary grades. Initiating from the roots of the loyalty towards one' family neighbourhood, school, loyal community, state and nation, it can cultivate into the feelings of world-mindedness. Hence, the study of Social Science helps in the achievement of a very prominent objective of school education such as developing the feelings of nationality and international understanding.

It can be properly understood that the type of education needed for the younger generation of our country, wedded to the principles of democracy, socialism and secularism, can only be properly provided through the teaching and learning of social studies. The need of introducing social studies as a course of study in the schools may also be felt universally all over the globe, which is evident from the observation of the famous American author and scholar James Hemming (1950) who states, "The development of Social Science in our schools is not only desirable but urgently necessary if our young people are to be properly prepared for full personal life, if this country is to be provided with a sufficient proportion of self-reliant participants, mature citizens to make her survival as prosperous nation a practical possibility and if world mindedness is to be developed."

1.1.2 Aims of Teaching Social Science

The content of the social science curriculum and the methods and strategies to be adopted for its transaction will naturally depend upon the purpose for which the subject is being taught to pupils. The aims as well as the objectives of teaching Social Science are the basis for the entire process of teaching and learning. The general aims of teaching Social Science are the following (Sivarajan, 2008).

1. To acquaint the children with the past and present social, cultural and geographical environment and to gain insights.
2. To take a keen interest in the ways in which various socio-economic and political institutions assist and regulate human life.
3. To appreciate the rich cultural heritage of one's nation as well as of other nations.

4. To enable the students to recognize and get rid of what is undesirable and antiquated especially in the context of social change.
5. To develop a will and ability in every pupil to participate in the most important task of the reconstruction of society and economy with a sense of social commitment.
6. To develop a faith in the minds of students in the destiny of our nation in terms of promoting a spirit of tolerance and assimilation and peace and harmony among the people of the world.
7. To help pupils develop an insight into human relationships, social values and attitudes.
8. To participate effectively in the affairs of the community, the state, the country and the world at large.
9. To promote the values and ideals of humanism, secularism, socialism and democracy.
10. To inculcate attitudes and skills helpful for the maximization of economic and social welfare.
11. To enable the students to spend their leisure time properly.
12. To provide a pattern and experience study that will serve as a foundation for specialization at a large stage of education of the students.
13. To develop an appreciation of 3 R's- rights, responsibilities and relationship.
14. To develop qualities like clarity of thought, intellectual conscience courage, love of truth, initiative, self-reliance spontaneity, tolerance, unbiased attitude etc. which go a long way in the development of a well-balanced personality.

1.1.3 Objectives of Teaching Social Science

Social science has been considered as one of the major sources of energy required for fulfilling all the objectives of education. Now for the education of the 21st century, some of the major curricular concerns have been identified which can be taken as ideational objectives of Social Science (NCERT, 1999). These are:

i) Developing the sense of inter- dependence of man and environment- natural as well as social.

ii) Providing education to establish a socially cohesive society.

iii) Developing understanding of an egalitarian social system where everyone has access for equal opportunity.

iv) Strengthening national identity and preserving cultural heritage coupled with India's contribution to mankind.

v) Developing life skills and promoting social personal qualities.

vi) Instilling democratic norms and participatory behavior.

vii) Equipping the students to cope up with challenges of globalization.

viii) Developing the skills of learning to learn.

1.1.4 Methods of Teaching Social Science

A method of teaching is primarily a scientific way of transacting curriculum, keeping in mind the psychological and physical requirements of the children. Methods are the means of attaining predetermined goals. In fact it forms the most important link in the total teaching –learning cycle. It has on the one hand, the goals and purposes, and on the other hand results. Results can be in terms of cognitive development or the development of desirable habits, interests, attitudes and values and skills related to the various domains of human life.

Selection of appropriate teaching methods for providing learning experiences and organising teacher pupil activities is crucial for the achievement of curricular objectives. While selecting a particular method for teaching learning the teacher should consider factors like learner's capabilities, availability of resources, entry behaviour of students, objectives to be achieved and nature of content.

The Secondary Education Commission has emphasised the need for right methods of teaching in these words, "Every teacher and educationist of experience knows that even the best curriculum and the most perfect syllabus remain dead unless quickened into life by the right methods of teaching and the right kind of teachers. Sometimes even an unsatisfactory and unimaginative syllabus can be made interesting and significant by the gifted teacher who does not focus his mind on the subject matter to be taught or the information to be imparted but on his students – their interests and aptitudes, their reactions and response. He judges the success of his lesson not by the amount of matter covered by the understanding, the appreciation and the efficiency achieved by the students" (Aggarwal, 2006).

The growth of Science and technology tremendously changed the world. Therefore the education system also tries to gear itself to provide training to the younger generation to meet the growing challenges. In this juncture, we have to move towards the innovative methods of teaching. Concept mapping is an interesting and innovative technique of teaching.

1.2.0 CONCEPT MAPPING

Concept mapping is a powerful cognitive strategy to design the instruction for making the teaching learning successful and result oriented. By concept mapping even old and familiar material, recognize new relationships and meaning. The technique of concept mapping was developed by Novak and his research group in 1970s at Cornell University (Novak, 1998). David Ausubel (1963) published the theory of cognitive learning and this became the psychological foundation for Novak and his research group's work on concept mapping.

- According to Barbara Beyerbach (1988) Concept mapping is a technique of graphical representation of concepts to show their hierarchical interrelationships.
- Ault Charles (1985) defines Concept mapping as a study strategy which leads learners away from rote learning and move them towards true understanding of concepts and their interrelationships.
- Concept mapping is a technique for organizing and representing information (Dianne Raubenheimer and Kevin Oliver, 2006).
- Concept mapping is a powerful tool for stimulating learning (Jonassen, 2000).

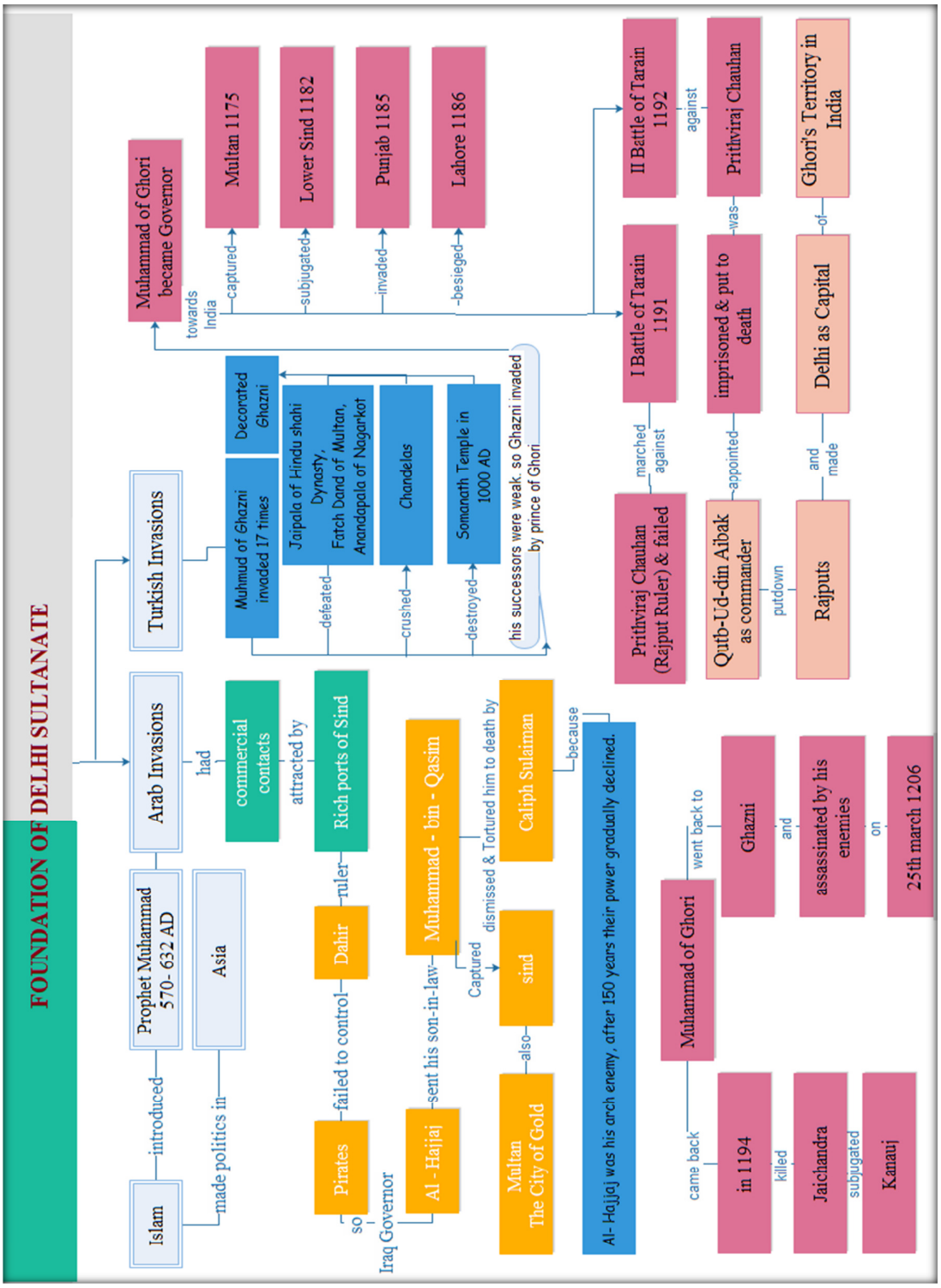
Concept maps are two-dimensional representations of cognitive structures showing the hierarchies and the interconnections of concepts involved in a discipline and a sub discipline. It is a teaching learning tool for facilitating meaningful learning. Concept maps are pictures or graphic representations that allow learners to link, differentiate and relate concepts to one another. Links provide information about the nature of the relationships. The links between the concepts can be one-way, two-way or non-directional. The concepts and the links may be categorized and the concept

may show temporal or casual relationships between concepts (Plotnick, 1997). Concept maps are constructed to represent visually represent visually meaningful relationships among concepts in the form of propositions. According to Novak and Canas (2006) “propositions are statements about some object or even in the universe, either naturally occurring or constructed. Proportions contain two or more concepts connected using linking words or phrases to form a meaningful statement”. The propositions are the element that marks concept maps different from other similar graphic organizers (e.g., mind maps).

Concept mapping enables people to visualise both the specific relationships among concepts and the hierarchical structure and organisation of these relationships. Concept maps should be hierarchical with superordinate concepts at the apex, labelled with appropriate linking words, and cross-linked so that relations between sub-branches of the hierarchy are identified. A concept map organized hierarchically is given in figure.

Figure: 1

A concept map organized hierarchically



Novak and Gowin (1984) defined concept mapping as a technique, which sees words essentially as labels for concepts or ideas, and individuals to define the relationship between them. They articulated that the hierarchical structure develops as new concepts are added, which are subsumed to more general inclusive concepts. The expansion of the hierarchy is governed by the principles of progressive differentiation, so that new concepts and links are added to the hierarchy either by creating new branches or by differentiating existing ones further. The external representations of cognitive structures, however, are not constrained by hierarchical concept mapping. Concept maps can also have a network, spider or chain structure.

The relationship between concepts can either be static or dynamic. A change in one concept can affect the state of the subsequent concept. A dynamic relationship between two concepts reflects and emphasizes the propagation of change in these concepts. It shows how a change in the quantity, quality, or state of one concept causes a change in the quantity, quality, or state of the other concept – signalling the functional interdependency of the two concepts involved. There are two features of concept maps that are important in the facilitation of creative thinking: the hierarchical structure that is represented in a good map and the ability to search for and characterize new cross-links.

1.2.1 Definitions of Concept Map

- Concept maps are graphical representations that illustrate how people visualize relationship between various concepts (Plotnick, 1997).
- A teaching-learning tool for facilitating meaningful learning (Novak and Gowin, 1984).

1.2.2 Steps in Constructing a Concept Map

Novak and Canas (2006) explained the following steps for the construction of concept maps.

Step 1: For the construction of a concept map, it is important to define the context for a concept map. Focus question is the starting point for constructing a concept map. Every concept map respond to a focus question, and a good focus question can lead to a much richer concept map.

Step 2: Select a meaningful paragraph from a text. Key concepts should be identified from the text. List these concepts as they are identified.

Step 3: Place the most inclusive concept at the top of the map. List the next most general, most inclusive concepts, working through the first list until all concepts are rank ordered.

Step 4: Add more specific concepts and do hierarchical arrangement of concepts.

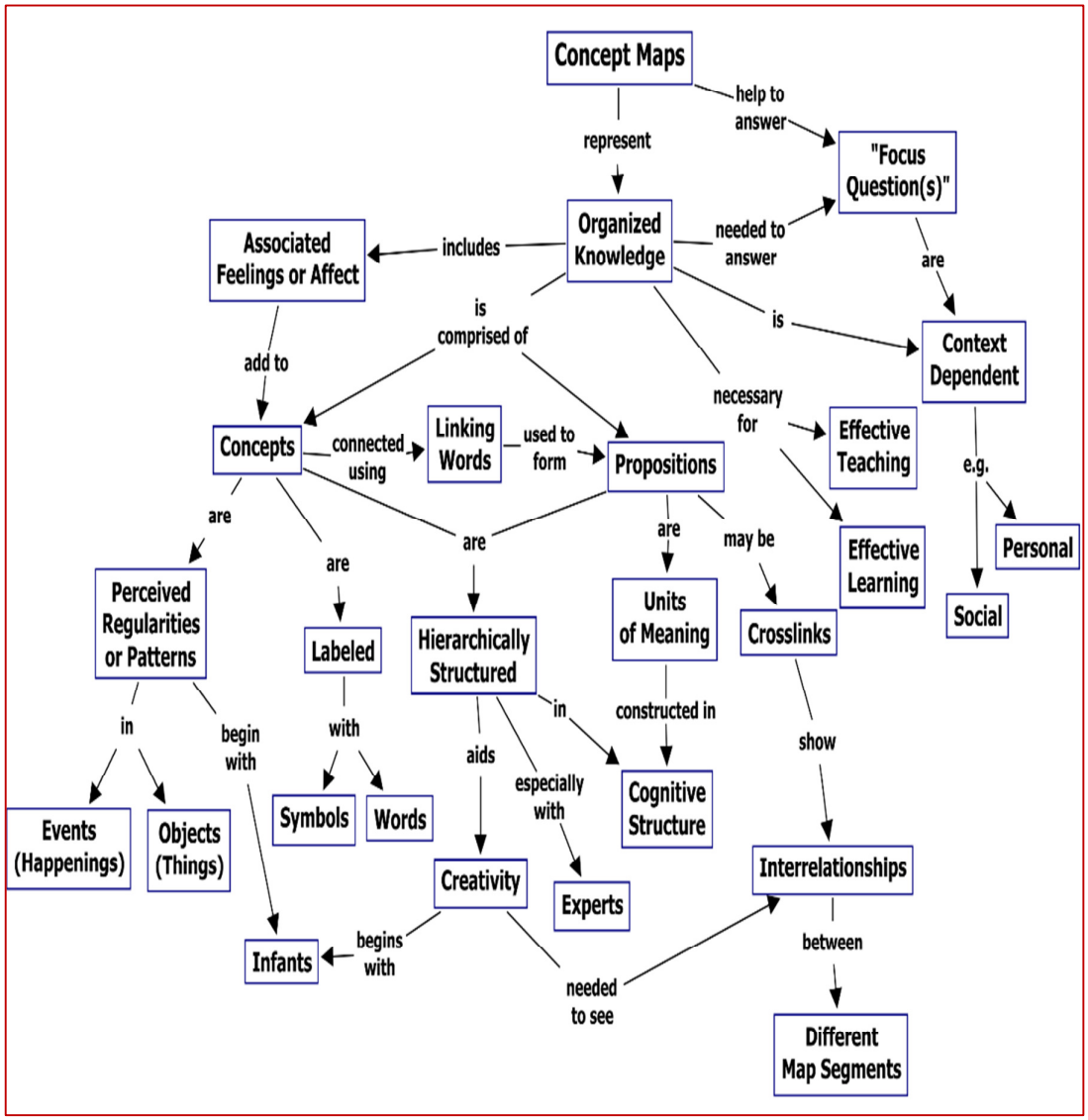
Step 5: Connect the concepts by lines and label the lines with linking words. Students can help in choosing good linking words to form the prepositions shown by the lines on the map. The linking words define the relationship between the two concepts. The connection creates meaning. Look for cross-links between concepts in one section of the map and concepts in another part of the concept 'tree'. Cross-links give more meaning to the concept mapping.

Step 6: Specific examples of concepts can be added to the concept maps. But these are not included in ovals or boxes. They are specific events or objects and do not represent concepts.

Step 7: A concept map is never finished after a preliminary map is constructed, it is always necessary to revise this map and other concepts can be added. Good maps usually result from three to many revisions. A conceptual mapping model of Novak and Gowin, is given below.

Figure: 1.2

Conceptual Mapping Model (Novak and Gowin, 1984)



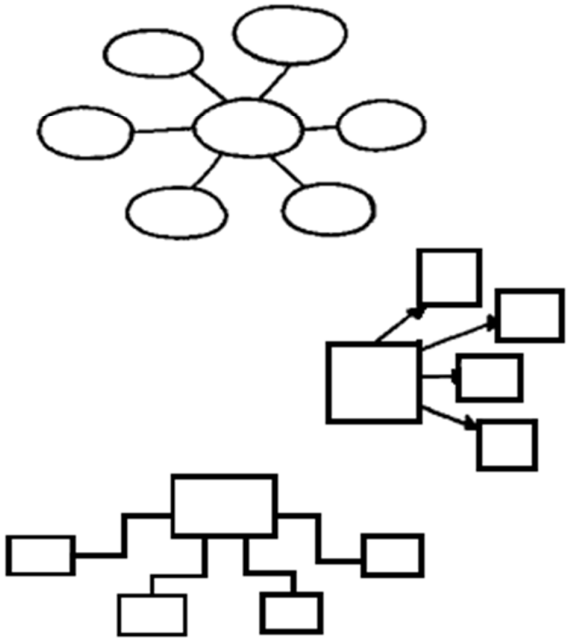
1.2.3 Kinds of Concept Mapping

According to the University of Illinois, US 2002, there are seven kinds of concept maps

- **A Spider Concept Map**: A Spider Concept Map is a kind of map that is used to investigate and enumerate various aspects of a single theme or topic, helping the students to organize their thoughts. It looks a bit like a spider's web; hence it is called as spider concept map.

Figure: 1.3

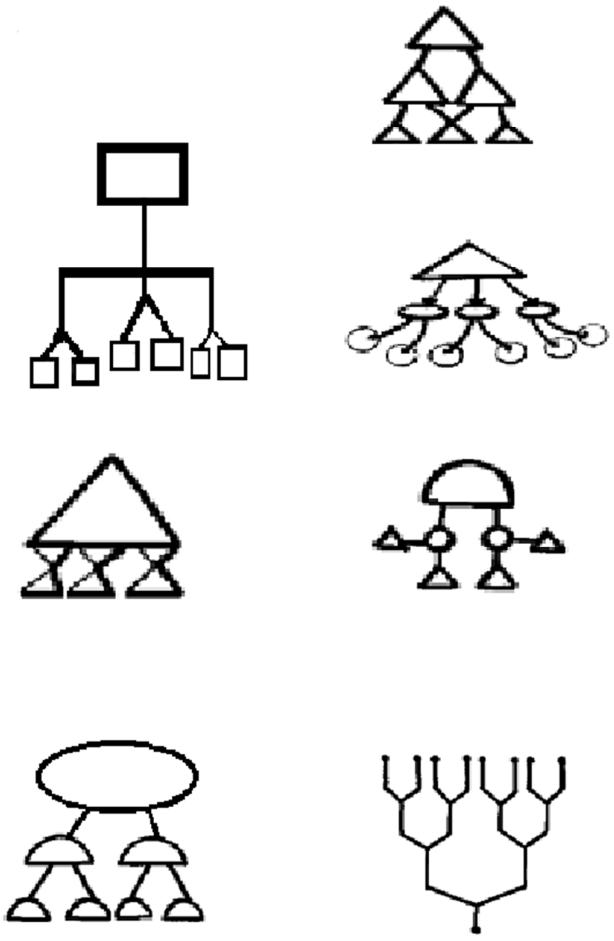
Spider Concept Maps



- **The Hierarchy concept map**: In hierarchy concept map information is structured from most inclusive and general to less inclusive and specific. The Hierarchy concept map presents information in a descending order of importance. The most important information is placed on the top.

Figure: 1.4

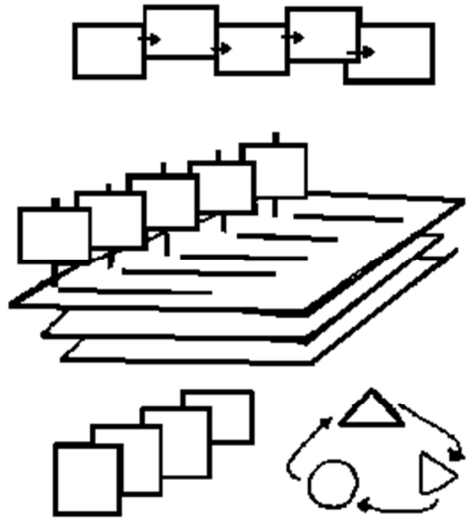
Hierarchy Concept Maps



- **The flowchart concept map**: In Flowchart concept map information is ordered in a linear format.

Figure: 1.5

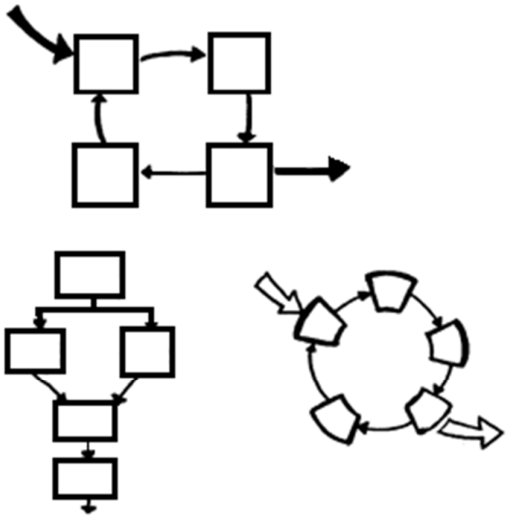
Flowchart Concept Maps



- **The systems concept map**: In systems concept map information is ordered like a flowchart with inputs and outputs.

Figure: 1.6

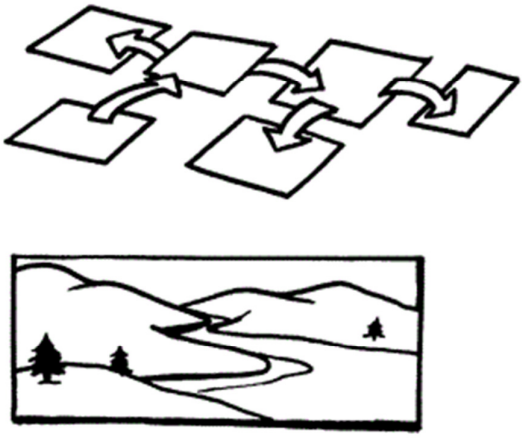
Systems Concept Maps



- **Picture landscape concept map**: It presents information in a landscape format.

Figure: 1.7

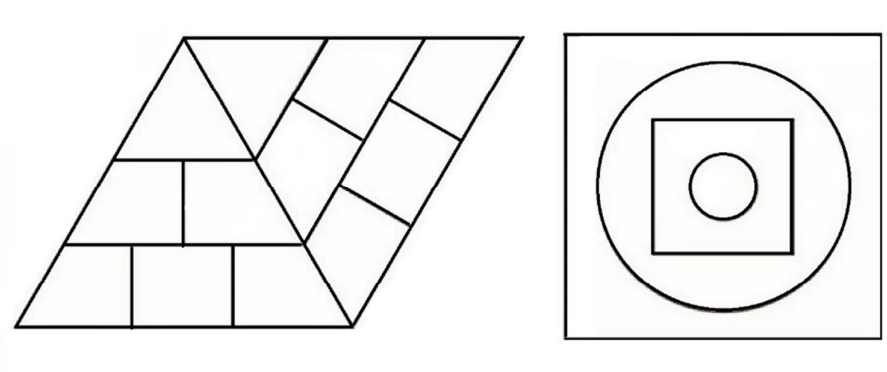
Picture landscape Concept Maps



- **Multidimensional concept map**: It describes the flow or state of information or resources which are too complicated for a simple two-dimensional map.

Figure: 1.8

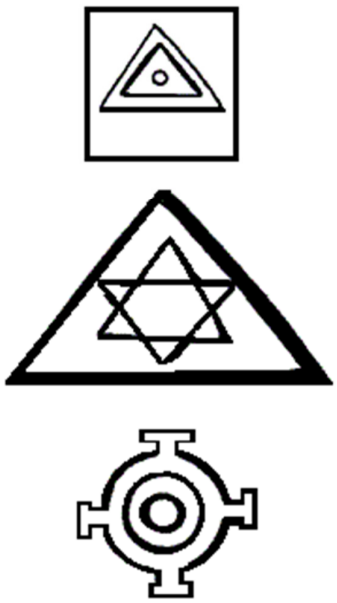
Multidimensional Concept Maps



- **Mandala Concept map**: Information is presented within a format of interlocking geometric shapes. A telescoping factor creates compelling visual effects which focus the attention and thought processes of the viewer.

Figure: 1.9

Mandala Concept Maps



1.2.4 CONCEPT MAPS IN EDUCATION

1.2.4.1. Concept maps for teaching and learning

Concept maps can facilitate teaching and learning in several ways. They help both teachers and students to identify the key concepts and principles that they must focus on for any specific learning task. Concept maps provide "a kind of visual road map" to connect meanings of concepts in propositions. Concept maps provide a graphical summary of what students have learned, which in turn help teachers detect and eventually break down students' misconceptions and misunderstandings (Novak and Gowin, 1984).

Concept maps were first used for research purposes as a tool to collect relevant data. As a teaching tool, concept maps can be used to help children clarify, organize, relate, and group ideas and information about a topic. Concept maps help teachers to identify, understand, and organize the concepts. Teaching can be made more meaningful by the use of concept maps. Concept maps prepared by the teacher help the students to use their prior knowledge effectively in understanding the new knowledge. Concept maps create interest among the students. While preparing the concept maps students can develop their innate potentialities. Concept maps play a pivotal role in the teaching learning process as research tool, teaching tool and learning tool. Thus, concept maps are helpful in the achievement of the objectives of teaching learning process.

1.2.4.2Concept Maps for Evaluation

Concept mapping is used as a tool to summarize understandings acquired by students after they study a unit or chapter. When concept maps are used in instruction, they can also be used for evaluation. The criteria for scoring concept maps can be used to assess and evaluate the performance of students with regard to their understanding of the subject. Concept maps can supplement the usual evaluation tools like test and examinations.

1.2.4.3. Concept Maps and Curriculum Planning

In curriculum planning, concept maps are very useful. They present the key concepts and principles to be taught in a highly concise manner. The hierarchical organization of concept maps suggests more optimal sequencing of instructional material. Using concept maps in planning a curriculum or instruction on a specific topic helps to make the instruction “conceptually transparent” to students.

1.2.5 Advantages of Concept Mapping

The advantages of concept mapping are the following (Mukundan and Padmakala, 2010).

- Concept map helps in understanding the relationship between various ideas put forth in a lesson and how these ideas lead to the general principles.
- Concept mapping is a learning strategy that allows learners to externalize their thinking in a visual/verbal form to improve students' understanding of learning.
- It helps to understand how the different general principles are themselves related.
- It helps to prepare a classified summary of the ideas learnt in a lesson. Starting from a general principle, each specific idea has to be put, one beneath the other in a hierarchial way. Linkage and cross linkage between the different general principles are to be indicated.
- It helps the teacher to prepare the lesson for his class.
- It can be given as a follow up activity to pupils so that it forms stimulated home assignment.
- This promotes analytical thinking in students and their learning becomes meaningful and comprehensive.
- Concept map can help someone creating a presentation to organize it in a logical format. They serve as a guide for creating concise, logical representations.
- It addresses different forms of learning and individual differences between students.

- With a concept map, students can often grasp ideas much more quickly than by reading them in an article or book.
- It also helps students to understand the hierarchy of ideas, understanding how each component relates to the others.
- Concept maps can be used as an assessment tool in school settings.
- It can encourage student-teacher interaction when they create a map together by discussing.
- It is easy to learn and teach.
- Scope based.
- Concept mapping is student-centered active technique.

1.3.0 DIGITAL CONCEPT MAPPING

Digital concept mapping technique is open ended approach which is enough for rich and detailed responses from students and also it is manageable for teachers to administer in the classroom. Digital concept mapping means preparation of concept maps in computer with the help of concept mapping software. Digital concept mapping in teaching and learning process means preparation of concept maps for particular topics in computers and teaching those topics with the help of prepared concept maps. Concept mapping applications help students visually represent logical or causal relationships between ideas associated with a certain phenomenon. In using concept-mapping apps, students identified a variety of key words. Students could insert the words into circles or boxes, drawing lines between ideas with spokes into which they inserted sub-topics. These connecting lines served to define the logical relationships between ideas (Divya and Usha, 2014).

Use of concept-mapping applications helps students collaboratively develop and expand topics. Online collaboration to create, revise, and develop maps with others is also a key feature. By sharing the same concept maps, a group of students working on the same project can visually represent their thinking for each other so that they are literally and figuratively on the same page. Students can then pose questions of each other based on their maps, for example, questions about connections between ideas or the need for more information to solidify understanding of a topic. While concept mapping can also be accomplished using paper and pencil, revision capabilities are limited. In the digital form, substantial changes can be made effortlessly, making revision more palatable to students.

Angelo and Cross (1993) indicated that concept maps develop student abilities in certain critical areas such as:

- The ability to draw reasonable inferences from observations
- The ability to synthesize and integrate information and ideas
- The ability to learn concepts and theories in the subject area.

Digital Concept mapping is a type of knowledge representation. The main purpose of digital concept mapping is to make the learner to understand the subjects in an easiest, interesting and meaningful way. De Simone, Schmid and McEwen (2001) combined the use of electronic concept mapping and online collaborative learning where concept mapping aids in externalizing the thinking of individuals or of the group as a whole.

1.3.1 Advantages of Computer Support for Concept Mapping

Jonassen (1990) proposes that few of the computer tools used today for learning have been designed as learning tools. Usually educators use existing tools for

teaching purposes. According to Jonassen, concept mapping computer tools belong to the rare category of computer tools that were designed specifically for learning. Some of the advantages of computer support for concept mapping include:

Dynamic Linking: Most computer assisted concept mapping tools allow the user to point and drag a concept or group of concepts to another place on the map and automatically update all the appropriate links.

Conversion: Once a concept map is created using a computer, the program usually allows the user to convert the map to different electronic formats. These electronic formats can be stored, sent, manipulated, used, printed, and deleted just like any computer file.

Communication: A concept map in digital format allows the user to send concept maps as attached files with e-mail messages, or include them in World Wide Web pages. Digitizing enhances the possibilities of using concept maps as communication tools.

Storage: Computer assisted concept mapping allows for digital storage of concept maps. Digital storage takes less space, makes retrieval easier, and is especially important if concept maps will be used on a large scale.

1.3.2 Advantages of Digital Concept Mapping

Digital concept mapping offers many benefits for both teachers and students.

- Digital concept mapping helps to organize a presentation in a logical format.
- Helps the learner to grasp ideas much more quickly than by reading them in an article or book. This visual mode of presenting information makes it easily comprehensible in a short time.

- Helps the students to understand the hierarchy of ideas, understanding how each component relates to the others. They also display cross-links between different components.
- It can be used as an assessment tool in school settings. After studying a unit, students could be asked to create a concept map as homework or in lieu of a standard test. It helps to illustrate their knowledge of a subject more clearly than multiple choice tests.
- It is valuable as a planning tool for essays or projects and also as a tool for teachers to assess student learning.
- It can be used as a communication tool for people to discuss concepts and the relationship between concepts.
- A concept map makes ideas concrete and visual, which can lead to greater understanding. Also, concept maps make it easy to integrate new knowledge with prior knowledge and understanding.
- Concept maps foster long-term memory and self-directed lifelong learning.

1.3.3 Procedure for Making Concept Maps on the Computer

For making concept maps in computer we need concept making software. By using of concept mapping soft ware colourful concept maps can be prepared.

Instructions

1. The first step is to open concept map tools in the computer.
2. Insert a circle by clicking "Insert" and then "Shapes." Click on the circle. Click and drag the mouse on the page to draw the circle.
3. Double-click on the circle and select the "Edit Text" icon from the "Format" toolbar. A cursor will now appear inside the circle, which helps to type the main topic for concept map.

4. Click and drag the circle to move it to the appropriate position on the page. The main topic can be placed at the top of the page or at the centre of the page. If the main topic is placed at the top of the page, place all subtopics underneath. If the main topic is placed in the centre of the page, place supporting information around it.
5. Insert circles for all of the information about the topic by repeating steps two and three.
6. Create connections among ideas by inserting lines or arrows among related concepts by clicking on "Insert," "Shapes" and selecting the line or arrow. Click and drag to position it on the page.
7. Add connecting words on each line or arrow. To do this, select "Insert," "Text Box," draw it in the appropriate position and add connecting text. Continue to add ideas and make connections till the map is complete.

1.4.0 CREATIVE THINKING

1.4.1 Thinking

Thinking is a special gift provided by nature to man. Human being is considered as a rational being because he is capable of thinking and reasoning. His superiority over other animals in learning and adjustment lies in his capacity for better thinking. In a broad sense, thinking includes all forms of cognitions, perceptions, imagination, memory and conception. Sometimes the term thinking is used to mean the process of problem solving. According to Ross (1951) “thinking is mental activity in its cognitive aspect or mental activity with regard to psychological objects.”The challenges and problems faced by the individuals or by society in general are solved through serious efforts involving thinking and reasoning.

1.4.2 Definitions of Thinking

- Thinking is an activity which consists essentially of a connected flow of ideas which are directed towards some end or purpose – Valentine (1965).
- Thinking is behaviour which is often implicit and hidden and in which symbols (images, ideas, concepts) are ordinarily employed – Garrett (1968).
- Thinking is an implicit problem-solving behaviour – Mohsin (1967).

1.4.3 Nature of Thinking

1. Thinking is essentially a cognitive activity.
2. It is always directed towards achieving some purpose.
3. Thinking is described as a problem-solving behavior. From the beginning till end, there is some problem around which the whole process of thinking resolves. But every problem-solving behavior is not thinking. It is related only to the inner cognitive behavior.
4. In thinking, there is mental exploration rather than motor explanation. One has to suspend one's overt or motor activities while engaging in thinking through some kind of mental exploration or the other.
5. Thinking is symbolic activity. In thinking, a mental solution of the problem is carried out through some signs, symbols and mental image.
6. Thinking can shift instantaneously over a span of time and space.

1.4.4 Different Kinds of Thinking

The different kinds of thinking are the following. (Mangal, 2014)

1. **Perceptual or concrete thinking**

This is the simplest form of thinking. The basis of this type of thinking is perception i.e. interpretation of sensation according to one's experience. It

is also called concrete thinking as it is carried out on the perception of actual or concrete objects and events.

2. **Conceptual or Abstract thinking**

Unlike perceptual thinking, this does not require the perception of actual objects or events. It is an abstract thinking where one makes use of concepts, and the generalized ideas and language. It is regarded as being superior to perceptual thinking as it economizes efforts in understanding and problem solving.

3. **Reflective thinking**

This is somewhat higher form of thinking. It aims at solving problems rather than simple problems. It requires reorganization of all the relevant experiences and the finding of new ways of reacting to a situation or of removing an obstacle instead of a simple association of experiences or ideas. Mental activity in reflective thinking does not involve the mechanical trial and error type of efforts. There is an insightful cognitive approach in reflective thinking.

4. **Creative thinking**

Creative thinking chiefly aimed at creating something new, novel or unusual. It looks for new relationships and associations to describe and interpret the nature of things, events and situations. The individual himself usually formulates the problem and is also free to collect the evidences and to fashion the tools for its solution. The thinking of the scientists or inventors is an example of creative thinking. It involves having different idea that works as well or better than previous ideas. Divergent thinking is

known as creative thinking. Divergent thinking starts from a common point and moves outward into a variety of perspectives.

5. **Critical thinking**

It is the type of thinking that helps a person in stepping aside from his own personal beliefs, prejudices and opinions to sort out the facts and discover the truth, even at the expense of his basic belief system. In this way it represents a challenging thought process which leads a person to new avenues of knowledge and understanding. It is a structural approach of thinking to find ways and means for the improvement of thinking process itself. It is a higher order well-disciplined thought process, which involves the use of cognitive skills like conceptualization, interpretation, analysis, synthesis and evaluation for arriving at an unbiased, valid and reliable judgment of the gathered or communicated information or data as a guide to one's belief and action.

1.4.5 Creative Thinking

The main goal of education should be the discovery and development of creative potentialities of the children. Creativity is the capacity of the individual to discover or produce new ideas. The ability to think creatively is an essential skill for everyone. By applying creativity, it is possible to break out of usual routines and patterns of behavior and to increase personal effectiveness. Creative thinking refers to the ability to form new combinations of ideas to fulfil a need, or to get original or otherwise appropriate results by the criteria of the domain in question. The outcome of creative thinking is novelty and innovativeness.

1.4.6 Definitions

Creative thinking means that the predictions and/or inferences for the individual are new, original, ingenious, and unusual. The creative thinker is one who explores new areas and makes new observations, new predictions, and new inferences – Skinner (1968).

Creative thinking is a special form of thinking, a way of viewing the world and interacting with it in a manner different from that of the general population. It is the ability to discover new solutions to problems or to produce new ideas, inventions or works of art - Levin (1978).

1.4.7 Nature and Characteristics of Creative Thinking

Creative thinking helps an individual to create, discover or produce a new idea or object including the rearrangement or reshaping of what is already known to him. The nature and characteristics of creative thinking are the following. (Mangal, 2014)

- Creative thinking, in all its shapes and forms, is absolutely an internal mental process and hence should be considered as an important component of one's cognitive behavior.
- Every one of us is capable of creative thinking and hence it is a universal phenomenon.
- Creative thinking results in the production of something new or novel.
- Any creative expression as a result of one's Creative thinking is a source of joy and satisfaction for the creator. Although our creative abilities involving Creative thinking are natural endowments, they can be nourished and nurtured by training or education.
- Creative thinking in all its dimensions involve divergent thinking instead of the routine and fixed type of convergent thinking.

- The mind must have complete freedom to wander around to create a new idea.
- The field of Creative thinking and its output is quiet comprehensive and wide. It covers all the aspects of human accomplishments belonging to an individual's life.
- The elements or factors in one's Creative thinking are: i) Ideational fluency, ii) originality, iii) flexibility, iv) divergent thinking, v) self-confidence and persistence, vi) ability to see and build relationships.

1.4.8 Stages of Creative Thinking

According to James and Alwan (2014) Creativity is an attitude of mind which is encouraged by openness of thinking, willingness to work with conflicting ideas and not to have the solutions immediately, eagerness to learn, an appreciation of the working of the unconscious and preparedness to play with an imagination and by a readiness to stand back and question the obvious. There are different stages in creative thinking.

Wallas identified four stages of creative thinking such as preparation, incubation, illumination and verification. (Patrick, 1964)

b) Preparation

Preparation is the first stage in the creative thought process. Preparation is made for the more discrete phases of a solution by certain approximate regional demarcations i.e. by phases in which necessary but not yet sufficient properties of the solution are demanded. Such implicit phases of a solution do not quite fulfil even the first prerequisite of a solution. It includes the sensing of a need or problem. The problem identified or analysed and this stage is set for its solution. Relevant facts and

materials considered essential for the solution are collected, analysed and a plan of action is formulated. Then work starts according to the set plan. During the preparation time the subject will receive new ideas.

c) Incubation

The period of incubation is characterized by the recurrence of the chief idea, which is finally adopted as the solution to a problem or the subject of a work of art in the stage of illumination. At the end of this stage, the idea which has been incubating is more clearly defined than it was at the beginning. This stage is characterized by overt behavior. During this stage, no new knowledge or experience is added to the existing stock.

d) Illumination

The stage of illumination follows incubation. Illumination is characterized by the suddenness and spontaneous appearance with which the hunch or correct idea appears, whether in the field of science or art. Another characteristic of illumination is the feeling of certainty and confidence which accompanies the appearance of the hunch or solution. The characteristics of the sudden idea are its fitness for the problem at hand, its capacity for expansion, and its vitality, freshness and originality. During this stage, the idea which has been incubating assumes definite form. The idea appears suddenly. It comes spontaneously, with a feeling of certainty. It is typically accompanied by an emotional reaction of pleasure, even joy or elation. This stage is generally of short duration. This stage of illumination is called Eureka, since the individual suddenly perceives the solution of this problem by insight. So illumination may occur anytime, even during dreams.

e) Verification

Verification or revision is the final stage in the creative process. The revision may be slight or involve much effort. During this stage the individual evaluates his hypothesis, submits himself to critical appraisal and even abandons his hypothesis if sufficient proof was not available. In this stage, the solution can be determined whether it is right or wrong. But sometimes the solution needs some modification.

1.4.9 Dimensions of Creative Thinking

The dimensions of creative thinking include fluency, flexibility, originality and elaboration. Guilford's three dimensional structure of intellect showed that each brick has its three main faces showing content, process and product, but the three dimensions are so closely related that in any psychological activity more contents, more processes and more products can go together. Creative thinking in Guilford's terminology includes fluency, flexibility, originality and elaboration and evaluative abilities (Sharma, 1979).

1. Fluency

It refers to the ability to take continuous advantage of a developing situation – to use each completed step as a new vantage point from which to assess the problem and move on. Fluency is the quantitative representation of the units of product. It emphasises the rate of production of all units within all classes. The total number of all units gives numerically the measure of fluency. Fluency is of four types: ideational, expressional, associational and word.

2. Flexibility

Flexibility represents number of classes of objects or trains of ideas produced. It indicates in how many distinct different ways an individual can respond to a

stimulus. Quantitatively it is a measure of variety. Thus the number of different classes of ideas or things determines the numerical value of flexibility. It differs from fluency in the way that the former is the representation of classes whereas the latter is that of units. Flexibility is of two types: spontaneous and adaptive.

3. Originality

It is the measure of quality. It indicates uncommonness or newness in the product. Therefore, various names like new, uncommon, unusual, clever, singular, individual, idiographic, non-classifiable, novel, unique, remote, infrequent, surprise etc. are used to designate original responses. The originality in terms of either figural or verbal or symbolic transformations, may be designated as uncommon or unusual.

4. Elaboration

It indicates expanding and combining activities of higher thought. It is to provide specification of details that contribute to the development of a general idea. Thus elaboration shows production of detailed steps, variety of implications and consequences which can be quantitatively measured. Elaboration can be drawn by the 'divergent production' process using 'figural', 'symbolic' and 'semantic' contents to give the product of 'implications'. The use of contents designates the elaboration as figural, symbolic or semantic etc. Elaboration can be used for both verbal and non-verbal products, as through planning, figure production etc.

1.4.10 Techniques for Fostering Creative Thinking

An important goal of education is to help the students become more creative. The current transmission and acquisition model of education is responsible for a creativity deficit in students, who ultimately fail to reach their full potential. The teacher has got an important role in developing creative thinking ability among

students. Teachers and parents should realize the need of creating an environment conducive to development of creative thinking abilities of children.

Santrock (2006) suggested some good strategies for developing creative thinking ability among adolescents.

- Have adolescents engage in brainstorming and come up with as many ideas as possible. Brainstorming technique allows the group to explore ideas without judgment.
- Introduce adolescents to environments that stimulate creativity. For this provide exercises and activities that stimulate them to find insightful solutions to problems, rather than asking a lot of questions that require rote answers.
- Don't over control. Letting the adolescents select their interests and supporting their inclinations are less likely to destroy their natural curiosity than dictating which activities they should engage in.
- Encourage internal motivation. Creative adolescents' motivation is the satisfaction generated by the work itself. Competition for prizes and formal evaluations often undermine intrinsic motivation and creativity.
- Introduce adolescents to creative people. Teachers should invite creative people to their classrooms and ask them to describe what helps them become creative or to demonstrate their creative skills.

Woolfolk, Misra and Jha (2010) have suggested the following guidelines for fostering creative thinking:

- Accept and encourage divergent thinking.
- Tolerate dissent.
- Encourage students to trust their own judgement. Emphasise that everyone is capable of creativity in some form.

- Provide time, space and materials to support creative projects.
- Be a stimulus for creative thinking. For this use class brainstorming sessions whenever possible. Encourage students to delay judging a particular suggestion for solving a problem until all the possibilities have been considered.

The other ways for fostering creative thinking are:

- Use of gaming technique, in a playful spirit help the children in the development of creative thinking. This technique provides valuable learning experiences in a relaxed spontaneous and evaluative situation.
- Provide opportunity for ego involvement. Actually, a child can be expected to put in determined efforts in to creative activities only when his ego is involved.
- The curriculum should be properly organized for the development of creative thinking ability among students. For this curriculum should cater to the individual needs of each student rather than to the generalized needs of all students.
- Teachers should increase the use of open ended questions.
- Make the students to change their routine work. Make them to do things in a different way.
- Make the students to combine some of the features of different objects or ideas to create several more.
- Factors like faulty methods of teaching, rigid habits of work unsympathetic treatment, over emphasis on school marks, authoritarian attitude of teachers and parents etc. may hinder the development of creative thinking ability. So parents and teachers should avoid such blocks to creative thinking.

1.5 NEED AND SIGNIFICANCE OF THE STUDY

The study of Social Science is an integral component of general education. Social Science is a compulsory subject during the first ten years of schooling. The study of Social Science is very important in creating knowledgeable and engaged citizens for our nation. Teaching of Social Science helps to analyze the social, political, and economic trends of the past.

Education is an important instrument for bringing out the potentialities of human beings. According to Piaget the most important aim of education is not to train individuals who repeat the previous generations, but to train inventors who are creative and possess the skill of producing new things. Creative thinking is absolutely an internal mental process and hence should be considered as an important component of one's cognitive behavior. Creative thinking is defined as thinking that enables students to apply their imagination to generate ideas, questions and hypotheses, and to evaluate their own and their peers' ideas, final products and processes. Edward De Bono says, "Creative thinking is not a talent; it is a skill that can be learnt. It empowers people by adding strength to their natural abilities which improves team work, productivity and where appropriate, profits".

NPE emphasizes the development of creative thinking and problem-solving abilities to make the teaching–learning process more successful and innovative in nature. It would also enhance the skill of "learning to learn" among the children. Suitable learning situations must be provided to develop various intellectual abilities and skills among the students. To make the teaching-learning process more meaningful and fruitful teachers have to select suitable strategies and create a good learning environment.

The lecture method is the most commonly employed method in schools for teaching Social Science. So far no attention has been given to innovative teaching methods to strengthen the educational programmes for developing Creative Thinking ability among the students. The National Policy on Education (1986) has stressed the necessity of innovative teaching learning strategies for the development of potentialities of the learners. (Shan, 1993)

To make teaching Social Science interesting and meaningful innovative teaching techniques like digital concept mapping can be used. Concept maps present the key concepts and principles to be taught in a highly concise manner. According to Novak (1984), concept map is the graphical and hierarchial representation of concepts that exists in the mind. This metacognitive tool can do a great deal to overcome the difficulties faced with respect to Social Science learning.

Use of digital concept maps in instruction on a specific topic helps to make the instruction "conceptually transparent" to students. If concept maps are used in planning instruction and students are required to construct concept maps as they are learning, previously unsuccessful students can become successful in making sense out of science and any other discipline, acquiring a feeling of control over the subject matter (Novak and Canas, 2006).

Digital concept mapping in teaching Social Science means the teaching of Social Science concepts through the use of the software concept mapping. It helps the students to understand Social Science concepts by actively and visually approaching them. Through digital concept mapping teaching learning process become more interesting and meaningful. By using concept maps, the learning process becomes active rather than passive.

A review of research literature revealed that limited studies have been conducted on digital concept mapping. Most of the studies are foreign studies. Studies conducted by Chiou, Lee, Tien, Wang, and Yu-Min (2017), Chiou, Lee, Tien, Wang, and Yu-Min (2017), Chang, Liu, Chen, Huang, Lai and Yeh (2017), Chang, Yeh, and Shih (2016), Chioua, Leeb, and Liua (2012), Schaal (2009) and Asan and Askin (2007) revealed that Digital Concept Mapping technique is effective in enhancing Achievement. Studies conducted by Afify (2018) Bai (2013), and Engelmann (2010) revealed that Digital Concept Mapping technique is effective in developing meaningful and constructive learning and Problem Solving ability. Study conducted by Widiana, Jampel, and Nyoman (2016) revealed that Mind Mapping technique is effective in developing Creative Thinking Ability. In India very few studies have been conducted on Digital Concept Mapping. Studies conducted by Divya and Usha (2014), Amma (2012) revealed that Digital Concept Mapping technique is effective in enhancing Achievement.

Even though educators and teachers are quite aware of the significance of digital concept mapping in teaching – learning process, they are not in a position to use digital concept mapping in teaching –learning process successfully. It is presumed that a study of this kind will be of immense use for the teachers and educators to redefine the process of instruction and to make Social Science teaching more effective and interesting. The present study is expected to be an exploratory study intended to investigate the effect of Digital Concept Mapping on achievement in Social Science and Creative Thinking Ability of high school students.

1.6 STATEMENT OF THE PROBLEM

The present study is designed to study the effect of Digital Concept Mapping on Achievement in Social Science and Creative Thinking Ability of high school

students. The problem selected for the study has been entitled as **"EFFECT OF DIGITAL CONCEPT MAPPING ON ACHIEVEMENT IN SOCIAL SCIENCE AND CREATIVE THINKING ABILITY OF HIGH SCHOOL STUDENTS".**

1.7 OPERATIONAL DEFINITIONS OF THE KEY TERMS

Effect

Effect refers to the outcome of the study when the influence of one factor or condition is dependent on the presence or absence of another factor or condition.

Digital Concept Mapping

Digital concept mapping means preparation of concept maps in computer with the help of concept mapping software.

Achievement in Social Science

Achievement in Social Sciences refers to the marks obtained by the students in the achievement test in Social Science constructed by the investigator.

Creative Thinking Ability

Creative thinking ability is the ability to discover new solutions to problems or to produce new ideas, inventions or works of art - Levin (1978).

In this study creative thinking ability refers to the scores obtained in the verbal and non-verbal test of creative thinking developed by Baqer Mehdi.

High School Students

High school students refer to the students studying in $9^{th}$and 10^{th}standard of high schools in Tamil Nadu following the syllabus prescribed by state board of Education. In this study, high school students refer to 9^{th} standard students.

1.8. OBJECTIVES OF THE STUDY

1. To prepare digital concept maps for teaching selected topics in Social Science of standard IX.
2. To study the effectiveness of digital concept mapping on achievement in Social Science of high school students for the total sample and sub samples based on sex and type of management of the school.
3. To study the effectiveness of digital concept mapping on creative thinking ability of high school students for the total sample and sub samples based on sex and type of management of the school.
4. To find out whether there is any significant difference in the ratings of students on the efficacy of digital concept mapping technique and lecture method in realizing the learning outcomes in Social Science.
5. To find out the extent of use of digital concept mapping technique by the high school teachers for teaching Social Science.
6. To find out the suitability of digital concept mapping for teaching Social Science in terms of existing syllabus.
7. To find out the extent of learning outcomes get through the use of digital concept mapping technique.
8. To find out the suitability of digital concept mapping technique for attaining the objectives of teaching Social Science.
9. To identify the practical difficulties in using digital concept mapping technique by the high school Social Science teachers.
10. To collect suggestions of teachers for the effective use of digital concept mapping technique for teaching Social Science at high school level.

1.9 HYPOTHESES FORMULATED

The following are the major hypotheses formulated for the present investigation.

- ***H 1*** There will be significant difference in the mean posttest scores of achievement in Social Science of digital concept mapping group and lecture method group with respect to the total sample and sub samples based on gender and type of management of the school.
- ***H 2*** There will be significant difference in the mean gain scores of achievement in Social Science of digital concept mapping group and lecture method group with respect to the total sample and sub samples based on gender and type of management of the school.
- ***H 3*** There will be significant difference between the means of pretest and posttest scores of achievement in Social Science of digital concept mapping group with respect to the total sample and sub samples based on gender and type of management of the school.
- ***H 4*** There will be significant difference between the means of pretest and posttest scores of achievement in Social Science of lecture method group with respect to the total sample and sub samples based on gender and type of management of the school.
- ***H 5*** There will be significant difference in the mean posttest scores of creative thinking ability of digital concept mapping group and lecture method group with respect to the total sample and sub samples based on gender and type of management of the school.
- ***H 6*** There will be significant difference in the mean gain scores of creative thinking ability of digital concept mapping group and lecture method group

with respect to the total sample and sub samples based on gender and type of management of the school.

- ***H 7*** There will be significant difference between the means of pretest and posttest scores of creative thinking ability of digital concept mapping group with respect to the total sample and sub samples based on gender and type of management of the school.
- ***H 8*** There will be significant difference between the means of pretest and posttest scores of creative thinking ability of lecture method group with respect to the total sample and sub samples based on gender and type of management of the school.
- ***H 9*** There will be significant difference in the mean rating scores on the efficacy of the digital concept mapping technique and lecture method in realizing the learning outcomes in Social Science.

1.10.0 METHODOLOGY IN BRIEF

The present study is intended to investigate the effect of Digital Concept Mapping on Achievement in Social Science and Creative Thinking Ability of High School Students. Hence, the investigator selected Experimental method for this study.

1.10.1 Experimental Design Selected

The investigator selected quazi experimental design. It is difficult for the investigator to arrange equivalent groups by matching students as it may disturb the daily routine class work. These difficulties can be overcome by conducting the experiment in normal classroom group which are normally non-equivalent groups. The design adopted for the present study was the non-equivalent pretestposttest design.

1.10.2 Variables of the Study

The independent variable selected for this study was methods of teaching. The investigator used digital concept mapping technique for the experimental group and the Lecture method for the control group. The dependent variables are achievement of students in Social Science and creative thinking ability.

1.10.3 Tools Used for the Study

The following tools were used in the present study:

- Lesson transcripts and Digital concept maps developed by the investigator.
- Achievement Test in Social Science prepared by the investigator.
- Verbal and Non-Verbal test of Creative Thinking developed by Baqer Mehdi (2015).
- Rating Scale on the Comparative efficacy of Digital Concept Mapping Technique and Lecture Method, developed by the investigator.
- Questionnaire for Teachers, developed by the investigator.

1.10.4 Sample for the study

The study was conducted on a sample of 145 ninth standard students selected from two schools viz. Government Higher Secondary School, Munchirai and Mar Gregorious Matriculation School, Kirathoor in Kanyakumari district. The experimental group consisted of 70 students and the control group consisted of 75 students. The experimental group was taught through the digital concept mapping technique and the control group through the Lecture method.

1.10.5 Statistical Techniques Used

The statistical techniques used for the analysis and interpretation of the data were t test, ANCOVA and Percentage.

1.11 LIMITATIONS OF THE STUDY

Certain limitations of the study as identified by the investigator are the following.

1. The study was conducted on a sample of 145 students only.
2. The study was limited to ninth standard students only.
3. The duration of the experimental study was limited to one month only.
4. The study was limited to schools which follow the syllabus prescribed by the state board of education.

In spite of the above limitations it is hoped that this study would serve as the basis for further research in this area.

1.12 ORGANISATION OF THE REPORT

Chapter I deals with the introduction, conceptual frame work, need and significance of the study, statement of the problem, operational definitions of terms, objectives, hypotheses, procedure of the study, limitations of the study and organisation of the report.

Chapter II deals with the review of related studies. It includes studies related to Concept Mapping, Digital Concept Mapping and Creative Thinking Ability.

Chapter III deals with methodology of the present investigation. This chapter consists of method adopted, tools used, experimental procedure, sample selected and statistical techniques used.

Chapter IV deals with analysis and interpretation of collected data.

Chapter V deals with the major findings, conclusions, educational implications of the study, and suggestions for further research.

CHAPTER- II

REVIEW OF RELATED STUDIES

The literature in any field forms the foundation upon all future work will be built. If we fail to build the foundation of knowledge provided by the review of literature our work is likely to be shallow and will often duplication work that has already been by someone else –

W.R. Borg

The review of related literature is an essential part of investigation. It allows the researcher to acquaint himself with current knowledge in the field or area in which he is going to conduct his research. Fruitful research can be carried out only after a process of analysis and interpretation of past research and thinking with current research. According to Mouly (1963), "The investigator can be sure that his problems do not exist in vacuum, and that considerable work has already been done, on problems which are directly related to his proposed investigation. The success of his efforts will depend in no small measure on the extent to which he capitalize on the advances both empirical and theoretical mode by previous researchers." Since effective research is based on past knowledge, review of related studies helps to eliminate the duplication of what has been done and provides useful hypotheses and helpful suggestions for significant investigation.

The investigator collected as much studies as possible related to different aspects of the problem under investigation. The studies reviewed are classified under the following heads.

1. **Studies related to Concept Mapping**
2. **Studies related to Digital Concept Mapping**
3. **Studies related to Creative Thinking Ability**

2.1. STUDIES RELATED TO CONCEPT MAPPING

2.1.1 INDIAN STUDIES

Charles, and Kumar (2018) conducted a study on the Impact of Concept Mapping and Modular Learning Techniques on Pupils' Achievement for the Selected Topics in Mathematics. In this study the investigator made an attempt to determine the effectiveness of using concept maps and modular learning techniques in improving the mathematics achievement of higher secondary students and compare it with the traditional approach for a mathematics unit. The study revealed that the concept mapping and modular learning techniques is effective in teaching Mathematics for the selected topics over the Conventional lecture method at the higher secondary school level.

Sukanya and Shailaja (2017) conducted a study on the effect of Concept Mapping on Academic Achievement of Students in Physics in Relation to Gender. The objectives of the Study were to study the significant difference between pretest and posttest of academic achievement in physics of male students in control group, to study the significant difference between pretest and posttest of academic achievement in physics of female students in control group, to study the significant difference between pretest and posttest of academic achievement in physics of male students in

experimental group and to study the significant difference between pretest and posttest of academic achievement in physics of female students in experimental group. The findings of the study were: The pretest and posttest scores of academic achievement of male students in physics in control group are similar, The pretest and posttest scores of academic achievement of female students in physics in control group are similar, The posttest scores of academic achievement in Physics of male students in experimental group are significantly higher as compared to pretest scores and the posttest scores of academic achievement in Physics of female students in experimental group are significantly higher as compared to pretest scores.

Sharma and Singh (2016) conducted a study on the effect of collaborative concept mapping strategy on achievement in Economics of IX graders. Here the investigator intended to investigate the effect of teaching through collaborative concept mapping strategy on the achievement in Economics. 600 samples were taken from IX class students from two Government secondary schools of Moga district of Punjab, India. Collaborative concept mapping strategy was applied to the experimental group and the controlled group was exposed to conventional method. The results of the study showed a drastic degree of variation in the achievement in Economics. The group exposed to collaborative concept mapping strategy was significantly high in their achievement as compared to that of the group taught by conventional method.

Chawla (2015) conducted a study on the "Effect of Concept Mapping Strategy on Achievement in Chemistry of IX Graders in Relation to Gender". The study investigated the significance of difference in achievement in Chemistry of the males and females taught through Concept mapping. Sample for the study consisted

of 236 (118 experimental group and 118 controlled group) IX class students from four Government schools of Ludhiana city. Experimental group was exposed to Concept mapping method and the controlled group was exposed to Conventional method (lecture and discussion). The results of the study showed that achievement in Chemistry of the group taught by Concept mapping was significantly more as compared to group taught by Conventional method. It was also found that males and females of experimental group do not differ in their achievement in Chemistry.

Chawla and Singh (2015) studied the "Effect of Concept Mapping Strategy on Achievement in Chemistry among IX Grader Females". The objective of the study was to investigate the effect of Concept Mapping on the achievement in Chemistry among female students. Experimental group was exposed to Concept Mapping method and the controlled group was exposed to conventional method (lecture and discussion). The study revealed that achievement in Chemistry of the females taught by Concept Mapping was significantly more as compared to females taught by conventional method.

Akila (2014) conducted a study on the effectiveness of concept mapping in learning Mathematics in standard IX students. The objective of the study was to find out the effectiveness of concept mapping over conventional method in learning Mathematics. Non-equivalent pretest and posttest parallel group design was used for the study. The sample consisted of 72 ninth standard students. The study revealed that concept mapping is more effective than the conventional method in learning Mathematics.

Shanbhag (2014) conducted a study on "Effectiveness of Concept Mapping as a tool in learning VIII Standard Geometry". The objectives of the study were to

study the effectiveness of Concept Mapping as a teaching tool in attainment of Geometry content and development of concept mapping skill and to study the gender difference in attainment of geometry content and development of concept mapping skill among VIII standard students. The study revealed that concept mapping as a teaching tool is effective in attainment of VIII standard geometry content and developing concept mapping skill. No significant difference was found between males and females of VIII standard in attainment of geometry content and concept mapping skill that have learnt through concept mapping.

Ramachandran and Vadivu (2014) conducted a study on "An innovative method of teaching-learning strategy to enhance the learner's educational process: paradigm shift from conventional approach to modern approach by neurocognitive based concept mapping". The main objective of this study was to examine the effect of NBCM strategy in teaching high school students in science. The study revealed extremely statistically significant difference between pretest and posttest of experimental group at 0.01 level of significance. Hence neurocognitive based concept mapping strategy enhances the students to secure good scores and this strategy can be implemented to various subjects.

Sharma, Harsana and Sharma (2013) investigated the "Effectiveness of Using Concept Maps in Science among VI Grade Students." The objectives of the study were to develop concept maps in science, to study the effect of using concept maps on achievement of VI grade student in science class, and to study the effectiveness of using concept maps over traditional method in learning concepts of science among VI grade students. The findings of the study were: the posttest achievement scores of students of control group were significantly higher than their pretest achievement scores. The posttest achievement scores of students of

experimental group were higher than their pretest achievement scores. A significant difference was found between the means scores of posttest of the achievement test administered to the control group and experimental group at 0.05 and 0.01 levels. This indicated the effectiveness of the learning through concepts maps over lecture method and provided that concepts Maps play positive role in enhancement of learning basic concepts of science.

Viji and Benedict (2013) conducted a study on "An expedition into the conceptualization of group concept mapping model and lesson template in science teaching."The objectives of the study were (i) to create and develop a fundamental structure for the Group Concept Mapping Model of teaching for implementing in the classrooms, (ii) to develop a lesson template on the Group Concept Mapping Model of teaching, and (iii) to identify the content areas in Science, for the application of Group Concept Mapping Model in actual classroom situations. The findings of the study were: Concept maps promote and assess conceptual change in a higher education setting, and therefore become an innovative tool in the evaluation of students' learning. Concept mapping forms a helpful metacognitive tool, promoting understanding in which new material interacts with the students' existing cognitive structure. It can be used to help children build a widespread framework of concepts and the relationships between them, and externalize their ideas. This assists teachers to assess children's conceptual development and understanding, identify misconceptions, and facilitate learning by building knowledge on old knowledge, thereby forming a comprehensive mental scheme.

Mehar and Singh (2013) conducted a study on "Effect of concept mapping strategy on achievement in Biology in relation to attitude towards Biology". The objectives of the study were (i) to compare the performance of group taught through

concept mapping strategy and conventional teaching strategy, (ii) to study the performance of students with different levels of attitude towards science, and (iii) to examine the interaction effect of concept mapping strategy and attitude towards science. The findings indicated that concept mapping strategy group had significantly higher achievement score as compared to the control group. Performance of students with different attitude towards biology taught through concept mapping strategy was found significant.

Sharma (2012) conducted a study on the Effect of Concept Mapping Strategy on the Learning outcome in Relation to Intelligence and study habits. The objectives were: 1. To develop the Concept Maps for teaching Social Studies Concepts from the curriculum of standard IX. 2. To prepare the achievement test of the selected topics of Social Studies to measure the Learning Outcome of students of standard IX. 3. To check the effectiveness of Concept Mapping Strategy in Learning Outcome in Social Studies. 4. To study the difference between high and low Intelligence groups in Learning Outcome in Social Studies. The result of the study showed that concept mapping strategy is significantly superior to traditional method in teaching Social Studies.

Jagadeesh (2012) studied the effect of concept mapping strategy on science achievement in relation to scientific aptitude and problem solving ability of secondary school students. The objectives of the study were to study the effect of concept mapping on science achievement of secondary school students and to identify the relative effectiveness of both conventional instruction and concept mapping in relation to scientific aptitude and problem solving ability. The study revealed that concept mapping strategy is effective in improving the achievement in science and in fostering scientific aptitude and problem solving ability. The concept mapping is an

innovative strategy for teaching science which was effective in fostering not only achievement in science and also in improving problem solving ability and scientific aptitude of secondary school students.

Chitra (2012) conducted a study on Preparation and Testing of Concept Maps for Teaching Chemistry at Higher Secondary Level. The objectives of the study were to prepare concept maps for teaching chemistry at higher secondary level and to test the effectiveness of concept maps for teaching Chemistry by comparing the achievement scores of treatment groups for total sample and sub samples. The study revealed that concept map group and activity method group differ significantly with regard to the posttest achievement scores. The difference was in favour of concept map group. The study also revealed that there is no significant difference between the mean scores of sub samples like sex, locale and type of management.

Sushma and Geetha (2011) investigated the effectiveness of concept maps in teaching social studies at secondary level. The objectives were to test the effectiveness of concept maps in teaching social studies at secondary level and to examine the significance of difference between the pretest and posttest scores of students in experimental and control group. The experimental group was treated with concept mapping and control group with lecture method. The study revealed that there is no significant difference between the control group and experimental group on pretest achievement scores in Social Studies and there is significant difference between the control group and experimental group on posttest achievement scores in Social Studies.

Gafoor and Ali (2011) studied the efficacy of concept maps to assess student teachers' understanding of physics. The objective of the study was to validate concept mapping as a tool for assessing conceptual understandings in secondary school

physics among student teachers. The study revealed that by using concept maps as a tool for evaluation, one can easily distinguish between students who have grasped and students who have not grasped a particular concept clearly.

Biju (2008) conducted a study on the effectiveness of concept mapping technique in comparison with the conventional method of teaching on the achievement in Geography of secondary school students of Kerala. The major finding of the study was that concept mapping technique is more effective than the conventional method of teaching.

Abhijina (2008) conducted a study on the effectiveness of concept mapping approach in teaching English grammar at higher secondary level. The study was conducted on a sample of 72 students of Standard VIII by using pretest, posttest non-equivalent group design. The study revealed that concept mapping approach excels the conventional approach in the attainment of English grammar at secondary level.

2.1.2 FOREIGN STUDIES

Abbas, Eldin and Elsayed (2018) conducted a study on the Effect of Concept Mapping and Mind Mapping Utilization on Students' Understanding Level: An Empirical Study. The purpose of this study was to investigate the effect of mind mapping (MM) and concept mapping (CM) on the understanding of challenging text. The study revealed that the students in the concept mapping group spent approximately half the time spent by students in the control group. Students in concept mapping and mind mapping groups performed better than those in the control group.

Akcay, and **Hakan (2017)** conducted a study on Constructing Concept Maps to Encourage Meaningful Learning in Science Classroom. The objective of this study was to demonstrate science teaching and assessing what is learned via using concept maps. Concept maps allow the students to understand the relationships between concepts of science by creating a visual map of the connections. Concept map have been used in science to promote meaningful learning and effective teaching. It can be used by students as a study tool or by teachers to evaluate students understanding of science and to enhance science teaching.

Aein and Aliakbari (2017) studied the Effectiveness of concept mapping and traditional linear nursing care plans on critical thinking skills in clinical pediatric nursing course. This study examined whether concept mapping helped students develop better CT skills than the traditional method in an undergraduate pediatric clinical course. The study revealed that concept mapping can be used as a clinical teaching learning activity to promote CT in nursing students.

Wilson, Kim, and **Wonsun (2016)** investigated the Effects of Concept Mapping and Academic Self-Efficacy on Mastery Goals and Reading Comprehension Achievement. The purpose of this study was to investigate the effects of concept mapping on mastery goal orientation and academic self-efficacy in a collaborative learning environment. The results indicated that concept-mapping did not increase mastery goals and mastery goals had no effect on test scores. In addition, the interaction effect between academic self-efficacy and condition did not increase mastery goals and had no effect on test scores.

Simper, Reeve and Kirby (2016) studied the effects of Concept Mapping on Creativity in Photo Stories. This research tested the use of concept map planning to

support the development of creativity in photo stories, hypothesizing that skills taught to support organization would improve creativity.

Okafor, and **Gabriel (2016)** conducted a study on Effect of Concept Mapping and Outline Note-Taking Patterns in Students Academic Achievement in Geography in Secondary Schools in Enugu South Lga of Enugu State. This study examined the effect of concept mapping and note-taking patterns on the academic achievement in Geography. A non-equivalent quasi-experimental research design was adopted by the researcher. The experimental group one was taught with concept mapping notes; experimental group two was taught with outline notes and the control group was taught with the conventional notes. The result of the study revealed that the students of the experimental groups achieved better than the control group with those taught using concept mapping being the best.

Erdogan and **Yavuz (2016)** made An Investigation of the Effectiveness of Concept Mapping on Turkish Students' Academic Success. The study revealed that the concept mapping instructional strategy had a significantly positive effect on the Turkish students' academic success. The effect of concept mapping instructional strategy in terms of academic success was higher than traditional method.

Mutodi, Chigonga and Benard (2016) conducted a study on Concept Map as an Assessment Tool in Secondary School Mathematics: An Analysis of Teachers' Perspectives. The purpose of the study was to find out teachers' views on concept mapping: its applicability; reliability; advantages and; difficulties. The findings indicate that Mathematics teachers generally perceive that concept map: is useful; effective; is a practical tool for teaching mathematical concepts; represents and

organizes knowledge; helps retention and recall of concepts learnt and; provides feedback on the understanding of the concepts learnt.

Ogonnaya, Patricia; Okafor, Gabriel; Abonyi, Okechukwu; and **Ugama (2016)** investigated the "Effects of Concept Mapping Instruction Approach on Students' Achievement in Basic Science". The study employed pretest posttest non-equivalent control group research design was used. The treatment group was taught basic science with concept mapping approach while the other was taught with conventional method. Results showed that concept mapping fosters students' achievement in basic science than conventional method.

Alhomaidan (2015) conducted a study on the Effectiveness of Concept Mapping on Learning: A Study in a Saudi College-Level Context. The objective of the study was to investigate the effect of using concepts mapping on developing the learning outcome of college-level students studying at the College of Technology at Arrass. The experimental group has been asked to employ concepts mapping in their learning, while the control group members were not given instructions to do so. Both groups were tested before and after the study. The posttests results showed that the experimental group members scored higher grades compared to counterparts in the control group.

Chia-Hui Hung and **Chen-Yung Lin (2015)** conducted a study on using concept mapping to evaluate knowledge structure in problem-based learning. The study employed concept mapping to illustrate the effects of PBL by examining the patterns of concepts and differences in the knowledge structures of students taught with and without a PBL approach. Results revealed that three categories of concept maps were identified as follows: isolated, departmental, and integrated. The students

in the control group constructed more isolated maps, while the students in the PBL group tended toward integrated mapping. Concept Relationships, Hierarchy Levels, and Cross Linkages in the concept maps were significantly greater in the PBL group; however, examples of concept maps did not differ significantly between the two groups.

Sakiyo, John; Waziri, Kawu (2015) conducted a study on Concept Mapping Strategy: An Effective Tool for Improving Students' Academic Achievement in Biology. The study investigated the use of concept mapping teaching method on secondary school students' academic achievement in biology. The result revealed that, concept mapping method enhanced students' academic achievement in biology.

Luchembe, Chinyama, Jumbe, and Jack (2014) conducted a study on the Effect of Using Concept Mapping on Student's Attitude and Achievement When Learning the Physics Topic of Circular and Rotational Motion. The purpose of this study was to show the effectiveness of concept mapping as a teaching strategy to undergraduate students taking introductory physics course. The mean post test score of experimental group was higher than the mean score of the control group. This showed that concept mapping was more effective than the tutorial sheet strategy. It was also found students had a positive attitude towards the use of concept mapping.

Ajaja (2013) examined Which strategy best suits biology teaching? Lecturing, concept mapping, cooperative learning or learning cycle. The objective of this study was to compare the achievement of students taught with concept mapping, cooperative learning, 5E learning cycle and lecture methods for identifying which one among them could be most suitable for teaching Biology. The major findings of the

study include: significant effect of the four instructional methods on achievement and retention; students in the 5E learning cycle and cooperative leaning groups significantly outscored those in the concept mapping and lecture groups on achievement and retention tests; students in concept mapping outscored those in lecture group both on immediate achievement and retention tests; students in 5E learning cycle and cooperative learning groups did not significantly differ on achievement and retention tests.

Hanan, **Youssef, Magda, and Mansour** (2012) conducted a study on the Effect of Concept Mapping on Students' Learning Achievement and Interests in Taif University. The objectives of this study were to find out whether concept mapping improved students' learning achievement in an advanced nursing course within the nursing baccalaureate program; and to identify students' attitudes towards using concept mapping as a learning tool. The study revealed that concept mapping strategy can significantly improve students' learning achievement compared to using a traditional teaching method. It was also found that most of the students were satisfied with using concept mapping in advanced nursing courses.

Nirmala and Shakuntala (2012) conducted a study on Attitude of Students on Concept Mapping - An Innovative Teaching Learning Strategy. The objective of this study was to identify the attitude of student nurses in relation to Concept mapping. The findings of the study were: the mean attitude score was 74.5% which showed that the students were in favor of concept mapping. 97% of the students had said that they can easily apply it to the nursing process and 77% of them agreed that it can be used for the entire subjects including non-nursing subjects like basic sciences. However, 61% of the students had said the preparation of concept mapping as a time

consuming task and they would prefer traditional method of writing care plans. They had expressed that concept mapping.

Paulette (2011) made a study on Concept Mapping and the Science Achievement of Third Grade Students. The objective of the study was to analyze the relationship between concept mapping and science achievement. The study examined whether a significant difference exists between the concept mapping (treatment) and the traditional (control) groups on posttest scores and on test scores across time and group. Results revealed a statistically significant effect was found within subjects' main effect across time and between subjects main effect by group.

Awofala (2011) investigated the Effect of Concept Mapping Strategy on Students' Achievement in Junior Secondary School Mathematics. The objective of the study was to find out the effect of concept mapping strategy on achievement in mathematics of 88 junior secondary year three Nigerian students. The study adopted a pretest, posttest nonequivalent control group quasi experimental design. Results showed that concept mapping is an effective strategy for teaching and learning mathematics. The strategy is also capable of improving students' mastery of content at the higher-order levels of cognition.

Karakuyu (2010) made a study on the effect of concept mapping on attitude and achievement in a physics course. The objective of this study was to investigate the effect of concept mapping on physics achievement and attitudes toward physics lesson. Results showed that there were no significant differences in the attitude and achievement between the experimental and control groups. However, the experimental group students were observed to have a tendency of more positive

attitude than the control group students. Results also showed that drawing concept map instruction was more effective than traditional instruction in improving physics achievement of the participating students.

Chei-Chang Chiou (2008) conducted a study on the effect of concept mapping on students' learning achievements and interests. The Objectives of the study were to find out whether concept mapping improved students' learning achievement in an advanced accounting course within the School of Management; and to identify students' attitudes towards using concept mapping as a learning tool. The study revealed that concept mapping strategy can significantly improve students' learning achievement compared to using a traditional expository teaching method.

2.2. STUDIES RELATED TO DIGITAL CONCEPT MAPPING

2.2.1 INDIAN STUDIES

Divya and Usha (2014) conducted a study on Effectiveness of computer based concept mapping strategy on retention in biology of students at secondary school level. The objectives of the study were, to study the effectiveness of computer based concept mapping strategy on total retention in biology of students at secondary school level, and to compare the effectiveness of computer based concept mapping strategy with constructivist teaching strategy on retention in biology of students at secondary school level under the category of objectives: Knowledge, Understanding and application. The findings revealed that computer – based concept mapping strategy used as experimental treatment is more effective than constructivist teaching strategy which is used as control group treatment on retention in biology of students at secondary school level.

Amma (2012) made a study on Preparation and Testing of Computer Assisted Concept Maps for Teaching Biology at Higher Secondary Level. The objectives of the study were to construct computer assisted concept maps on Recombinant DNA Technology for teaching higher secondary students, to test the effectiveness of the computer assisted concept maps and activity method for teaching the unit Recombinant DNA Technology and to compare the achievement of IX standard students in the control group and experimental group based on gender, type of management and locality. The study revealed that the computer assisted concept maps were more effective in enhancing the achievement of standard IX students, when compared to activity method. Significant difference was found in the posttest scores of students in control group and experimental group. It was also found that the computer assisted concept mapping is more effective with respect to retention capacity than the activity method of teaching.

2.2.2 FOREIGN STUDIES

Guyer (2019) investigated "The Effect of Digital Concept Maps in Online Learning Environments on Students' Success and Disorientation". The study investigated the impact of the use of digital concept maps as navigation tools in online learning environments on student success and disorientation. The study revealed that the success of students in both groups has a significant increase positively. Besides, students who used websites with a content tree are more successful than students who used websites with concept maps.

Afify (2018) conducted a study on "Learning content design standards based on interactive digital concepts maps in the light of meaningful and constructivist learning theory". The objective of the study was to identify standards of interactive

digital concepts maps design and their measurement indicators as a tool to develop, organize and administer e-learning content in the light of Meaningful Learning Theory and Constructivist Learning Theory. The investigator prepared a list of E-learning content design standards based on interactive digital concepts maps. It involved (11) general standards and (40) performance indicators. It was investigated by 21 teaching staff members who are experts in educational technology and e-learning to ration the list and its performance indicators. Results illustrated that standards are too significant and appropriate for the purpose of the study.

Chiou, Lee, Tien, Wang, and **Yu-Min** (2017) **a**nalyzed the Effects of Various Concept Mapping Techniques on Learning Achievement under Different Learning Styles. This study analyzed the effectiveness of different concept mapping techniques on the learning achievement of senior accounting students and whether achievements attained using various techniques are affected by different learning styles. The techniques are computer-assisted construct-by-self-concept mapping (CACSB), computer-assisted construct-on-scaffold concept mapping (CACOS), paper-and-pencil concept mapping (PAP), and traditional textbook exercise (TTE) methods. The study revealed that the two computer-assisted concept mapping techniques (CACSB and CACOS) are more beneficial to students' learning achievement than PAP and TTE.

Chang, Liu, Chen, Huang, Lai and Yeh (2017) conducted a study on "The Effects of a Collaborative Computer-based Concept Mapping Strategy on Geographic Science Performance in Junior High School Students". This study explored the effects of a collaborative computer-based concept mapping strategy on Geographic Science learning outcomes in junior high school students. The findings revealed that the Collaborative Computer-based Concept Mapping and Computer-based Concept

Mapping groups scored better than the group that received instruction on without concept mapping assistance on the post-test. On the retention test, the Collaborative Computer-based Concept Mapping group outperformed the group that received instruction without concept mapping assistance on all subtests.

Chang, Yeh, and Shih (2016) investigated "The Effects of Integrating Computer-Based Concept Mapping for Physics Learning in Junior High School". The study explored the effects of incorporating computer-based concept mapping in physics instruction. One group received computer-based concept mapping assisting instruction (CBCM), and the other group received "Work, Power, and Energy Curriculum" instruction without concept mapping assistance (NCM). The findings revealed that the CBCM group students scored higher than the NCM group students on the cognition understanding and higher order thinking subtests. The results of the study indicated that concept mapping activities effectively promote higher order thinking and knowledge retention.

Balim (2013) conducted a study on Use of Technology-Assisted Techniques of Mind Mapping and Concept Mapping in Science Education: A Constructivist Study. The aim of the study was to investigate the effects of using mind maps and concept maps on students' learning of concepts in science courses. The experimental group 1 was taught by using technology-assisted technique of mind mapping, experimental group 2 by using technology-assisted technique of concept mapping, and the control group by means of traditional classroom instruction. From this study it was found out that all groups' understanding of concepts was equivalent. Significantly, students in the experimental group 2 reported that learning through concept maps was useful and engaging.

Bai (2013) conducted a study on Using Digital Mapping Tool in Ill-structured Problem Solving. The purpose of this study was to investigate how using a digital concept mapping tool could affect students' problem solving in instructional design. It was found that the students who used the digital mapping tool performed better than those who did not use the tool in providing arguments when defining the problem and justifying the solutions. The results indicated that digital concept mapping could facilitate students' ill-structured problem solving.

Chioua, Leeb, and Liua (2012) made a study on Effect of Novak Colorful Concept Map with Digital Teaching Materials on Student Academic Achievement. The purpose of this study was to explore the effect digital teaching materials based on Novak colorful concept maps on improving student's learning performance for the Advanced Accounting. This study investigated if four kinds of digital teaching materials such as the CDMs, MCMDMs, hierarchical CCMDMs and clustered CCMDMs had difference in improving students' short-term learning achievements and long-term memories. The results of the study were: the MCMDMs and CCMDMs can significantly improve student achievement than CDMs. CCMDMs can significantly improve student long-term memory than MCMDMs and CDMs.

Schaal (2009) conducted a study on "Cognitive and motivational effects of digital concept maps in pre-service science teacher training. The objective of the study was to examine if the use of complementary concept maps influences achievement and motivational variables. The results revealed that different achievement levels for low- and high-intensity concept map users and concept map use might influence the learning outcome within the domain of human biology.

Furthermore, motivational variables influence the concept map use while it is not affected by the potential difficulties in using digital concept maps.

Asan and Askin (2007) conducted a study on Concept Mapping in Science Class: A Case Study of Fifth Grade Students. The purpose of this study was to determine the effects of incorporating concept mapping on the achievement of fifth grade students in science class. In this study the control group was given a traditional oral review of the material and the experimental group was exposed to the review by the use of Inspiration, which is computer based concept mapping tool. The results indicated that concept mapping has a noticeable impact on student achievement in science classes.

Tergan (2005) conducted a study on Digital Concept Maps for Managing Knowledge and Information. This study analyzed the potential of digital concept maps for supporting processes of individual knowledge management.

2.3 STUDIES RELATED TO CREATIVE THINKING ABILITY

2.3.1 INDIAN STUDIES

Senthamizh (2015) conducted a study on Creative thinking and achievement in History of high school students. The objectives of the study were to find out the significant difference in the mean scores of creative thinking and achievement in History of high school students with respect to gender, locality, religion, community and type of management and to study the correlation between creative thinking and achievement in History of high school students. The study revealed thatthe high school students have low creative thinking. Gender, locale, religion, community and type of management have influence on the creative thinking and achievement in

History of high school students. Creative thinking and achievement in History are positively and significantly correlated with each other.

Divya (2013) conducted a study on creative thinking and achievement in Mathematics among higher secondary students of Kanyakumari district. The objective of the study were to find out the creative thinking ability of higher secondary students, to compare mean scores of creative thinking ability of higher secondary students with respect to age, gender, locality, type of management, parental qualification and parental occupation, and to compare mean scores of achievement in mathematics among higher secondary students with respect to age, gender, locality, type of management, parental qualification and parental occupation. The study revealed that the higher secondary students possessed the average level of creative thinking and achievement in Mathematics. It was also found that age, type of school, qualification of parents, occupation of parents had influence on creative thinking and achievement in Mathematics. The study also revealed that gender and locality had no influence on creative thinking and achievement in Mathematics.

2.3.2 FOREIGN STUDIES

Ulger (2019) conducted a study on 'Comparing the effects of art education and science education on creative thinking in high school students'. The investigator intended to determine the role of art education in creative thinking. A causal-comparative research design was used. Results showed that creative thinking in visual arts students in Grade 10 with high scores differed significantly from that in music and science students; however, this difference was not found among students in Grade 11. From this study, it was concluded that the effect of different education

disciplines—called education department effect—on creative thinking can be significant.

Ulger (2018) studied the Effect of Problem-Based Learning on the Creative Thinking and Critical Thinking Disposition of Students in Visual Arts Education. The problem-based learning (PBL) approach was implemented as a treatment for higher education visual arts students over one semester to examine its effect on the creative thinking and critical thinking disposition of these students. PBL had a significant effect on creative thinking, but critical thinking disposition was affected to a lesser degree. The results of this study indicated that PBL can help students with non-routine problem-solving processes by maintaining uncertainty and enhancing creative thinking.

Anally, Helena, Robertson, Lindsay, Hancox and John (2018) investigated the effects of an Outdoor Education Programme on Creative Thinking and Well-Being in Adolescent Males. Here the investigator promoted the effects of an outdoor education programme (Tihoi) with no access to electronic media among 14 year-old males and compared creative thinking, socio-emotional well-being, and materialism with their peers attending regular classes at their normal school. The study revealed that a programme of outdoor activity and reduced media exposure may improve creative thinking and well-being in adolescents.

Selin (2018) investigated the Creative Thinking Tendency of Prospective Mathematics Teachers in Terms of Different Variables. This study investigated the level of creative thinking tendencies of prospective Mathematics teachers and examines this level in terms of different variables. The study revealed that the creative

thinking tendencies of the prospective mathematics teachers are high range in the total score section.

Wojciehowski, Ernst and Julie (2018) investigated the influence that a nature preschool experience has on the development of creative thinking in young children. Results indicated that nature preschooler's creative thinking scores increased significantly from pretest to posttest measures.

Copping and Adrian (2018) explored writing pedagogy in the primary classroom and connections between children thinking creatively and their achievement in writing. The study revealed that creative thinking contributes greatly to the writing process.

Widiana, Jampel, and Nyoman (2016) conducted a study on improving Students' Creative Thinking and Achievement through the Implementation of Multiple Intelligence Approach with Mind Mapping. The results of the study showed that the implementation of multiple intelligence approach with mind mapping improved the students' creative thinking and achievement in science.

Mohanty (2015) studied Information Processing and Creative Thinking Abilities of Residential and Non-Residential School Children. Here the investigator intended to assess and compare the residential and non-residential schoolchildren in information-processing skills and creative thinking abilities. The residential school children were found to perform better both in information processing and creative thinking tasks than the non-residential school children. Due to ashram environment, creative pedagogy, and various co-curricular activities, the residential school children were found to be more creative than their formal school counterparts. Significant

positive correlations exists between information processing skills and creative thinking dimensions.

Sriwongchai, Jantharajit, Chookhampaeng, and Sumalee (2015) developed the Mathematics Learning Management Model for Improving Creative Thinking in Thailand. The main objective of the study was to evaluate the effectiveness of model in efficiency of learning process, and to compare the pretest and posttest on creative thinking and achievement of students. The effectiveness of model based on achievement score was 76.25%, and based on creative thinking was 61.67%. The average posttest in achievement and creative thinking abilities of the experimental group were higher than pretest, and experimental group showed higher creative thinking than control group at the 0.01 level of significance.

Pany (2015) made a comparative study on Creative thinking ability of primary school males and females. The objectives of the study were to compare the creative thinking ability of primary school males and females, to compare the creative thinking ability of government and private primary school students, to compare the creative thinking ability of government primary school males and females, to compare the creative thinking ability of private primary school males and females, to compare the creative thinking ability of government and private primary school males, and to compare the creative thinking ability of government and private primary school females. The findings of the study were the primary school males and females, students of government and private primary schools, government primary school males and females, government and private primary school males differ significantly in their creative thinking ability whereas the private primary school males and

females, and the government and private primary school females do not differ significantly on their creative thinking ability.

He and Li (2015) conducted a study on Critical and creative thinking as learning processes at top-ranking Chinese middle schools: possibilities and required improvements. Findings of this study indicated that it is possible to acquire knowledge by thinking critically and creatively and the higher achieving students use such processes more intensively than lower achieving students.

Riga and Chronopoulou (2014) conducted a study to identify certain strategies and conditions that should be used by teachers in kindergarten so as to foster creative thinking and creative behaviours to children. The results of the study showed that following MacKinnon's approach could foster creative thinking and creative behaviours in kindergarten children.

Abascaland Diaz (2013) explored the relation between affect and production of creative thinking. The results indicated that positive affect, both general positive affect and the happy affect increased the production of creative thinking. Negative affect had no impact on the production of creative thinking, neither general negative affect nor the experimentally induced effects of sadness and anger.

Liu, Zhang, Zhang, Lee, Wang & Brownell (2013) studied autonomous Motivation and Chinese Adolescents' Creative Thinking: The Moderating Role of Parental Involvement. This study examined the relationship between autonomous/controlled motivation and creative thinking as well as the moderating role of parental involvement/autonomy support on this relationship. This study provided the result that autonomous motivation positively predicted creative thinking, and this relationship was moderated by parental involvement. For both junior and

senior high school students, autonomous motivation was more strongly related to creative thinking when there was high maternal involvement.

Lew (2012) investigated the relationships among Creative Thinking Ability, Creative Personality and Motivation. The results of the study were as follows: there were significant positive relationships between the intrinsic motivation and the creative personality of the young children but there were no statistically significant relations between the intrinsic/extrinsic motivation and the creative thinking ability. The intrinsic-high/extrinsic-high motivation group was higher than any other types of motivation groups in creative personality.

Robson and Rowe (2012) conducted a study on Observing young children's creative thinking: engagement, involvement and persistence. This study looks at young children's creative thinking as inferred through observations of their activities. Results showed that activities such as gardening and construction were as valuable for supporting creative thinking as ones traditionally associated with creativity, for example, music and painting. Outdoor play of all kinds and socio-dramatic play were also found effective.

Anwar, **Rasool and Haq** (2012) conducted a study on Comparison of Creative Thinking Abilities of High and Low Achievers Secondary School Students. The objectives of the study were to: Compare high achievers' and low achievers' creative thinking abilities and to identify the differences in student's creative thinking and level of achievement based on gender and residential area. The study revealed that there was no difference between high achievers and low achievers in terms of creative thinking abilities. Females and the students belonging to urban areas were found better in their creative thinking.

Scibinetti Tocci and Pesce (2011) attempted to study Motor Creativity and Creative Thinking in Children: The Diverging Role of Inhibition. The investigator made an attempt to investigate the commonalities and differences between motor creativity and creative thinking in children and how executive functions differently influence them. Results showed that there is no association between motor creativity and motor competence, but a significant association between creative moving and thinking for all their dimensions except for originality. Moreover, originality in thinking was predicted by low inhibitory ability, although originality in moving by high inhibitory ability.

Ogletree (1996) studied the Comparative Status of the Creative Thinking Ability of Waldorf Education Students. The objective of the study was to determine if there was a significant difference between the creative thinking ability of Waldorf students and state school students in England, Scotland, and Germany. The findings suggested that Waldorf students were more creative than their state school peers.

2.4 CRITICAL REVIEW

In this section a summary of the studies given in this chapter is given. The investigator reviewed 38 studies related to Concept Mapping, 13 Digital Concept Mapping and 21 Creative Thinking conducted in India as well as abroad. Majority of the studies were experimental. Most of the studies were conducted at school level. The studies related to the effectiveness of Concept Mapping on achievement include Charles and Kumar (2018), Sukanya and Shailaja (2017), Chawla (2015), Chawla and Singh (2015), Akila (2014), Shanbhag (2014), Ramachandran and Vadivu (2014), Sharma, Harsana and Sharma (2013), Mehar and Singh (2013), Jagadeesh (2012), Chitra (2012), Gafoor and Ali (2011), Wilson, Kim, and Wonsun (2016), Erdogan and

Yavuz (2016), Ogonnaya, Patricia; Okafor, Gabriel; Abonyi, Okechukwu; and Ugama (2016), Sakiyo, John; Waziri, Kawu (2015), Luchembe, Chinyama, Jumbe, and Jack (2014), Ajaja (2013), Hanan, Youssef, Magda, and Mansour (2012), Paulette (2011), Awofala (2011), Karakuyu (2010) and Chei-Chang Chiou (2008). All these studies indicated that Concept Mapping is effective in enhancing achievement.

The studies conducted by Sharma and Singh (2016), Sharma (2012), Sushma and Geetha (2011), Biju (2008) and Okafor, and Gabriel (2016) indicated the effectiveness of Concept Mapping on achievement in Social Science.

The results of the studies conducted by Aein and Aliakbari (2017) and Simper, Reeve and Kirby (2016) indicated the effectiveness of Concept Mapping in developing Creativity and Critical Thinking Skills.

The studies related to the effectiveness of Digital Concept Mapping on achievement include Divya and Usha (2014), Amma (2012), Chiou, Lee, Tien, Wang, and Yu-Min (2017), Chiou, Lee, Tien, Wang, and Yu-Min (2017), Chang, Liu, Chen, Huang, Lai and Yeh (2017), Chioua, Leeb, and Liua (2012), Schaal (2009) and Asan and Askin (2007). All these studies indicated that Digital Concept Mapping is effective in enhancing achievement. But studies on effectiveness of Digital Concept Mapping in developing Creative Thinking are very limited. The results of the studies conducted by Afify (2018), Chang, Yeh, and Shih (2016), Bai (2013), and Engelmann (2010) indicated the effectiveness of Digital Concept Mapping in developing meaningful learning, higher order thinking and Problem Solving.

The studies related to the relationship between Creative thinking ability and achievement include Copping and Adrian (2018) Senthamizh (2015), He and

Li (2015) and Divya (2013). The study conducted by Widiana, Jampel, and Nyoman (2016) indicated the effectiveness of Mind Mapping in developing Creative Thinking Ability.

The review of related studies helped the researcher to build on to the work of others by knowing what has been done or not done so far on the topic of his research study. It also provided the needed information and feedback for the planning and execution of the present study. Review of related studies revealed that very few studies have been conducted in India on the effectiveness of Digital Concept Mapping on achievement but the effect of Digital Concept Mapping on Creative Thinking Ability has not been explored by researchers. Hence the investigator has selected this topic for the study.

CHAPTER- III

METHODOLOGY

Research methodology is a way to solve the research problems systematically. A Well planned methodology that outlines the procedure in which the investigation is carried out is an essential pre-requisite for any systematic research. The vehicle of research cannot perform its function without it, since it is the methodology, which lays out the way that formal research is to be carried out and which outlines the detailed description of the research variables and procedures- Arvil S. Barr (1960). Methodology involves the systematic procedure by which the researcher starts from the initial step of identifying the problem to the final conclusion. It consists of the procedure adopted for conducting the study, tools used for collecting data, the details of the sample used and the statistical procedures used for the analysis of the data. The details of the methodology adopted by the investigator are presented under the following heads.

- Method adopted for the study
- Experimental Design selected
- Variables of the study
- Tools used for the study
- Sample selected for the study
- Experimental procedure
- Statistical techniques used

3.1 METHOD ADOPTED

Method in research refers to various procedures adopted in studying a problem with certain objectives. The success of research depends upon the suitability of the method adopted for the study. The selection of a suitable method depends upon the nature of the problem and the type of information to be gathered for obtaining the solution. The present study is concerned with investigating the effect of Digital Concept Mapping on Achievement in Social Science and Creative Thinking Ability of High School Students. Therefore, the investigator selected 'Experimental method' for this study.

3.1.1 Experimental Research

Experimental research describes what will be when certain variables are carefully controlled or manipulated (Best and Kahn, 2008). Experimental research is a type of research aimed at establishing the possible cause and effect relationship between variables under study through some systematic and well planned observations carried out in controlled conditions (Mangal and Mangal, 2015). Beyond discovering such casual relationship experimental research further seeks to explore how much cause will produce how much effect.

3.1.2 Experimental Design Selected

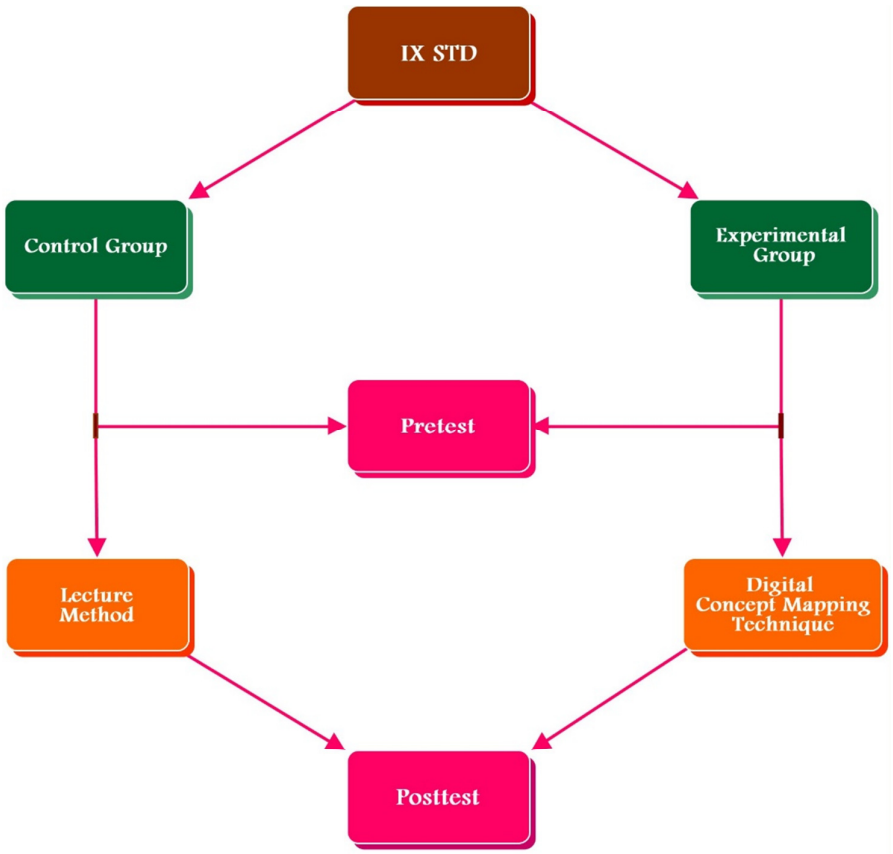
The research design is the conceptual structure within which the research is conducted; it constitutes the blue print for the collection, measurement and analysis of data (Kothari and Garg, 2016).In order to conduct an experimental study, an appropriate experimental design has to be selected. According to Best and Kahn (2008) 'the experimental design is the blue print of the procedures that enables the researcher to test his hypotheses by reaching valid conclusions about relationships between independent and dependent variables'. Selection of a particular design is

based on the purpose of the experiment, the type of variables to be manipulated and the conditions or limiting factors under which it is conducted'.

In this study the investigator used a quasi-experimental design. It is difficult for the investigator to arrange equivalent groups by matching students as it may disturb the daily routine class work. These difficulties can be overcome by conducting the experiment in normal classroom group which are normally non-equivalent groups. Hence the investigator decided to conduct the experiment in non-equated classroom groups. The design adopted for the present study was the non-equivalent pretest posttest design.

Figure: 3.1

Diagrammatic representation of Non-equivalent pretest posttest design



3.2 VARIABLES OF THE STUDY

Variables are the conditions or characteristics that the experimenter manipulates, controls or observes (Best and Khan, 2008).

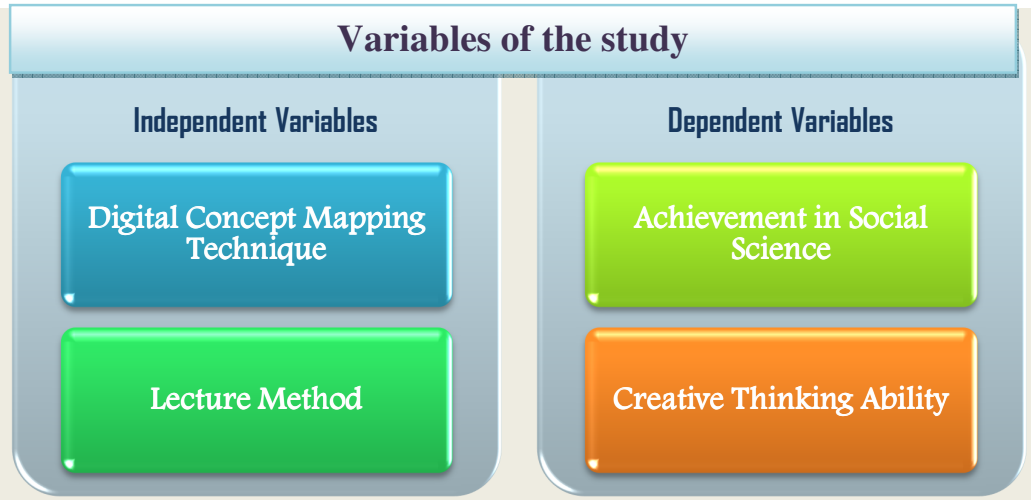
3.2.1 Independent Variable

Independent variables are those variables that are very much in control of the experimenter and are subjected to deliberate manipulation and variation by the experimenter for observing their effects on the dependent variable (Mangal and Mangal, 2015). The independent variables selected for the study were methods of teaching. The investigator used digital concept mapping technique for the experimental group and the Lecture method for the control group.

3.2.2 Dependent Variable

The dependent variables are conditions or characteristics that appear, disappear or change as the experimenter introduces, removes or changes independent variable (Best and Khan, 2008). In this study the dependent variables are achievement of students in Social Science and creative thinking ability. The variables of the study are presented in figure 3.2.

Figure- 3.2



3.3.0 TOOLS USED FOR THE STUDY

The following tools were used in the present study:

- Lesson transcripts and Digital concept maps developed by the investigator.
- Achievement Test in Social Science prepared by the investigator.
- Verbal and Non-Verbal test of Creative Thinking developed by Baqer Mehdi (2015).
- Rating Scale on the Comparative efficacy of Digital Concept Mapping Technique and Lecture Method, developed by the investigator.
- Questionnaire for Teachers, developed by the investigator.

3.3.1 Description of the Tools

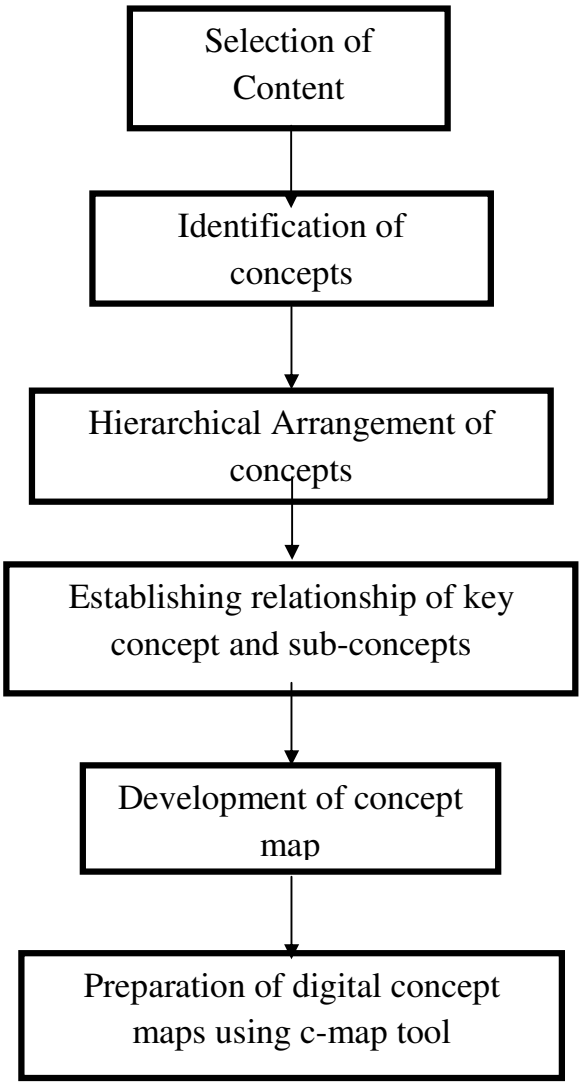
The details regarding the preparation of the tools used for the present study are given below.

3.3.2 *TOOL 1*: Digital Concept Maps

The investigator prepared the lesson transcripts and digital concept maps for teaching the selected topics in Social Science. The topics selected were Beginning of Modern Age, Industrial Revolution, Manufacturing Industries, Transport and Communication, The State Government and Rights and Duties. For the preparation of digital concept maps, the investigator analyzed the Social Science text books for ninth standard prescribed by the Tamil Nadu state board and other supplementary reading materials related to the topics. The investigator also collected information regarding the method of preparation of digital concept maps. The prepared lessons and digital concept maps were finalized in consultation with expects in the field of education.

a. Steps in Constructing the Concept Map

The digital concept maps were prepared by the investigator based on the following steps.



b. The Details of the Steps involved in the Preparation of Digital Concept Maps

SELECTION OF CONTENT

STEP: 1

The investigator selected the content from the Social Science text book for standard IX prescribed by Tamil Nadu state board.

STEP: 2

IDENTIFICATION OF CONCEPTS

Various concepts and sub-concepts are identified and enlisted them.

STEP: 3

ARRANGEMENT OF CONCEPTS

The listed concepts are arranged hierarchically with the broader or general concepts at the top and the less inclusive concepts at the bottom.

STEP: 4

ESTABLISHING RELATIONSHIP

The relationship between key concepts and sub concepts are analysed and various concepts are interlinked by using lines. These lines are labelled with linking words or phrases, which help to illustrate meaningful relationships between various concepts.

STEP: 5

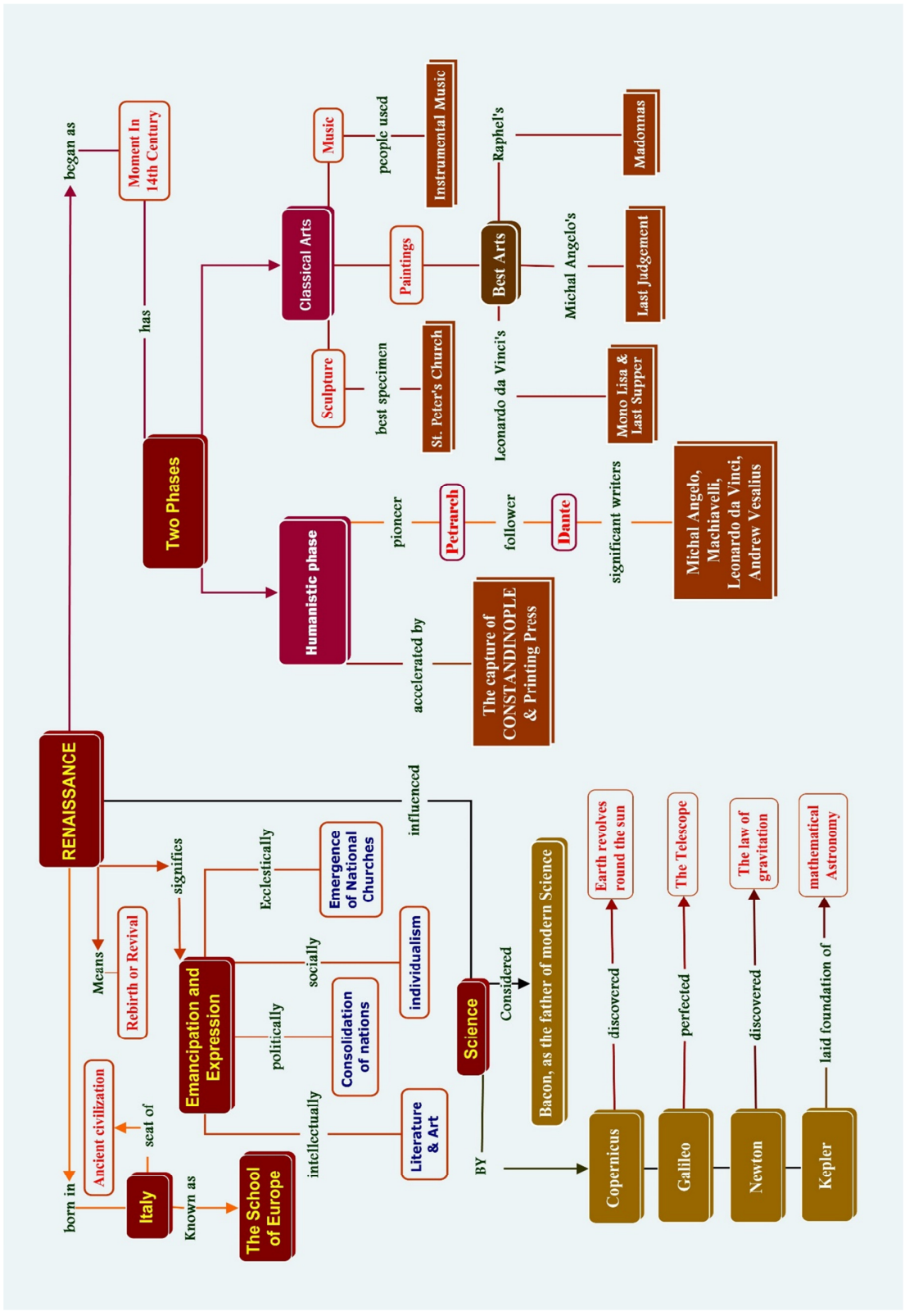
CONSTRUCTION OF DIGITAL CONCEPT MAPS

Using C-map tools digital concept maps were prepared in the computer.

A model concept map is given below.

Figure: 3.3

Model concept map



Lesson – I

Unit : History - Beginning of Modern Age Topic : Renaissance

Objectives : To understand the concept of Renaissance

To identify the role of Italy in Renaissance

To explain the phases of Renaissance

Lesson Description: Renaissance means revival or Rebirth. Renaissance signifies emancipation and expression. It marked, intellectually – revival of literature and art, politically – consolidation of nations, socially – individualism and ecclesiastically – emergence of national churches.

Italy, 'the school of Europe' and also the seat of ancient civilization was the birth place of Renaissance. Renaissance as a movement began in the 14th century with publication of the 'Divine Comedy' by Dante.

The renaissance movement comes under two broad divisions: Humanistic movement and Classical Arts. The Humanistic movement was accelerated by the capture of Constantinople by the Turks in 1453. Leonardo Da Vinci, Michal Angelo and Raphel contributed for the artistic phase. Renaissance influenced the science also.

The lesson transcripts and the digital concept maps prepared by the investigator on the selected topics are given as Appendix-I.

c. Establishing validity of digital concept maps

The validity of the digital concept maps prepared by the investigator was ensured by logical analysis of the content (Social Science syllabus for Standard IX) and judgment of the experts in the field. For this, the tool was submitted to the experts and based on their suggestions, necessary modifications were made in the concept map design.

3.3.3 *TOOL 2:* Achievement Test in Social Science

Achievement test can be defined as a test designed to measure the effect of specific teaching or training in an area of curriculum. The investigator prepared an achievement test in Social Science to test the effectiveness of digital concept mapping on student's achievement in Social Science. The investigator followed Tamil Nadu government public exam pattern including objective type, short answer and essay questions. The achievement test consisted of 37 questions spread over in seven sections. Maximum marks for the achievement test is 100 and the time allotted is two and a half hours.

The different sections in Achievement Test are given below.

Section I: This section consists of 14 objective type questions, each carries 1 mark.

Section II: This section consists of 2 match the following questions each carries 5 marks.

Section III: This section consists of 10 short answer questions, each carries 2 marks.

Section IV: This section consists of 4 Distinguish questions, each carries 2 marks.

Section V: This section consists of 2 caption questions, each carries 4 marks.

Section VI: This section consists of 4 paragraph questions, each carries 5 marks.

Section VII: This section consists of 2 questions, each carries 10 marks.

(A copy of the achievement test prepared by the investigator is given in Appendix-II).

The details regarding the blue print of the achievement test in Social Science for high school students are given below.

Table 3.2

Weightage to Objectives

Sl.No	OBJECTIVES	MARKS
1.	Knowledge	20
2.	Understanding	50
3.	Application	20
4.	Skill	10

Table 3.3

Weightage to content

Sl.No	CONTENT	MARKS
1.	Beginning of Modern Age	18
2.	Industrial Revolution	23
3.	Manufacturing Industries	33
4.	Transport and Communication	8
5.	The State Government	9
6.	Rights and Duties	9

Table 3.4

Weightage to form of questions

Sl.No	CONTENT	MARKS
1.	Choose the best	14
2.	Match	10
3.	Short answer	20
4.	Distinguish	8
5.	Caption	8
6.	Paragraph	20
7.	Essay and Map	20

Table 3.5

Weightage to form of questions

Sl.No	CONTENT	MARKS
1.	Easy	15
2.	Average	70
3.	Difficult	15

Figure: 3.4

Blueprint for Achievement Test

	Choose		Match	Short Answer			Distinguish	Caption		Paragraph		Essay /Map	
History	K	U	U	K	U	A	U	K	U	U	A	U	S
1. Beginning of Modern Age	$(1)^3$		$(1)^2$	$(2)^1$		$(2)^1$		2	2		$(5)^1$		
2. Industrial Revolution	$(1)^1$	$(1)^1$	$(1)^3$		$(2)^1$	$(2)^1$		4			$(5)^1$	$(5)^1$	
Geography													
1. Manufacturing Industries	$(1)^2$	$(1)^1$	$(1)^3$		$(2)^1$	$(2)^2$	$(2)^3$			$(5)^1$			$(10)^1$
2. Transport & Communication	$(1)^2$		$(1)^2$	$(2)^1$			$(2)^1$						
Civics													
1. The State Government	$(1)^2$				$(2)^1$							$(5)^1$	
2. Rights and Duties		$(1)^2$				$(2)^1$				$(5)^1$			
Total	10	4	10	4	6	10	8	6	2	10	10	10	10
Grand Total	14		10	20			8	8		20		20	

Establishing Validity and Reliability of Achievement Test

A test is said to be valid if it measures what it intends to measure. The investigator established face validity and content validity of the test. Face validity of a test is a judgment concerning how relevant the test items appear to be just on the basis of their face value. For ascertaining validity of the achievement test, it was submitted to a panel of experts consisting of teacher educators and senior experienced high school Social Science teachers and the relevancy of the items to measure the achievement of students in Social Science was established.

The content validity of the test was also established by verifying the comprehensiveness in the coverage of the content of the test and on the basis of opinion of subject experts. In the opinion of experts the test has adequate face validity and content validity. Reliability of a test refers to the degree of consistency with which it measures what it is intended to measure. The reliability of the achievement test was established by test re-test method. In test retest method the same test is administered to the same subjects after an interval of time. The correlation coefficient between the scores of the test and retest is found out. The reliability coefficient was found to be 0.81.

3.3.4 *TOOL 3:* Verbal and Non - Verbal Test of Creative Thinking

To assess the creative thinking ability of students in experimental group and control group, Baquer Mehdi's Verbal and Non-Verbal Test of creative thinking (2015) was used.

3.3.4.1 Verbal Test of Creative Thinking

This test is meant to identify creative talent at all stages of education except pre-primary and primary. The type of tasks included in the test have been chosen so

that they could be most easily and economically administered over a wide age range of sample starting from middle school and going up to the graduate level.

Description of the Verbal Test of creative thinking

The verbal test is part of the total battery which consists of both verbal and non-verbal tests. The verbal test of creative thinking includes four sub-tests, viz., and consequences test, unusual uses test, similarity test, and product improvement test.

(i) **Consequences Test** – The consequences test consists of three hypothetical situations: (a) What would happen if man could fly like birds? (b) What would happen if our schools had wheels? and (c) what would happen if man does not have any need for food?

The subject is required to think as many consequences of these situations as he can, and write them under each situation in the space provided. The situations being hypothetical, minimize the effect of experience and also provide the subject with an unlimited opportunity to make responses. The test encourages free play of imagination and originality. The time allowed for the three problems is 4 minutes each.

(ii) **Unusual Uses Test** – This test presents the subject with the names of three common objects-a piece of stone, a wooden stick, and water-and requires him to write as many novel, interesting and unusual uses of these objects as he may think of. The example given on the test booklet properly acquaints the subjects with the nature of the task. This test measures the subject's ability to retrieve items of information from his personal information in storage. Evidently, it measures also the subject's ability to shift frames of reference to use the environment in an original manner. The time allowed for the three tasks is 5 minutes each.

(iii) **New Relationships Test** – This test presents the subject with three pairs of words apparently different-tree and house, chair and ladder, air and water, and requires him to think and write many novel relationships as possible between the two objects of each pair in the space provided. The test provides an opportunity for the free play of imagination and originality. The time allowed for each pair of words is 5 minutes.

(iv) **Product Improvement Test** – In this test, the subject is asked to think of a simple wooden toy of a horse and suggest addition of new things to it to make it more interesting for the children to play. The time allowed is 6 minutes.

The total time required for administering the test is 48 minutes in addition to the time necessary for giving instructions, passing out test booklets to children and collecting them back.

Reliability of the test

The test-retest reliabilities of the factor scores and also the total score are given in Table 3.6.

TABLE 3.6

Test-retest Reliabilities of Factor Scores and the Total Creativity Score (N=31)

Fluency	Flexibility	Originality	Total Creativity Score
0.945	0.921	0.896	0.959

As will be seen, both the factor score and the total creativity score reliabilities are considerably high ranging from 0.896 to 0.959. These values are highly satisfactory. The reliability of the total creativity score which came out to be 0.959 is quite high.

Validity of the test

The validity coefficients against the teacher ratings for each factor are given in table 3.7.

TABLE 3.7

Validity Coefficient for Factor Scores Against Teacher Rating (N=300)

Fluency	Flexibility	Originality	Total Creativity Score
0.40	0.32	0.34	0.39

All correlations are significant beyond 01 level. The validity coefficients for factor scores and the total creativity score are high enough (significant beyond 0.01 level) to place confidence in the use of the test.

A copy of Verbal Test of Creative Thinking is given as appendix – III.

Administration and Scoring

a. Preliminary Instructions to Pupils

The investigator first gave preliminary instructions to the pupils. After giving the instructions for motivating the children, the investigator distributed the booklets and asked them to fill in the columns for name, class, etc. After they have filled in the required columns, the investigator asked them to put down their pens and pencils. After this general instructions were given to the pupils.

After the general instructions have been given, the investigator asked them to open the booklet. The investigator read the instructions for the first activity, asking the children to go through with him silently.

At the end of 15 minutes, the investigator asked the children to put down their pens and open the page for Activity II. After giving instructions for activity II the investigator announced time at the end of every four minutes. After 12 minutes are over, students were asked to open the page for Activity III. 6 minutes was given for activity III.

When the time for Activity IV is up, the investigator announced that 5 minutes extra time will be allowed so that anyone who wants to do additional work at any item may do so.

b. Procedure for Scoring

As there is no right or wrong responses for the test, much care has to be exercised at the time of scoring.

c. Instructions for Scoring

(1) **Scoring for Fluency** – In scoring for fluency, the scorer should go through the responses to the item in question carefully and strike off those which are irrelevant and / or have been repeated. He should then count the remaining number of responses and enter this number as the fluency score for the item in the appropriate box in the scoring-sheet.

(2) **Scoring for Flexibility** – In the scoring for flexibility, the scorer should first acquaint himself with the categories of responses given for each item in the scoring guide. For convenience sake, he should note in bracket against each response, the alphabet serial of the category to which it belongs. If he comes across a response which has not been mentioned in the scoring guide, he should himself determine the category to which it would seem to belong. If the response is such that it belongs to an entirely new category not considered in the scoring guide, he should

give it a new alphabet serial, and note it down in bracket against the response in question. After he has gone through all the response to a given item, he should see how many different categories have been used by the testee. This can be easily determined on the basis of the number of different alphabet serials used. The flexibility score will be the total number of different alphabet serials used. Thus, if out of eight responses given by the testee to an item, two have been given under category A, three have been given under category B, one has been given under category C, and two have been given under category D, then the flexibility score for this item will be four.

(3). **Scoring for Originality** –originality scoring is done on the basis of statistical uncommonness of responses. The more uncommon the response, the higher the originality weight. The weights for originality scoring have been determined on the basis of the following scheme. If a response has been given by 1% to 99% of the testees, then the responses will get an originality weight of 5; if a response has been given by 1%to 1.99% of testees, then the response will get an originality weight of 4; if a response has been given by 2% to 2.99% of the testee, then the response will get an originality weight of 3; if a response has been given by 3% to 3.99% of the testee, then the response will get an originality weight of 2; and if response has been given by 4% to 4.99% of the testees, then the response will get an originality weight of 1 response given by 5% or more of the testees will get originality weight of zero.

d. Scoring Summary

The scores for fluency, flexibility and originality obtained by the testee on different activities are summarized in a table provided in the scoring sheet. The total fluency, flexibility and originality scores have to be entered in the appropriate columns of the table. The composite creativity scores is entered after converting the

raw scores into standard scores. This is necessary because the standard deviations of the three scores sometimes nakedly vary, and if raw scores are added up then the ranking will be greatly affected.

e. Procedure of Converting Raw Scores into 'T' Scores

Once the total raw scores have been obtained for fluency, flexibility and originality dimensions of creativity, the following procedure for converting raw scores into 'T' scores was adopted:

1. Calculated Mean and SD for the total raw scores of each dimension.
2. For converting the raw scores into 'T' scores with M = 50 and SD = 10, the following formula was used.

$$T = 10\frac{(X-M)}{SD} + 50$$

For making the calculations easier the formula can be written as $\frac{10}{SD}(X - M) + 50$, where $\frac{10}{SD}$ will be a constant value by which each X – M can be multiplied; then add 50. In the total sample, the same raw may occur a number of times, therefore the calculation of 'T' scores can be further facilitated by first preparing a conversion table. The conversion table can be used easily for converting the actual raw scores by merely looking at the conversion table.

3. The composite creativity scores are based on standard scores instead of raw scores.

3.3.4.2 Non-Verbal Test of Creative Thinking

This battery is meant to identify creative talent at all stages of education except pre-primary and primary. The type of tasks included in the test have been chosen so that they could be most easily and economically administered over a wide age range of sample, starting from middle school and going up to the graduate level.

Description of the Non-Verbal Test of creative thinking

The non-verbal test is part of the total battery which consists of both verbal and non-verbal tests. The non-verbal test of creative thinking is intended to measure the individual's ability to deal with figural content in a creative manner. Three types of activity are used for this purpose, viz., picture construction, picture completion, and triangles and ellipses. The total time required for administering the test is 35 minutes, in addition to the time necessary for giving instructions, passing out booklets and collecting them back. A brief description of these activities is given below.

(i) **Picture Construction Activity**

This activity presents the subject with two simple geometrical figures, a semi-circle and a rhomb, and requires him to construct an elaborate picture using each figure as an integral part. The subject is allowed to turn the page to use the figure in any way he likes for making the picture. Emphasis is put on originality and elaboration. Originality is emphasized by the instruction that the subject should try to make as novel a picture as possible such that no one else will be able to produce. Elaboration is emphasized by the instruction that the subject may add as many details as he thinks necessary in order to make the picture tell as complete and as interesting a story as possible. Ten minutes are allowed for the two tasks.

The pictures are scored for elaboration and originality. The subject is also asked to give an interesting and unusual title to each picture. The titles may also be scored for verbal elaboration and originality and the scores added to the verbal creativity score obtained on the verbal creativity test. The scoring of titles however is optional.

(ii) **Incomplete Figures Activity**

This activity consists of 10 line drawings which could be made into meaningful pictures of different objects. The subject is asked to make a picture which no one else in the group will be able to think of. He is also asked to give an interesting and suitable title to each picture he makes. The subject is given 15 minutes for the 10 items. Each item is scored for elaboration and originality. Titles may also be scored for verbal elaboration and originality, and the scores added to the verbal creativity score obtained on the verbal creativity test. The scoring of titles however is optional.

(iii) **Triangles and Ellipses Activity**

In this activity the subject is provided with 7 triangles and 7 ellipses and he is required to construct different meaningful pictures based on the two given stimuli. As the subject is here encouraged "to make multiple associations to single stimuli", the responses could be scored for flexibility also, besides elaboration and originality, but as this is the only activity in which flexibility scoring is possible, it is recommended that here too the test user should confine himself to elaboration and originality scoring alone. A total time of 10 minutes is allowed for this activity.

The subject is also asked to give an interesting and suitable title to each picture which should also be scored for verbal elaboration and originality and the scores added to the verbal creativity score obtained on the verbal creativity test. The scoring of the titles however is optional. The three activities taken together provide ample opportunity to the subject to use his imagination with different types of figural tasks and come out with some novel ideas.

Reliability of the Test

The test-retest reliabilities of the factor scores and also the total score are given in Table 3.8.

TABLE 3.8

Test-retest Reliabilities of Factor Scores and the Total Creativity Score (N=50)

Elaboration	Originality	Total Creativity Score
0.93	0.94	0.94

As will be seen, the reliabilities of factor scores and also the total creativity score reliabilities are considerably high ranging from 0.93 to 0.94.

Validity of the Test

The validity coefficients against the teacher ratings for each factor and the total creativity scores are given in Table 3.9.

TABLE3.9

Validity Coefficient for Factor Scores and the Total Creativity Score against Teacher Ratings (N=50)

Elaboration	Originality	Total Creativity Score
0.34	0.32	0.38

Significant beyond 0.01 level.

A copy of the non-verbal test of creative thinking is given as Appendix – IV.

Administration and Scoring

a. Preliminary instructions to pupils

The investigator first gave preliminary instructions. After the instruction for motivating the children, the investigator distributed the test booklets and asked them to fill in the columns for name, class, etc. After they have filled in the required columns, the investigator asked them to put down their pens and pencils. After this general instructions were given to the pupils. The investigator asked them to open the booklet and read the instructions for the first activity asking the children to go with him silently.

At the end of five minutes the investigator asked the children to construct the next picture. When five minutes for the second picture are also over, the investigator asked the children to put down their pens and open the page for Activity II. He then read the instructions for Activity II. When the time for this Activity is over the investigator asked the students to put down their pens and open the page for Activity III and gave instructions for activity III.

After the time for this Activity is over, the investigator announced that 5 minutes extra will be allowed so that anyone who wants do additional work at any item may do so.

b. Procedure for Scoring

As there are no right or wrong responses for the test, much care has to be exercised at the time of scoring. The following points have to be kept in mind while scoring the test.

(1) Each item is to be scored for elaboration and originality. Only the items in Activity III may be scored for flexibility.

(2) **Elaboration** – Elaboration is represented by a person's ability to add pertinent details (more ideas) to the minimum and primary response to the stimulus figure. The minimum and the primary response to the stimulus figure is that response which gives essential meaning to the picture.

Score for elaboration is given only if the primary and minimum response is meaningful and relevant to the stimulus. If the figure is not relevant and meaningful, it is ignored. The total elaboration score consists of a score of one for the primary and minimum response plus one score each for all the additional new ideas.

c. Scoring of the Title

These scores will be considered as verbal rather than non-verbal and will have to be calculated separately. In scoring the title for elaboration, care has to be taken to identify the primary and minimum response and all additions have to be taken as elaborations over it.

1. **Originality** – Originality is represented by uncommonness of a given response. Responses given only by less than 5 per cent of the group are considered, and are given differential weights. The weights have to be determined on the basis of the following scheme. If response has been given by 1 per cent to .99 per cent of the testees, the response will get an originality weight of 5; if a response has been given by 2 per cent to 2.9 per cent of the testees, then the response will get an originality score of 3, if a response has been given by 3 percent to 3.9 percent of the testees, then the response will get an originality weight of 2; if the response has been given by 4 percent to 4.9 percent of the testees, then the response will get an originality weight of 1.

Responses given by 5 percent or more of the testees will get an originality weight of zero.

Originality Scoring for the Title

(1) A zero score will be given to a title, if just names the object such as cat, dog, man, etc. These are obvious "thing" titles.

(2) A score of one will be given to a title, if it attempts to describe the object in somewhat elaborate terms, such as 'A Fat Man', 'A Hungry Cat', A beautiful Bird', etc.

(3) A score of two will be given to a title which is imaginative and goes beyond a mere physical description of the object. Examples are 'A King from Mars', 'A Cat That Never Mewed'.

(4) A score of three will be given to a title which is abstract but appropriate and says something which goes beyond what can be observed. Examples are; 'Pilot Returning After bombarding the Enemy'.

2. **Flexibility** – Flexibility is represented by a person's ability to produce ideas which differ in approach or thought trend. All ideas which differ in approach or thought trend and treated as one for purposes of flexibility scoring. Thus if five ideas are produced, and all belong to only one category of approach or thought trend, the score for flexibility will be one, but if all the five ideas are based on five different approaches or thought trends, then the flexibility score will be 5. There could be intermediate scores for flexibility, depending on the number of categories of thought trends to which the responses belong. In the non-verbal test, only Activity III, viz. Triangle and Ellipses may be scored for flexibility as the testee is asked to make different pictures from the same given stimulus.

Score Summary

The total elaboration and originality scores are entered in the appropriate columns of the table for summarizing the scores. The composite creativity score is entered after converting the raw scores into standard scores. The raw scores were converted into T scores using the same procedure given in Verbal Test of Creative Thinking.

3.3.4.5 *TOOL 4:* Rating Scale for students

A rating scale was developed by the investigator to collect the ratings of the students in experimental group on the comparative efficacy of digital concept mapping technique and Lecture method. The rating scale consists of 24 items, each item is followed a five point scale: Very High (VH), High (H), Moderate (M), Low (L) and Very Low (VL). For each item a score of 5,4,3,2 and 1 was given to the category Very High, High, Moderate, Low and Very Low. A copy of the rating scale is given in the Appendix-V.

3.3.4.6 *TOOL 5:* Questionnaire for high school teachers

A questionnaire for high school Social Science teachers was also developed by the investigator for collecting the responses of high school Social Science teachers regarding the usage of digital concept mapping in teaching Social Science, suitability of digital concept mapping to the present syllabus, learning outcomes get through digital concept mapping, extent of suitability of digital concept mapping for attaining the objectives of teaching Social Science, practical difficulties in using digital concept mapping and suggestions for the effective use of digital concept mapping for teaching Social Science. A copy of the questionnaire is given in Appendix-VI.

3.4 POPULATION

According to Best and Khan (2008) population is defined as a group of individuals with at least one common characteristics which distinguishes that group from other individuals. For the present study the population consisted of all the high school students studying in various schools of Tamil Nadu following Tamil Nadu state board syllabus.

3.4.1 Sample for the study

A sample is a small proportion of a population selected for observation and analysis. By observing the characteristics of the sample one can make certain inferences about the characteristics of the population from which it was drawn. The study was conducted on a sample of 145 ninth standard students selected from two schools viz. Government Higher Secondary School, Munchirai and Mar Gregorious Matriculation School, Kirathoor in Kanyakumari district. The investigator selected two intact classes for conducting the experiment from both schools. One division was selected as control group and the other division as experimental group in both schools. The experimental group consisted of 70 students and the control group consisted of 75 students. The experimental group was taught through the digital concept mapping technique and the control group through the Lecture method. The details of the sample selected for the experimental study are given in table 3.10.

Table: 3.10

Details of the sample selected for the experimental study

Sample	Number of students in experimental group	Number of students in control group
Total	70	75
Boys	31	36
Girls	39	39
Government	37	42
Private	33	33

3.4.2 Details of the sample selected for the Survey

The investigator conducted a survey to collect the ratings of teachers regarding the effectiveness of digital concept mapping and to identify the practical difficulties in using digital concept mapping for teaching Social Science at high school level. For this, 25 high school Social Science teachers from different schools of Kanyakumari district were selected using random sampling technique. The experimental group students were selected as sample to find out the ratings of the students on the comparative efficacy of digital concept mapping and Lecture method.

3.5 EXPERIMENTAL PROCEDURE

The steps involved in the experimental procedure are given below.

1. **Administration of pretest**

   Before the experiment the investigator administered the Achievement Test in Social Science and Verbal and Non-Verbal Test of Creative Thinking

as pretest to the students of experimental group and control group for assessing the entry behavior of the learners.

2. **Experimentation**

After conducting the pretest, the experimental group was exposed to digital concept mapping technique for learning the selected topics in Social Science.

C-map tools were used to prepare concept maps in computer. Knowledge of computer application is necessary for preparing digital concept maps. Therefore in the beginning the experimental group was taught about the computer operations. After gaining the basic computer knowledge the experimental group was taught the lesson through the digital concept mapping technique.

First students were made to read the selected topics from the text book carefully. The students were asked to identify various concepts and sub concepts and enlist them. Then the investigator listed those concepts on smart board and discussed them with the students. Then the students were asked to arrange the listed concepts in hierarchical order and to construct a concept map with help of good linking words. After this, students were made to create digital concept maps by using C-map tool in the computer and they were encouraged to interpret their own map. Finally the students summarize the major ideas evolved during discussion.

The control group was taught the same lesson through the Lecture method.

3. **Duration of teaching**

The experiment was conducted for a period of one month. The students of experimental group were taught for a duration of 90 minutes (two consecutive periods) per day. The control group was also taught the same lesson for the same duration.

4. **Administration of posttest**

After completing the experiment, both the experimental and control groups were subjected to the posttest. The same tests used for the pretest i.e. Achievement Test in Social Science and Baquer Mehdi's Verbal and Non-Verbal Test of Creative Thinking were administered as posttest.

5. **Administration of Rating scale for students**

After completing the posttest, a rating scale was administered to the students in experimental group to find out on the comparative efficacy of digital concept mapping technique and Lecture method.

6. **Administration of questionnaire for teachers**

The investigator administered a questionnaire to 25 high school Social Science teachers for collecting the responses of teachers regarding various aspects of using digital concept mapping technique for teaching Social Science at high school level.

3.6 STATISTICAL TECHNIQUES USED

The following statistical techniques were used for the analysis of data.

1. t test
2. ANCOVA
3. Percentage.

1. **t test**

The test of significance for difference between the means was used to find out whether there exists significant difference between the means of the two groups under comparison. In this study, t value is interpreted in terms of P value. If $P<0.05$, it is significant at 0.05 level, if $P<0.01$, it is significant at 0.01 level and if $P>0.05$, it is not significant at any level.

2. **ANCOVA**

Analysis of covariance represents an extension of analysis of variance to allow for the correlation between initial and final scores. Through covariance analysis one is able to effect adjustments in final or terminal scores which will allow for differences in some initial variables (Garret, 2005).

3. **Percentage**

Percentage was used to analyse the responses of teachers regarding the various aspects of using digital concept mapping technique in teaching social science at high school level.

CHAPTER- IV

ANALYSIS AND INTERPRETATION

Analysis of the data is the heart of the research report. Analysis of data means studying the organized material in order to discover the inherent facts. Data collected by the investigator get their meaning when they are subjected to statistical analysis which describes the characteristics of data and will give the investigator an insight into the problem. Analysis leads to interpretation of data and interpretation implies the technique of drawing conclusions from the analytical and critical study of data. The results of the analysis along with interpretation are presented in this chapter.

4.1 Summary of the Analysis Done

4.2 Comparison of pretest scores of Achievement in Social Science

- Significance of difference between mean pretest scores of achievement in social science of students in experimental group (Digital Concept Mapping Group) and control group (Lecture Method Group) for the total sample and sub samples based on gender and type of management of the school.

4.3 Comparison of posttest scores of Achievement in Social Science

- Significance of difference between mean posttest scores of achievement in Social Science of students in experimental group and control group for the total sample and sub samples based on gender and type of management of the school.

4.4 Comparison of gain scores of experimental and control group

- Significance of difference between mean gain scores of achievement in Social Science of students in experimental and control groups
- Significance of difference between gain scores of achievement in Social Science of students in experimental group and control group with respect to gender and type of management of the school

4.5 Comparison of pretest and posttest scores of experimental and control group

- Significance of difference between pretest and posttest scores of achievement in Social Science of students in experimental group for the total sample and sub samples based on gender and type of management of the school.
- Significance of difference between pretest and posttest scores of achievement in Social Science of students in control group for the total sample and sub samples based on gender and type of management of the school.

4.7 Comparison of effectiveness of digital concept mapping and lecture method on achievement in Social Science for the total sample and sub samples based on gender and type of management of the school.

4.8 Comparison of pretest scores of Creative Thinking Ability

- Significance of difference between mean pretest scores of Creative Thinking Ability of students in experimental group and control for the total sample and sub samples based on gender and type of management of the school.

4.9 Comparison of posttest scores of Creative Thinking Ability

- Significance of difference between mean posttest scores of creative thinking ability of students in experimental group and control group for the total sample and sub samples based on gender and type of management of the school.

4.10 Comparison of gain scores of experimental and control group

- Significance of difference between mean gain scores of creative thinking ability of students in experimental group and control group
- Significance of difference between mean gain scores of creative thinking ability of students in experimental group and control group with respect to gender and type of management of the school

4.11 Comparison of pretest and posttest scores of experimental group and control group

- Significance of difference between pretest and posttest scores of creative thinking ability of students in experimental group for the total sample and sub samples based on gender and type of management of the school.
- Significance of difference between pretest and posttest scores of creative thinking ability of students in control group for the total sample and sub samples based on gender and type of management of the school.

4.13 Comparison of effectiveness of digital concept mapping and lecture method on creative thinking ability using ANCOVA

- Comparison of effectiveness of digital concept mapping and lecture method on creative thinking ability for the total sample and sub samples based on gender and type of management of the school.

4.14 Comparison of ratings of students in experimental group on the comparative efficacy of the digital concept mapping technique and lecture method in realizing learning outcomes.

4.15 Responses of teachers regarding various aspects of using digital concept mapping technique in teaching social science at high school level.

4.2 Comparison of pretest scores of Achievement in Social Science

Before the experiment was conducted, Achievement Test in Social Science was administered as pretest for both the experimental and the control groups. For the obtained pretest scores of the control group and the experimental group, mean, standard deviation, t test and ANCOVA were calculated. The results are given below.

4.2.1 Significance of difference between mean pretest scores of achievement in social science of students in experimental group (Digital Concept Mapping Group) and control group (Lecture Method Group) for the total sample

Ho 1 There exists no significant difference in the mean pretest scores of achievement in Social Science of experimental group and control group for the total sample.

Table 4.1

Data and results of test of significance of the difference between mean pretest scores of achievement in Social Science of experimental and control groups for the total sample

Group	Mean	SD	N	Mean Difference	t	p	Level of significance
Digital Concept Mapping	21.04	6.59	70	0.59	0.545	0.587	NS
Lecture	21.63	6.30	75				

Note: NS denotes not significant

From table 4.1, it is clear that the calculated t value 0.545 ($p > 0.05$) is not significant at any level. Since the calculated t value is not significant at any level, the null hypothesis "there exists no significant difference in the mean pretest scores of achievement in Social Science of experimental group and control group for the total sample" is accepted. This shows that there is no significant difference between the

mean pretest scores of achievement in Social Science of students in experimental group and control group. It means that both experimental and control groups do not differ significantly in their achievement scores. So it is inferred that before the experiment the two groups were similar in their achievement in Social Science.

4.2.2 Significance of difference between mean pretest scores of achievement in social science of students in experimental group and control group with respect to gender

Ho 2 There exists no significant difference in the mean pretest scores of achievement in Social Science of experimental group and control group with respect to gender.

Table 4.2

Data and results of test of significance of the difference between mean pretest scores of achievement in Social Science of experimental group and control group with respect to gender

Category	Group	Mean	SD	N	Mean Difference	t	p	Level of significance
Boys	Digital Concept Mapping	18.10	6.62	31	2.32	1.403	0.165	NS
	Lecture	20.42	6.86	36				
Girls	Digital Concept Mapping	23.38	5.62	39	0.64	0.504	0.616	NS
	Lecture	22.74	5.61	39				

From table 4.2, it is clear that the calculated t value 1.403 for boys and 0.504 for girls ($p>0.05$) are not significant at any level. Since the calculated t values are not significant at any level, the null hypothesis "there exists no significant difference in

the mean pretest scores of achievement in Social Science of experimental group and control group with respect to gender" is accepted. This shows that there is no significant difference between the mean pretest scores of achievement in Social Science of boys and girls in experimental and control group. Hence it is inferred that before the experiment boys and girls in experimental and control groups were similar in their achievement in Social Science.

4.2.3 Significance of difference between mean pretest scores of achievement in social science of students in experimental group and control group with respect to type of management of the school

Ho 3 There exists no significant difference in the mean pretest scores of achievement in Social Science of experimental group and control group with respect to type of management of the school.

Table 4.3

Data and results of test of significance of the difference between mean pretest scores of achievement in Social Science of experimental group and control group with respect to type of management of the school

Category	Group	Mean	SD	N	Mean Difference	T	p	Level of significance
Government	Digital Concept Mapping	19.95	6.84	37	0.64	0.411	0.682	NS
	Lecture	19.31	6.88	42				
Self financing	Digital Concept Mapping	22.27	6.18	33	2.31	1.812	0.075	NS
	Lecture	24.58	3.90	33				

From table 4.3, it is clear that the calculated t value, 0.411 for government school students and 1.812 for self financing school students ($p>0.05$) are not significant at any level. Since the calculated t values are not significant at any level, the null hypothesis "there exists no significant difference in the mean pretest scores of achievement in Social Science of experimental group and control group with respect to type of management of the school" is accepted. This shows that there is no significant difference between the pretest scores of achievement in Social Science of government and self financing school students in experimental and control group. Hence it is inferred that before the experiment government and self financing school students in experimental and control groups were similar in their achievement in Social Science.

4.3 Comparison of posttest scores of Achievement in Social Science

After conducting the experiment, achievement test in Social Science was administered as posttest for both the experimental and the control groups. For the obtained posttest scores of the control group and the experimental group, mean, standard deviation, t test and ANCOVA were calculated. The results are given below.

4.3.1 Significance of difference between mean posttest scores of achievement in Social Science of students in experimental group and control group for the total sample

Ho 4 There exists no significant difference in the mean posttest scores of achievement in Social Science of experimental group and control group for the total sample.

Table 4.4

Data and results of test of significance of the difference between mean posttest scores of achievement in Social Science of experimental group and control group for the total sample

Group	Mean	SD	N	Mean Difference	t	p	Level of significance
Digital Concept Mapping	44.61	14.40	70	11.96	6.129	0.000	0.01
Lecture	32.65	8.55	75				

From table 4.4, it is clear that the calculated t value 6.129 ($p< 0.01$) is significant at 0.01 level. Since the calculated t value is significant at 0.01 level, the null hypothesis "there exists no significant difference in the mean posttest scores of achievement in Social Science of experimental group and control group for the total sample" is rejected. This shows that there is significant difference between the mean posttest scores of achievement in Social Science of students in experimental group and control group. It is evident from the table that the posttest scores of experimental group (44.61) is greater than that of control group (32.65). Hence it can be interpreted that Digital concept mapping is more effective in enhancing the achievement in Social Science of high school students.

4.3.2 Significance of difference between mean posttest scores of achievement in Social Science of students in experimental group and control group with respect to gender

Ho 5 There exists no significant difference in the mean posttest scores of achievement in Social Science of experimental group and control group with respect to gender.

Table 4.5

Data and results of test of significance of the difference between mean posttest scores of achievement in Social Science of experimental group and control group with respect to gender

Category	Group	Mean	SD	N	Mean Difference	t	p	Level of significance
Boys	Digital Concept Mapping	34.16	12.17	31	5.35	2.295	0.025	0.05
	Lecture	28.81	6.45	36				
Girls	Digital Concept Mapping	52.92	9.98	39	16.71	7.853	0.000	0.01
	Lecture	36.21	8.78	39				

From table 4.5, it is clear that the calculated t value for boys 2.295 ($p<0.05$)is significant at 0.05 level. The t value obtained for girls 7.853 ($p<0.01$) is significant at 0.01 level. Since the calculated t values are significant the null hypothesis "there exists no significant difference in the mean posttest scores of achievement in Social Science of experimental group and control group with respect to gender" is rejected. This shows that there is significant difference between the mean posttest scores of achievement in Social Science of boys and girls in experimental group and control group. Since the means of the posttest scores of experimental group is greater than that of control group, it can be inferred that Digital concept mapping is more effective in enhancing the achievement in Social Science.

4.3.3 Significance of difference between mean posttest scores of achievement in Social Science of students in experimental group and control group with respect to type of management of the school

Ho 6 There exists no significant difference in the mean posttest scores of achievement in Social Science of experimental group and control group with respect to type of management of the school.

Table 4.6

Data and results of test of significance of the difference between mean posttest scores of achievement in Social Science of experimental group and control group with respect to type of management of the school

Category	Group	Mean	SD	N	Mean Difference	t	p	Level of significance
Govt	Digital Concept Mapping	42.97	13.40	37	14.64	6.219	0.000	0.01
	Lecture	28.33	6.86	42				
Self financing	Digital Concept Mapping	46.45	15.44	33	8.30	2.793	0.007	0.01
	Lecture	38.15	7.30	33				

From table 4.6, it is seen that the calculated t value for government school students 6.219 ($p<0.01$) is significant at 0.01 level. The t value obtained for self financing school students 2.793 ($p<0.01$) is significant at 0.01 level. Since the calculated t values are significant at 0.01 level the null hypothesis "there exists no significant difference in the mean posttest scores of achievement in Social Science of experimental group and

control group with respect to type of management of the school" is rejected. This shows that there is significant difference between the mean posttest scores of achievement in Social Science of government and self financing school students in experimental group and control group. Since the mean of the posttest scores of experimental group is greater than that of control group, it can be interpreted that Digital concept mapping is more effective in enhancing the achievement in Social Science.

4.4 Comparison of gain scores of experimental group and control group

To establish the effectiveness of digital concept mapping the performance of students in experimental group was compared with that of students in control group by testing the significance of difference between the mean gain scores of achievement in Social Science of experimental and control groups using t test. The data and results of test of significance of difference between mean gain scores of achievement in Social Science are given below.

4.4.1 Significance of difference between mean gain scores of achievement in Social Science of students in experimental and control groups

Ho 7 There exists no significant difference in the mean gain scores of achievement in Social Science of experimental group and control group for the total sample.

TABLE 4.7

Data and result of test of significance of difference between the gain scores of achievement in Social Science of experimental group and control group

Group	Mean	SD	N	Mean Difference	t	p	Level of significance
Experimental	23.57	11.09	70	12.54	8.639	0.000	0.01
Control	11.03	5.73	75				

From table 4.7, it is clear that the calculated t value 8.639 ($P<0.01$) is significant at 0.01 level. Since the calculated t value is significant at 0.01 level, the null hypothesis "there exists no significant difference in the mean gain scores of achievement in Social Science of experimental group and control group for the total sample" is rejected. This shows that there is significant difference between the mean gain scores of achievement in Social Science of students in experimental group and control group. The mean gain score of experimental group (23.57) is greater than that of control group (11.03). Hence it can be interpreted that Digital concept mapping technique is more effective in enhancing the achievement in Social Science of high school students than the lecture method.

4.4.2 Significance of difference between gain scores of achievement in Social Science of students in experimental group and control group with respect to gender and type of management of the school

Ho 8 There exists no significant difference in the mean gain scores of achievement in Social Science of experimental group and control group with respect to gender and type of management of the school.

TABLE 4.8

Data and result of test of significance of difference between the gain scores of achievement in Social Science of experimental group and control group with respect to gender and type of management of the school

Category	Group	Mean	SD	N	Mean Difference	t	p	Level of significance
Boys	Digital Concept Mapping	16.06	9.62	31	7.67	4.060	0.000	0.01
	Lecture	8.39	5.60	36				
Girls	Digital Concept Mapping	29.54	8.24	39	16.08	10.569	0.000	0.01
	Lecture	13.46	4.72	39				
Govt	Digital Concept Mapping	23.03	8.85	37	14.01	8.881	0.000	0.01
	Lecture	9.02	4.81	42				
Self financing	Digital Concept Mapping	24.18	13.29	33	10.60	4.197	0.000	0.01
	Lecture	13.58	5.85	33				

From the table, it is clear that the calculated t values for boys (4.060; $p<0.01$), girls (10.569; $p<0.01$), government school students (8.881; $p<0.01$), and self financing school students ((4.197; $p<0.01$) are significant at 0.01 level. Since the calculated t values are significant at 0.01 level, the null hypothesis "there exists no significant difference in the mean gain scores of achievement in Social Science of experimental group and control group with respect to gender and type of management of the school" is rejected. This shows that there is significant difference between the mean gain scores of achievement in Social Science of boys and girls in experimental group and control group and government school and self financing school students in experimental group and control group. The mean gain scores of experimental group are greater than that of control group. Hence it can be interpreted that digital concept mapping is more effective in enhancing the achievement in Social Science of high school students.

4.5 Comparison of pretest and posttest scores of experimental group and control group

Mean and standard deviation of pretest and posttest scores of achievement in Social Science of students in experimental group were found out and tested for the significance of difference between the means using paired t test. The data and result of test of significance are given below.

4.5.1 Significance of difference between pretest and posttest scores of achievement in Social Science of students in experimental group for the total sample

Ho 9 There exists no significant difference between the means of pretest and posttest scores of achievement in Social Science of students in experimental group.

TABLE 4.9

Data and result of test of significance of difference between mean pretest and posttest scores of achievement in Social Science of students in experimental group

Scores	Mean	SD	N	Mean Difference	Paired t	P	Level of significance
Pre test	21.04	6.59	70	23.57	17.78	0.000	0.01
Post test	44.61	14.40	70				

From the above table, it is clear that the calculated t value 17.78 ($P<0.01$) is significant at 0.01 level. Since the calculated t value is significant at 0.01 level, the null hypothesis "there exists no significant difference between the means of pretest and posttest scores of achievement in Social Science of students in experimental group' is rejected. This shows that there is significant difference between the means of pretest and posttest scores of achievement in Social Science of students in experimental group. This proves that digital concept mapping is more effective in enhancing achievement in Social Science of high school students.

4.5.2 Significance of difference between pretest and posttest scores of achievement in Social Science of students in experimental group with respect to gender and type of management of the school

Ho 10 There exists no significant difference between the means of pretest and posttest scores of achievement in Social Science of students in experimental group with respect to gender and type of management of the school.

TABLE 4.10

Data and result of test of significance of difference between mean pretest and post test scores of achievement in Social Science of students in experimental group with respect to gender and type of management of the school

Category	Scores	Mean	SD	N	Mean Difference	Paired t	P	Level of significance
Boys	Pre test	18.10	6.62	31	16.06	9.30	0.000	0.01
	Post test	34.16	12.17	31				
Girls	Pre test	23.38	5.62	39	29.54	22.38	0.000	0.01
	Post test	52.92	9.98	39				
Govt	Pre test	19.95	6.84	37	23.02	15.83	0.000	0.01
	Post test	42.97	13.40	37				
Self financing	Pre test	22.27	6.18	33	24.18	10.46	0.000	0.01
	Post test	46.45	15.44	33				

From table 4.10, it is clear that the calculated t values for boys (9.30; $p<0.01$), girls (22.38; $p<0.01$), government school students (15.83; $p<0.01$), and self financing school students (10.46; $p<0.01$) in experimental group are significant at 0.01 level. Since the calculated t values are significant at 0.01 level, the null hypothesis "there exists no significant difference between the means of pretest and posttest scores of achievement in Social Science of students in experimental group with respect to gender and type of management of the school' is rejected. This indicates that there is

significant difference between the means of pretest and posttest scores of achievement in Social Science of students in experimental group with respect to gender and type of management of the school.

4.5.3 Significance of difference between pretest and posttest scores of achievement in Social Science of students in control group

The Mean and standard deviation of pretest and posttest scores of achievement in Social Science of students in control group were found out and tested for the significance of difference between the means using paired t test. The data and result of the test of significance are given below.

Ho 11 There exists no significant difference between the means of pretest and posttest scores of achievement in Social Science of students in control group.

TABLE 4.11

Data and result of test of significance of difference between mean pretest and posttest scores of achievement in Social Science of students in control group

Scores	Mean	SD	N	Mean Difference	Paired t	P	Level of significance
Pre test	21.63	6.30	75	11.02	16.68	0.000	0.01
Post test	32.65	8.55	75				

From the above table, it is clear that the obtained t value 16.68 ($P<0.01$) is significant at 0.01 level. Since the calculated t value is significant at 0.01 level, the null hypothesis "there exists no significant difference between the means of pretest and posttest scores of achievement in Social Science of students in control group' is rejected. This shows that there is significant difference between the means of pretest and posttest scores of achievement in Social Science of students in control group.

4.5.4 Significance of difference between pretest and posttest scores of achievement in Social Science of students in control group with respect to gender and type of management of the school

Ho 12 There exists no significant difference between the means of pretest and posttest scores of achievement in Social Science of students in control group with respect to gender and type of management of the school.

TABLE 4.12

Data and result of test of significance of difference between mean pretest and posttest scores of achievement in Social Science of students in control group with respect to gender and type of management of the school

Category	Scores	Mean	SD	N	Mean Difference	Paired t	P	Level of significance
Boys	Pre test	20.42	6.86	36	8.39	8.99	0.000	0.01
	Post test	28.81	6.45	36				
Girls	Pre test	22.74	5.61	39	13.47	17.80	0.000	0.01
	Post test	36.21	8.78	39				
Govt	Pre test	19.31	6.88	42	9.02	12.17	0.000	0.01
	Post test	28.33	6.86	42				
Self financing	Pre test	24.58	3.90	33	13.57	13.33	0.000	0.01
	Post test	38.15	7.30	33				

From table 4.12, it is clear that the calculated t values for boys (8.99; $p<0.01$), girls (17.80; $p<0.01$), government school students (12.17; $p<0.01$), and self financing school students (13.33; $p<0.01$), in control group are significant at 0.01 level. Since the calculated t values are significant at 0.01 level, the null hypothesis "there exists no significant difference between the means of pretest and posttest scores of achievement in Social Science of students in control group with respect to gender and type of

management of the school' is rejected. This shows that there is significant difference between the means of pretest and posttest scores of achievement in Social Science of students in control group with respect to gender and type of management of the school.

4.6 Genuineness of the difference in performance of the groups

The analysis of pretest scores of students in experimental and control groups did not show any difference even at 0.05 level of significance. This means that there is not much difference between the initial abilities of students in both the groups. The analysis of posttest scores revealed that there is significant difference between the means of the posttest scores of achievement in Social Science of students in experimental and control groups. There was an increase in the posttest scores of students who underwent experimental treatment compared to control group. The comparison of pretest and posttest scores of the experimental and control groups indicate that there is an increase in the posttest scores of experimental group than the other group. The comparison of gain scores of experimental and control groups revealed a significant difference between the means of the gain scores of the students in experimental and control groups. From the above results, it can be interpreted that experimental group has an advantage over the control group.

Since the experimental and control groups selected for the study were nonequivalent groups, it cannot be concluded that students of the two groups differ significantly by simply comparing the post test scores and the gain scores. Hence, it is necessary to analyze the data using the statistical technique Analysis of Covariance (ANCOVA), by which the initial difference of two groups can be removed statistically, and the initial status can be equated.

4.7 Comparison of effectiveness of Digital Concept Mapping and Lecture Method on achievement in Social Science using ANCOVA

4.7.1 Comparison of effectiveness of digital concept mapping and lecture method of teaching on achievement in Social Science for the total sample

Analysis of covariance (ANCOVA) was used to compare the effectiveness of digital concept mapping and lecture method on achievement in Social Science of high school students. Before proceeding to ANCOVA, the scores were subjected to ANOVA. The details of analysis of variance of pretest (x) and posttest (y) scores of experimental and control groups taken separately are given in table 4.13.

TABLE 4.13

Result of summary of ANOVA of pretest and posttest scores of achievement in Social Science of students in experimental and control group for total sample

Source of variance	df	SSx	SSy	MSx	MSy	Fx	Fy
Between groups	1	12.34	5179.92	12.34	5179.92	0.297	37.563
Within groups	143	5942.42	19719.57	41.56	137.90		

The obtained Fx and Fy ratios were tested for significance. The obtained Fx (Fx =0.297; p>0.05) is not significant at any level. This indicates that there is no significant difference between the pretest scores of experimental and control group. The obtained Fy (Fy =37.563; p<0.01) is significant at 0.01 level. So it can be concluded that there is significant difference between the posttest scores of experimental and control group. After correcting the final achievement score for difference in initial scores, ANCOVA was applied to the final score. The results of ANCOVA are presented in Table 4.14.

TABLE 4.14

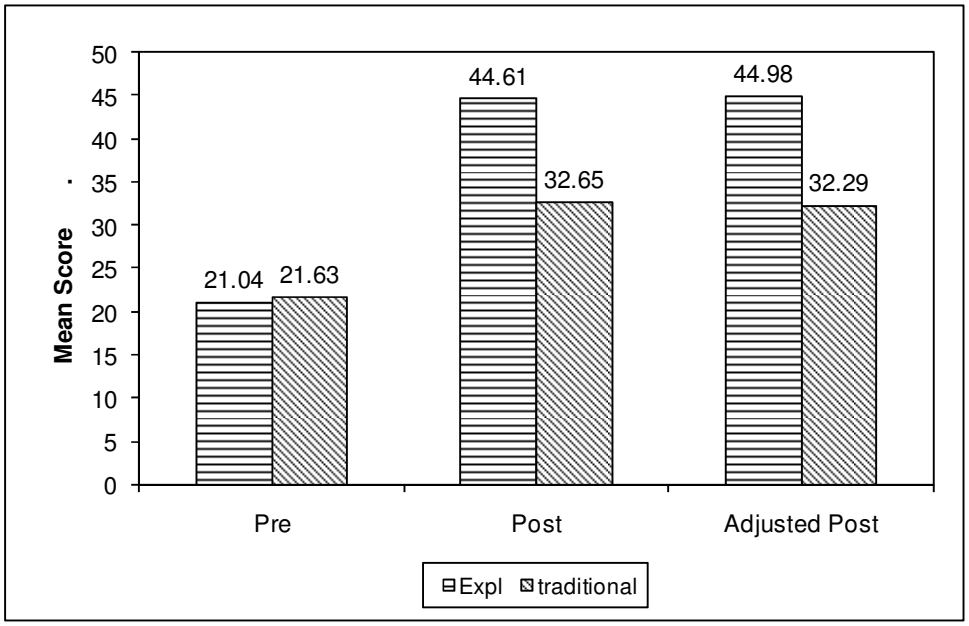
Summary of ANCOVA of pretest and posttest scores of achievement in Social Science of students in experimental and control group

Source of variance	df	SSx	SSy	SSy.x	MSy.x	Fy.x	p	Level of Sig.
Between groups	1	12.34	5179.92	5814.18	5814.18	78.087	0.000	0.01
Within groups	142	5942.42	19719.57	10572.95	74.46			

The Calculated value of Fy.x was tested for significance. The calculated value of Fy.x (Fy.x=78.087; p<0.01) is significant at 0.01 level. This indicates that the final mean scores of achievement in Social Science of students in experimental and control group differ significantly after they have been adjusted for initial difference in the pretest scores. So it can be concluded that digital concept mapping is more effective than the lecture method in enhancing achievement in Social Science of high school students. The comparison of pretest, posttest and adjusted posttest scores of experimental group and control group is presented in figure 4.1.

Figure 4.1

Comparison of pretest, posttest and adjusted posttest scores of achievement in Social Science of experimental and control group for the total sample



4.7.2 Comparison of adjusted means of posttest

The adjusted means of posttest scores of students in experimental and control groups were computed and the differences between the adjusted posttest means were tested for significance. The data and results of test of significance of difference between the adjusted means of posttest scores of students in experimental and control groups are given in table.

TABLE 4.15

Results of the test of Significance of difference between the adjusted means of posttest scores of students in experimental and control group

Group	Adjusted Mean	N	$SD_{(yx)}$	$SE_{D(yx)}$	t	*p*	*Level*
Experimental	44.98	70	8.63	1.46	8.70	*0.000*	*0.01*
Control	32.29	75					

The obtained t value 8.70 ($p<0.01$) is significant at 0.01 level. This shows that the experimental and control group differ significantly in their adjusted post test scores of achievement in Social Science. Since the adjusted mean scores of the experimental group (44.98) is greater than that of the control group (32.29), the experimental group is superior to control group in their achievement in Social Science. Therefore it may be concluded that the digital concept mapping is more effective than the lecture method in enhancing achievement in Social Science of high school students.

4.7.3 Comparison of effectiveness of digital concept mapping and lecture method on achievement in Social Science for Boys

The details of analysis of variance of pretest (x) and posttest (y) scores of boys in experimental and control group taken separately are given in table 4.16.

TABLE 4.16

Result of summary of ANOVA of pretest and posttest scores of achievement in Social Science of boys in experimental group and control group

Source of variance	df	SSx	SSy	MSx	MSy	Fx	Fy
Between groups	1	89.64	477.78	89.64	477.78	1.968	5.266
Within groups	65	2961.46	5897.83	45.56	90.74		

The obtained Fx and Fy ratios were tested for significance. The obtained Fx (Fx =1.968;p>0.05) is not significant at any level. This indicates that there is no significant difference between the pretest scores of boys in experimental and control groups. The obtained Fy (Fy =5.266;p<0.05) is significant at 0.05 level. So it can be concluded that there is significant difference between the posttest scores of boys in experimental and control group. After correcting the final achievement score for difference in initial scores, ANCOVA was applied to the final score. The results of ANCOVA are presented in table 4.17.

TABLE 4.17

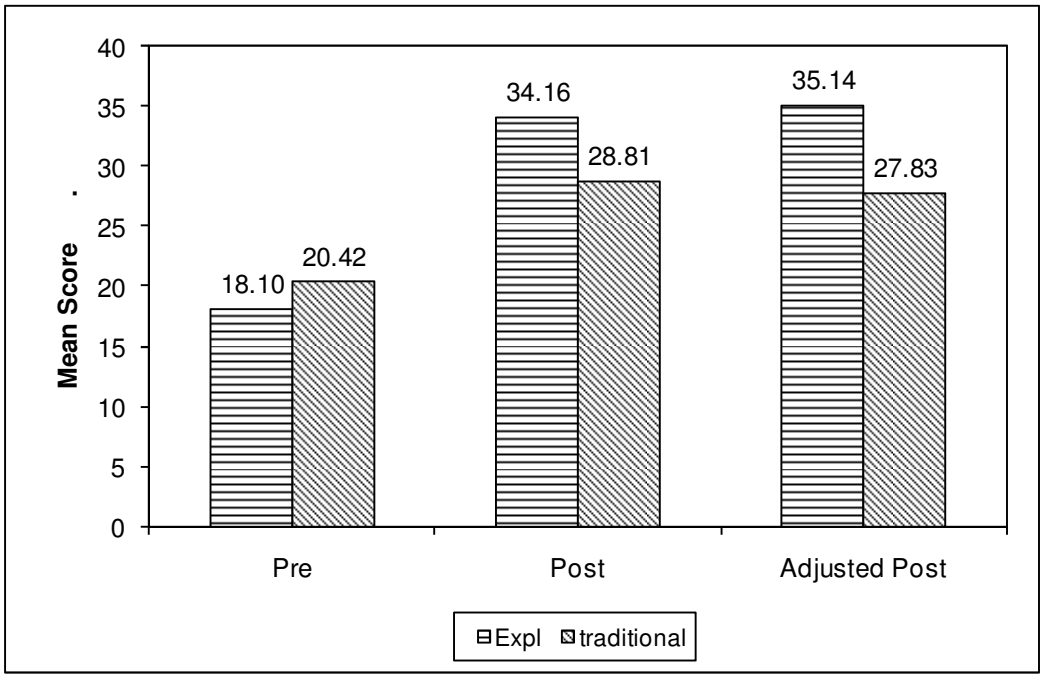
Summary of ANCOVA of pretest and posttest scores of achievement in Social Science of boys in experimental and control group

Source of variance	df	SSx	SSy	SSy.x	MSy.x	Fy.x	p	Level of Significance
Among groups	1	89.64	477.78	863.87	863.87	14.562	*0.000*	*0.01*
Within groups	64	2961.46	5897.83	3796.78	59.32			

The Calculated value of Fy.x was tested for significance. The calculated value of Fy.x (Fy.x=14.562; $p<0.01$) is significant at 0.01 level. This indicates that final mean scores of achievement in Social Science of boys in experimental and control group differ significantly after they have been adjusted for initial difference in the pretest scores. So it can be concluded that digital concept mapping is more effective than the lecture method in enhancing achievement in Social Science among boys. The comparison of pretest, posttest and adjusted post test scores of boys in experimental group and control group is presented in figure 4.2.

FIGURE 4.2

Comparison of pretest, posttest and adjusted post test scores of achievement in Social Science of boys in experimental group and control group



4.7.4 Comparison of adjusted means of posttest

The adjusted means of posttest scores of boys in experimental and control groups were computed and the difference between the adjusted posttest means were tested for significance. The data and results of test of significance of difference between the adjusted means of posttest scores of boys in experimental and control groups are given in table.

TABLE 4.18

Results of the test of Significance of difference between the adjusted means of posttest scores of boys in experimental and control group

Group	Adjusted Mean	N	$SD_{(yx)}$	$SE_{D(yx)}$	t	p	Level of Sig.
Experimental	35.14	31	7.70	1.96	3.74	0.000	0.01
Control	27.83	36					

The obtained t value 3.74 ($p<0.01$) is significant at 0.01 level. This shows that the boys in experimental group and control group differ significantly in their adjusted posttest scores of achievement in Social Science. Since the adjusted mean scores of the boys (35.14) in experimental group is greater than that of the control group (27.83), the boys in experimental group is superior to control group in their achievement in Social Science. Therefore it may be concluded that the digital concept mapping is more effective than the lecture method in enhancing achievement in Social Science among boys.

4.7.5 Comparison of effectiveness of digital concept mapping and lecture method on achievement in Social Science for Girls

The details of analysis of variance of pretest (x) and posttest (y) scores of girls in experimental and control group taken separately are given in table 4.19.

Table 4.19

Result of summary of ANOVA of pretest and posttest scores of achievement in Social Science of girls in experimental and control group

Source of variance	df	SSx	SSy	MSx	MSy	Fx	Fy
Between groups	1	8.01	5450.05	8.01	5450.05	0.254	61.664
Within groups	76	2396.67	6717.13	31.54	88.38		

The obtained Fx and Fy ratios were tested for significance. The obtained Fx (Fx =0.254;p>0.05) is not significant at any level. This indicates that there is no significant difference between the pretest scores of girls in experimental and control group. The obtained Fy (Fy =61.664;p<0.01) is significant at 0.01 level. So it can be concluded that there is significant difference between the post test scores of girls in experimental and control group. After correcting the final achievement score for difference in initial scores, ANCOVA was applied to the final score. The results of ANCOVA are presented in Table 4.20.

Table 4.20

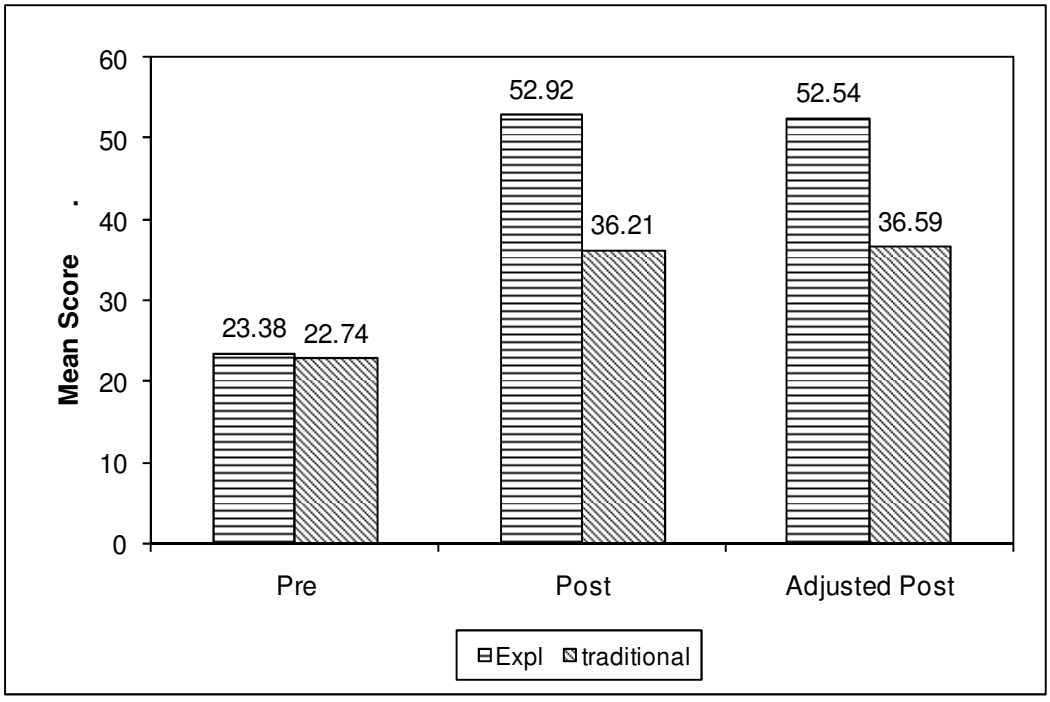
Summary of ANCOVA of pretest and posttest scores of achievement in Social Science of girls in experimental and control group

Source of variance	df	SSx	SSy	SSy.x	MSy.x	Fy.x	p	Level of Sig.
Between groups	1	8.01	5450.05	4949.13	4949.13	110.915	*0.000*	*0.01*
Within groups	75	2396.67	6717.13	3346.56	44.62			

The Calculated value of Fy.x was tested for significance. The calculated value of Fy.x (Fy.x=110.915; $p<0.01$) is significant at 0.01 level. This indicates that final mean scores of achievement in Social Science of girls in experimental and control group differ significantly after they have been adjusted for initial difference in the pretest scores. So it can be concluded that digital concept mapping is more effective than the lecture method in enhancing achievement in Social Science among girls. The comparison of pretest, posttest and adjusted post test scores of boys in experimental group and control group is presented in figure 4.3.

Figure 4.3

Comparison of pretest, posttest and adjusted post test scores of achievement in Social Science of girls in experimental and control group



4.7.6 Comparison of adjusted means of posttest

The adjusted means of posttest scores of girls in experimental and control groups were computed and the differences between the adjusted posttest means were tested for significance. The data and results of test of significance of difference between the adjusted means of posttest scores of girls in experimental and control groups are given in table.

Table 4.21

Results of the test of Significance of difference between the adjusted means of posttest scores of girls in experimental and control group

Group	Adjusted Mean	N	$SD_{(yx)}$	$SE_{D(yx)}$	t	p	Level of Sig.
Experimental	52.54	39	6.68	1.51	10.55	0.000	0.01
Control	36.59	39					

The obtained t value 10.55 ($p<0.01$) is significant at 0.01 level. This shows that the girls of experimental and control group differ significantly in their adjusted posttest scores of achievement in Social Science. Since the adjusted mean scores of the girls (52.54) in experimental group is greater than that of the control group (36.59), the girls in experimental group is superior to control group in their achievement in Social Science. Therefore it may be concluded that the digital concept mapping is more effective than the lecture method in enhancing achievement in Social Science among girls.

4.7.7 Comparison of effectiveness of digital concept mapping and lecture method on achievement in Social Science of government school students

The details of analysis of variance of pretest (x) and posttest (y) scores of government school students in experimental and control group taken separately are given in table 4.22.

Table 4.22

Result of summary of ANOVA of pretest and posttest scores of achievement in Social Science of government school students in experimental group and control group

Source of variance	df	SSx	SSy	MSx	MSy	Fx	Fy
Between groups	1	7.97	4215.85	7.97	4215.85	0.169	38.671
Within groups	77	3628.87	8394.31	47.13	109.02		

The obtained Fx and Fy ratios were tested for significance. The obtained Fx (Fx =0.169;p>0.05) is not significant at any level. This indicates that there is no significant difference between the pretest scores of government school students in experimental and control group. The obtained Fy (Fy =38.671;p<0.01) is significant at 0.01 level. So it can be concluded that there is significant difference between the posttest scores of government school students in experimental and control group. After correcting the final achievement score for difference in initial scores, ANCOVA was applied to the final score. The results of ANCOVA are presented in Table 4.23.

Table 4.23

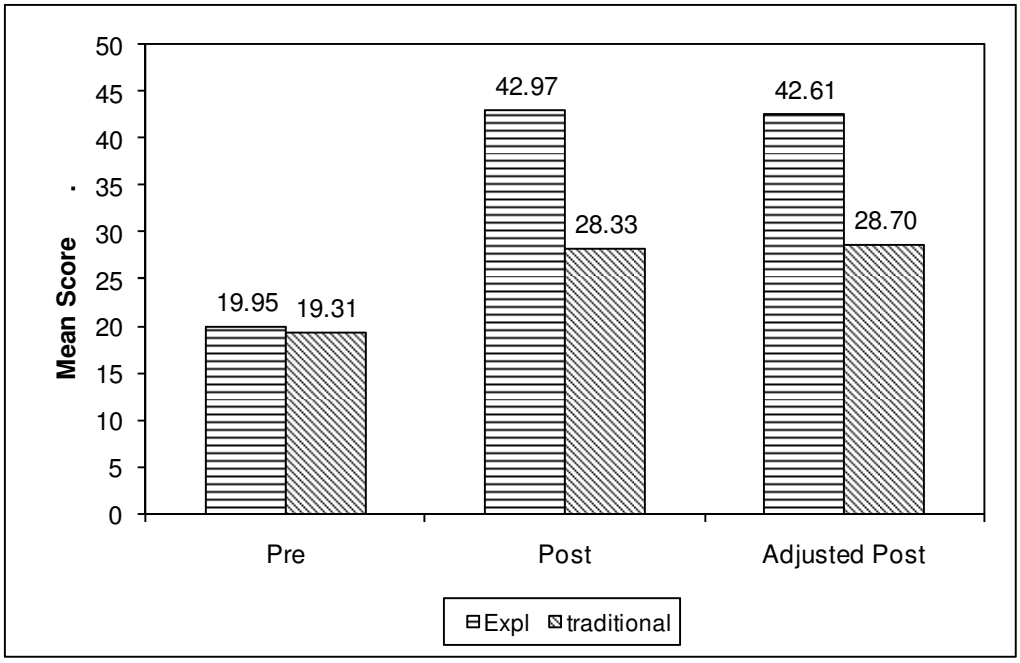
Summary of ANCOVA of pretest and posttest scores of achievement in Social Science of government school students in experimental group and control group

Source of variance	df	SSx	SSy	SSy.x	MSy.x	Fy.x	p	Level of Sig.
Between groups	1	7.97	4215.85	3800.79	3800.79	78.131	*0.000*	*0.01*
Within groups	76	3628.87	8394.31	3697.13	48.65			

The Calculated value of Fy.x was tested for significance. The calculated value of Fy.x (Fy.x=78.131; $p<0.01$) is significant at 0.01 level. This indicates that final mean scores of achievement in Social Science of government school students in experimental and control group differ significantly after they have been adjusted for initial difference in the pretest scores. So it can be concluded that digital concept mapping is more effective than the lecture method in enhancing achievement in Social Science of government school students. The comparison of pretest, posttest and adjusted posttest scores of government school students in experimental group and control group is presented in figure 4.4.

Figure 4.4

Comparison of pretest, posttest and adjusted posttest scores of achievement in Social Science of government school students in experimental and control groups



4.7.8 Comparison of adjusted means of posttest

The adjusted means of posttest scores of government school students in experimental and control groups were computed and the differences between the adjusted posttest means were tested for significance. The data and results of test of significance of difference between the adjusted means of posttest scores of government school students in experimental and control groups are given in table 4.24.

Table 4.24

Results of the test of Significance of difference between the adjusted means of posttest scores of government school students in experimental and control group

Group	Adjusted Mean	N	$SD_{(yx)}$	$SE_{D(yx)}$	t	p	Level of Sig.
Experimental	42.61	37	6.97	1.62	8.58	0.000	0.01
Control	28.70	42					

The obtained t value 8.58 ($p<0.01$) is significant at 0.01 level. This shows that the government school students in experimental and control group differ significantly in their adjusted posttest scores of achievement in Social Science. Since the adjusted mean scores of the government school students (42.61) in experimental group is greater than that of the control group (28.70), the government school students in experimental group is superior to control group in their achievement in Social Science. Hence it may be concluded that the digital concept mapping is more effective than the lecture method in enhancing achievement in Social Science of government school students.

4.7.9 Comparison of effectiveness of digital concept mapping and lecture method on achievement in Social Science of self financing School Students

The details of analysis of variance of pretest (x) and posttest (y) scores of self financing school students in experimental and control group taken separately are given in table 4.25.

Table 4.25

Result of summary of ANOVA of pretest and posttest scores of achievement in social science of self financing school students in experimental and control group

Source of variance	df	SSx	SSy	MSx	MSy	Fx	Fy
Between groups	1	87.52	1137.52	87.52	1137.52	3.282	7.801
Within groups	64	1706.61	9332.42	26.67	145.82		

The obtained Fx and Fy ratios were tested for significance. The obtained Fx (Fx =3.282;p>0.05) is not significant at any level. This indicates that there is no significant difference between the pretest scores of self financing school students in experimental and control group.

The obtained Fy (Fy =7.801; p<0.01) is significant at 0.01 level. So it can be concluded that there is significant difference between the posttest scores of self financing school students in experimental and control group. After correcting the final achievement score for difference in initial scores, ANCOVA was applied to the final score. The results of ANCOVA are presented in Table 4.26.

Table 4.26

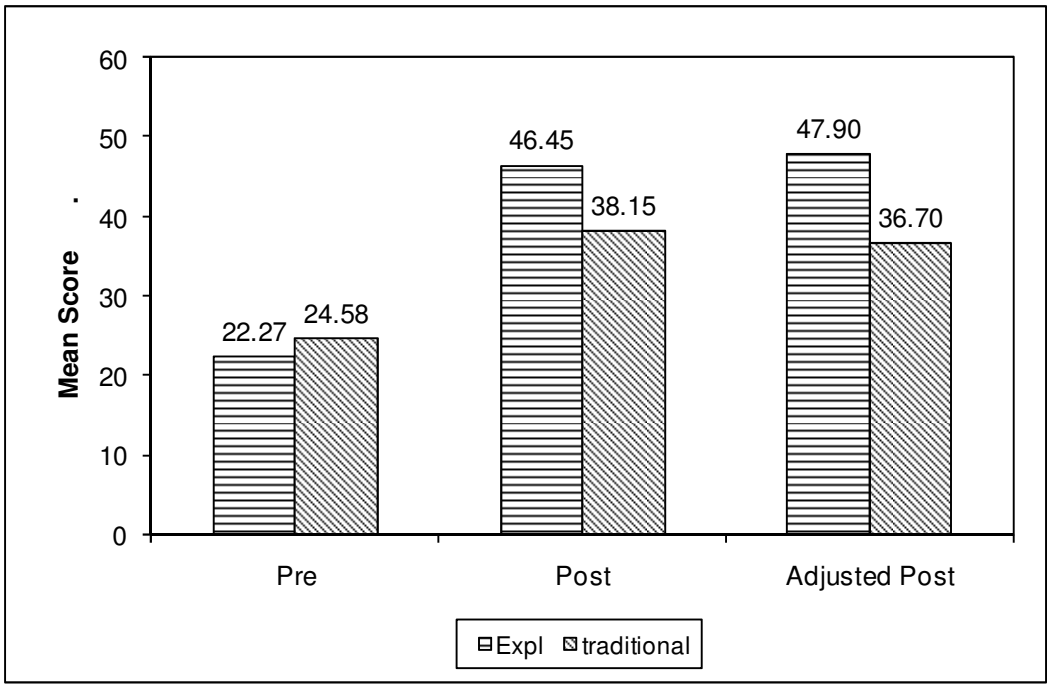
Summary of ANCOVA of pretest and posttest scores of achievement in Social Science of self financing school students in experimental and control group

Sources of variance	df	SSx	SSy	SSy.x	MSy.x	Fy.x	p	Level of Sig.
Between groups	1	87.52	1137.52	1968.94	1968.94	18.706	0.000	0.01
Within groups	63	1706.61	9332.42	6631.31	105.26			

The Calculated value of Fy.x was tested for significance. The calculated value of Fy.x (Fy.x=18.706; $p<0.01$) is significant at 0.01 level. This indicates that final mean scores of achievement in Social Science of self financing school students in experimental and control group differ significantly after they have been adjusted for initial difference in the pre test scores. So it can be concluded that digital concept mapping is more effective than the lecture method in enhancing achievement in Social Science of self financing school students. The comparison of pretest, posttest and adjusted posttest scores of self financing school students in experimental group and control group is presented in figure 4.5.

Figure 4.5

Comparison of pretest, posttest and adjusted posttest scores of achievement in Social Science of self financing school students in experimental and control group



4.7.10 Comparison of adjusted means of posttest

The adjusted means of posttest scores of self financing school students in experimental and control groups were computed and the differences between the adjusted posttest means were tested for significance. The data and results of test of significance of difference between the adjusted means of posttest scores of self financing school students in experimental and control groups are given in table 4.27.

Table 4.27

Result of the test of Significance of difference between the adjusted means of posttest scores of self financing school students in experimental group and control group

Group	Adjusted Mean	N	$SD_{(yx)}$	$SE_{D(yx)}$	t	p	Level of Sig.
Experimental	47.90	33	10.26	2.53	4.43	0.000	0.01
Control	36.70	33					

The obtained t value 4.43($p<0.01$) is significant at 0.01 level. This shows that the self financing school students in experimental and control group differ significantly in their adjusted posttest scores of achievement in Social Science. Since the adjusted mean scores of the self financing school students (47.90) in the experimental group is greater than that of the control group (36.70), the self financing school students in experimental group is superior to control group in their achievement in Social Science. Therefore it may be concluded that the digital concept mapping was more effective than the lecture method in enhancing achievement in Social Science of self financing school students.

4.8 Comparison of pretest scores of Creative Thinking Ability

Before the experiment was conducted, Test of Creative Thinking was administered as pretest for both the experimental and the control groups. For the obtained pretest scores of the control group and the experimental group, mean, standard deviation, t test and ANCOVA were calculated. The results are given below.

4.8.1 Significance of difference between mean pretest scores of Creative Thinking Ability of students in experimental group and control for the total sample

Ho 13 There exists no significant difference in the mean pretest scores of creative thinking ability of experimental group and control group for the total sample.

Table 4.28

Data and results of test of significance of the difference between mean pretest scores of Creative Thinking Ability of experimental and control groups for the total sample

Group	Mean	SD	N	Mean Difference	t	p	Level of significance
Digital Concept Mapping	400.64	57.66	70	1.77	0.208	0.835	NS
Lecture	402.41	44.25	75				

From table 4.28, it is clear that the calculated t value 0.835($p > 0.05$) is not significant at any level. Since the calculated t value is not significant at any level, the null hypothesis "there exists no significant difference in the mean pretest scores of creative thinking ability of experimental group and control group for the total sample" is accepted. This shows that there is no significant difference between the mean pretest scores of creative thinking ability of students in experimental group and control group. It means that both experimental and control groups do not differ significantly in their creative thinking ability. So it is inferred that before the experiment the two groups were similar in their creative thinking ability.

4.8.2 Significance of difference between mean pretest scores of creative thinking ability of students in experimental group and control group with respect to gender

Ho 14 There exists no significant difference in the mean pretest scores of creative thinking ability of experimental group and control group with respect to gender.

Table 4.29

Data and results of test of significance of the difference between mean pretest scores of creative thinking ability of experimental group and control group with respect to gender

Category	Group	Mean	SD	N	Mean Difference	t	p	Level of significance
Boys	Digital Concept Mapping	380.29	53.38	31	4.79	0.464	0.644	NS
	Lecture	385.08	29.33	36				
Girls	Digital Concept Mapping	416.82	56.39	39	1.59	0.132	0.895	NS
	Lecture	418.41	49.73	39				

From table 4.29, it is clear that the calculated t value 0.464for boys and 0.132 for girls ($p>0.05$) are not significant at any level. Since the calculated t value is not significant at any level, the null hypothesis "there exists no significant difference in the mean pretest scores of creative thinking ability of experimental group and control group with respect to gender" is accepted. This shows that there is no significant difference between the pretest scores of creative thinking ability of boys and girls in experimental and control group. Hence it is inferred that before the experiment boys and girls in experimental and control groups were similar in their creative thinking ability.

4.8.3 Significance of difference between mean pretest scores of Creative Thinking Ability of students in experimental group and control group with respect to type of management of the school

Ho 15 There exists no significant difference in the mean pretest scores of creative thinking ability of experimental group and control group with respect to type of management of the school.

Table 4.30

Data and results of test of significance of the difference between mean pretest scores of creative thinking ability of experimental group and control group with respect to type of management of the school

Category	Group	Mean	SD	N	Mean Difference	t	p	Level of sig.
Govt	Digital Concept Mapping	386.51	50.65	37	20.20	1.924	0.058	NS
	Lecture	406.71	42.67	42				
Self financing	Digital Concept Mapping	416.48	61.58	33	19.54	1.458	0.150	NS
	Lecture	396.94	46.26	33				

From table 4.30, it is clear that the calculated t value, 1.924 for government school students and 1.458for self financing school students ($p>0.05$) are not significant at any level. Since the calculated t values are not significant at any level, the null hypothesis "there exists no significant difference in the mean pretest scores of creative thinking ability of experimental group and control group with respect to type of management of the school" is accepted. This shows that there is no significant difference between the pretest scores of creative thinking ability of government and self financing school students in experimental and control group. Hence it is inferred that before the experiment government and self financing school students in experimental and control groups were similar in their creative thinking ability.

4.9 Comparison of posttest scores of Creative Thinking Ability

After conducting the experiment, Test of Creative Thinking was administered as posttest for both the experimental group and the control group. For the obtained post test scores of the control group and the experimental group, mean, standard deviation, t test and ANCOVA were calculated. The results are given below.

4.9.1 Significance of difference between mean posttest scores of creative thinking ability of students in experimental group and control group for the total sample

Ho 16 There exists no significant difference in the mean posttest scores of creative thinking ability of experimental group and control group for the total sample.

Table 4.31

Data and results of test of significance of the difference between mean posttest scores of creative thinking ability of experimental and control groups for the total sample

Group	Mean	SD	N	Mean Difference	t	p	Level of sig.
Digital Concept Mapping	581.47	117.04	70	116.42	7.710	0.000	0.01
Lecture	465.05	56.38	75				

From table 4.31, it is clear that the calculated t value 7.710 ($p< 0.01$) is significant at 0.01 level. Since the calculated t value is significant at 0.01 level, the null hypothesis "there exists no significant difference in the mean posttest scores of creative thinking ability of experimental group and control group for the total sample" is rejected. This shows that there is significant difference between the mean posttest scores of creative thinking ability of students in experimental group and control group. It is evident from the table that after the experiment the posttest scores of experimental group (581.47) is greater than that of control group (465.05). Hence it can be interpreted that digital concept mapping is more effective in developing the creative thinking ability of high school students.

4.9.2 Significance of difference between mean posttest scores of creative thinking ability of students in experimental group and control group with respect to gender

Ho 17 There exists no significant difference in the mean post test scores of creative thinking ability of experimental group and control group with respect to gender.

Table 4.32

Data and results of test of significance of the difference between mean post test scores of creative thinking ability of experimental group and control group with respect to gender

Category	Group	Mean	SD	N	Mean Difference	t	p	Level of sig.
Boys	Digital Concept Mapping	527.68	108.12	31	82.10	4.068	0.000	0.01
	Lecture	445.58	50.76	36				
Girls	Digital Concept Mapping	624.23	106.81	39	141.20	7.314	0.000	0.01
	Lecture	483.03	55.91	39				

From the above table, it is clear that the calculated t value for boys 4.068 ($p<0.01$)is significant at 0.01 level. The t value obtained for girls 7.314 ($p<0.01$) is significant at 0.01 level. Since the calculated t values are significant the null hypothesis "there exists no significant difference in the mean posttest scores of creative thinking ability of experimental group and control group with respect to gender" is rejected. This shows that there is significant difference between the mean posttest scores of creative thinking ability of boys and girls in experimental group and control group. Since the means of the posttest scores of experimental group is greater than that of control group, it can be inferred that digital concept mapping is more effective in developing the creative thinking ability of boys and girls.

4.9.3 Significance of difference between mean posttest scores of creative thinking ability of students in experimental group and control group with respect to type of management of the school

Ho 18 There exists no significant difference in the mean posttest scores of creative thinking ability of experimental group and control group with respect to type of management of the school.

Table 4.33

Data and results of test of significance of the difference between mean posttest scores of creative thinking ability of experimental and control groups with respect to Type of management of the school

Category	Group	Mean	SD	N	Mean Difference	t	p	Level of significance
Govt	Digital Concept Mapping	567.14	110.93	37	99.35	5.090	0.000	0.01
	Lecture	467.79	57.16	42				
Self financing	Digital Concept Mapping	597.55	123.25	33	135.97	5.769	0.000	0.01
	Lecture	461.58	56.05	33				

From the table 4.33, it is seen that the calculated t value for government school students 5.090 ($p<0.01$) is significant at 0.01 level. The t value for self financing school students 5.769 ($p<0.01$) is significant at 0.01 level. Since the calculated t values are significant at 0.01 level the null hypothesis "there exists no significant difference in the mean posttest scores of creative thinking ability of experimental group and control group with respect to type of management of the school" is rejected. This shows that there is significant difference between the mean posttest scores of creative thinking ability of government and self financing school students in experimental group and control group. Since the means of the posttest scores of experimental group is greater than that of control group, it can be interpreted that digital concept mapping is more effective in developing the creative thinking ability.

4.10 Comparison of gain scores of experimental and control group

The performance of students in both the groups was compared by testing the significance of difference between the mean gain scores of creative thinking ability of students in experimental and control groups using t test. The data and results of test of significance of difference between mean gain scores of creative thinking ability is given below.

4.10.1 Significance of difference between mean gain scores of creative thinking ability of students in experimental group and control group

Ho 19 There exists no significant difference in the mean gain scores of creative thinking ability of experimental group and control group for the total sample

TABLE 4.34

Data and result of test of significance of difference between the gain scores of creative thinking ability of experimental group and control group

Group	Mean	SD	N	Mean Difference	t	p	Level of significance
Experimental	180.83	86.59	70	118.19	11.139	0.000	0.01
Control	62.64	29.76	75				

From table 4.34, it is clear that the obtained t value 11.139($P<0.01$) is significant at 0.01 level. Since the calculated t value is significant at 0.01 level, the null hypothesis "there exists no significant difference in the mean gain scores of creative thinking ability of experimental group and control group for the total sample" is rejected. This shows that there is significant difference between the mean gain scores of experimental group and control group. The mean gain score of experimental group (180.83) is greater than that of control group (62.64). Hence it can be interpreted that the digital concept mapping technique is more effective in developing the creative thinking ability of high school students than the lecture method.

4.10.2 Significance of difference between mean gain scores of creative thinking ability of students in experimental group and control group with respect to gender and type of management of the school

Ho 20 There exists no significant difference in the mean gain scores of creative thinking ability of experimental group and control group with respect to gender and type of management of the school.

TABLE 4.35

Data and result of test of significance of difference between the gain scores of creative thinking ability of post test scores of experimental group and control group with respect to gender and type of management of the school

Category	Group	Mean	SD	N	Mean Difference	t	p	Level of sig.
Boys	Digital Concept Mapping	147.39	81.22	31	86.89	5.867	0.000	0.01
	Lecture	60.50	33.61	36				
Girls	Digital Concept Mapping	207.41	82.28	39	142.79	10.335	0.000	0.01
	Lecture	64.62	25.99	39				
Govt	Digital Concept Mapping	180.62	84.40	37	119.55	8.485	0.000	0.01
	Lecture	61.07	32.87	42				
Self financing	Digital Concept Mapping	181.06	90.31	33	116.42	7.125	0.000	0.01
	Lecture	64.64	25.62	33				

From table 4.35, it is clear that the calculated t value for boys (5.867; $p<0.01$), girls (10.335; $p<0.01$), government school students (8.485; $p<0.01$), and self financing school students (7.125; $p<0.01$) is significant at 0.01 level. Since the calculated t values are significant at 0.01 level, the null hypothesis "there exists no significant difference in the mean gain scores of creative thinking ability of experimental group and control group with respect to gender and type of management of the school" is rejected. This shows that there is significant difference between the mean gain scores of creative thinking ability of boys and girls of experimental group and control group and government school and self financing school students in experimental group and control group. The mean gain scores of experimental group are greater than that of control group. Hence it can be interpreted that the digital concept mapping method is more effective in developing the creative thinking ability of high school students.

4.11 Comparison of pretest and posttest scores of Experimental group and Control group

Mean and standard deviation of pretest and post test scores of creative thinking ability of students in experimental group were found out and tested for the significance of difference between the means using paired t test. The data and result of test of significance of difference between pretest and posttest scores of creative thinking ability of students in experimental group are given below.

4.11.1 Significance of difference between pretest and posttest scores of creative thinking ability of students in experimental group for the total sample

Ho 21 There exists no significant difference between the means of pretest and posttest scores of creative thinking ability of students in experimental group.

TABLE 4.36

Data and result of test of significance of difference between mean pretest and posttest scores of creative thinking ability of students in experimental group

Scores	Mean	SD	N	Mean Difference	Paired t	P	Level of significance
Pretest	400.64	57.66	70	180.83	17.47	0.000	0.01
Posttest	581.47	117.04	70				

From the above table, it is clear that the calculated t value 17.47($P<0.01$) is significant at 0.01 level. Since the calculated t value is significant at 0.01 level, the null hypothesis "there exists no significant difference between the means of pretest and posttest scores of creative thinking ability of students in experimental group' is rejected. This shows that there is significant difference between the means of pretest and posttest scores of creative thinking ability of students in experimental group. This proves that digital concept mapping is more effective in developing creative thinking ability of high school students.

4.11.2 Significance of difference between pretest and posttest scores of creative thinking ability of students in experimental group with respect to gender and type of management of the school

Ho 22 There exists no significant difference between the means of pretest and posttest scores of creative thinking ability of students in experimental group with respect to gender and type of management of the school.

TABLE 4.37

Data and result of test of significance of difference between mean pretest and posttest scores of creative thinking ability of students in experimental group with respect to gender and type of management of the school

Category	Scores	Mean	SD	N	Mean Difference	Paired t	P	Level of sig.
Boys	Pretest	380.29	53.38	31	147.39	10.10	0.000	0.01
	Posttest	527.68	108.12	31				
Girls	Pretest	416.82	56.39	39	207.41	15.74	0.000	0.01
	Posttest	624.23	106.81	39				
Govt	Pretest	386.51	50.65	37	180.63	13.02	0.000	0.01
	Posttest	567.14	110.93	37				
Self financing	Pretest	416.48	61.58	33	181.07	11.52	0.000	0.01
	Posttest	597.55	123.25	33				

From table 4.37, it is clear that the calculated t values for boys (10.10; $p<0.01$), girls (15.74; $p<0.01$), government school students (13.02; $p<0.01$), and self financing school students (11.52; $p<0.01$) in experimental group are significant at 0.01 level. Since the calculated t values are significant at 0.01 level, the null hypothesis "there exists no significant difference between the means of pretest and posttest scores of creative thinking ability of students in experimental group with respect to gender and type of management of the school" is rejected. This shows that there is significant difference between the means of pretest and posttest scores of creative thinking ability of experimental group with respect to gender and type of management of the school.

4.11.3 Significance of difference between pretest and posttest scores of creative thinking ability of students in control group for the total sample

The mean and standard deviation of pretest and posttest scores of creative thinking ability of students in control group were found out and tested for the significance of difference between the means. The data and results of test of significance of difference between pretest and posttest scores of creative thinking ability of students in control group are given in table 4.38.

Ho 23 There exists no significant difference between the means of pretest and posttest scores of creative thinking ability of high school students in control group.

TABLE 4.38

Data and result of test of significance of difference between mean pretest and posttest scores of creative thinking ability of students in control group

Scores	Mean	SD	N	Mean Difference	Paired t	P	Level of significance
Pretest	402.41	44.25	75	62.64	18.23	0.000	0.01
Posttest	465.05	56.38	75				

From the above table, it is clear that the t value 18.23 ($P<0.01$) obtained for creative thinking ability is significant at 0.01 level. Since the calculated t value is significant at 0.01 level, the null hypothesis "there exists no significant difference between the means of pretest and posttest scores of creative thinking ability of high school students in control group" is rejected. This shows that there is significant difference between the means of pretest and posttest scores of creative thinking ability of students in control group.

4.11.4 Significance of difference between pretest and posttest scores of creative thinking ability of students in control group with respect to gender and type of management of the school

Ho 24 There exists no significant difference between the means of pretest and post test scores of creative thinking ability of high school students in control group with respect to gender and type of management of the school.

TABLE 4.39

Data and result of test of significance of difference between mean pretest and posttest scores of creative thinking ability of students in control group with respect to gender and type of management of the school

Category	Scores	Mean	SD	N	Mean Difference	Paired t	P	Level of sig.
Boys	Pretest	385.08	29.33	36	60.50	10.80	0.000	0.01
	Posttest	445.58	50.76	36				
Girls	Pretest	418.41	49.73	39	64.62	15.53	0.000	0.01
	Posttest	483.03	55.91	39				
Govt	Pretest	406.71	42.67	42	61.08	12.04	0.000	0.01
	Posttest	467.79	57.16	42				
Self financing	Pretest	396.94	46.26	33	64.64	14.49	0.000	0.01
	Posttest	461.58	56.05	33				

From the above table, it is clear that the calculated t values for boys (10.80; $p<0.01$), girls (15.53; $p<0.01$), government school students (12.04; $p<0.01$) and for self financing school students (14.49; $p<0.01$) in control group are significant at 0.01 level. Since the calculated t values are significant at 0.01 level, the null hypothesis "there exists no significant difference between the means of pretest and post test scores of creative thinking ability of high school students in control group with

respect to gender and type of management of the school" is rejected. This shows that there is significant difference between the means of pretest and post test scores of creative thinking ability of students in control group with respect to gender and type of management of the school.

4.12 Genuineness of the difference in performance of the groups

The analysis of pretest scores of students in experimental and control groups did not show any difference even at 0.05 level of significance. This means that there is not much difference between the creative thinking ability of students in both the groups.

The analysis of posttest scores revealed that there is significant difference between the means of the posttest scores of creative thinking ability of students in experimental group and control group. There was an increase in the posttest scores of students who underwent experimental treatment compared to control group. The comparison of pretest and posttest scores of the experimental and control groups indicated that there is an increase in the posttest scores of experimental group than the other group. The comparison of gain scores of experimental and control groups revealed a significant difference between the means of the gain scores of the students in experimental group and control group. From the above results, it can be interpreted that experimental group has an advantage over the control group. Since the experimental and control groups selected for the study were nonequivalent groups, it cannot be concluded that students of two groups differ significantly by simply comparing the post test scores and the gain scores. Hence, it is necessary to analyze the data using the statistical technique Analysis of Covariance (ANCOVA), by which the initial difference of two groups can be removed statistically, and the initial status can be equated.

4.13 Comparison of effectiveness of digital concept mapping and lecture method on creative thinking ability using ANCOVA

4.13.1 Comparison of effectiveness of digital concept mapping and lecture method on creative thinking ability for the total sample

Analysis of covariance (ANCOVA) was used to compare the effectiveness of digital concept mapping and lecture method on creative thinking ability of high school students. Before proceeding to ANCOVA, the scores were subjected to ANOVA. The details of analysis of variance of pretest (x) and posttest (y) scores of experimental and control groups taken separately are given in table 4.40.

Table 4.40

Result of summary of ANOVA of pretest and posttest scores of creative thinking ability of students in experimental and control group(Total sample)

Source of variance	df	SSx	SSy	MSx	MSy	Fx	Fy
Between groups	1	113.49	490718.33	113.49	490718.33	0.043	59.445
Within groups	143	374292.26	1180469.23	2617.43	8255.03		

The obtained Fx and Fy ratios were tested for significance. The obtained Fx ($Fx = 0.043; p > 0.05$) is not significant at any level. This indicates that there is no significant difference between the pretest scores of experimental and control group. The obtained Fy ($Fy = 59.445; p < 0.01$) is significant at 0.01 level. So it can be concluded that there is significant difference between the posttest scores of experimental and control group. After correcting the final achievement score for difference in initial scores, ANCOVA was applied to the final score. The results of ANCOVA are presented in Table 4.41.

Table 4.41

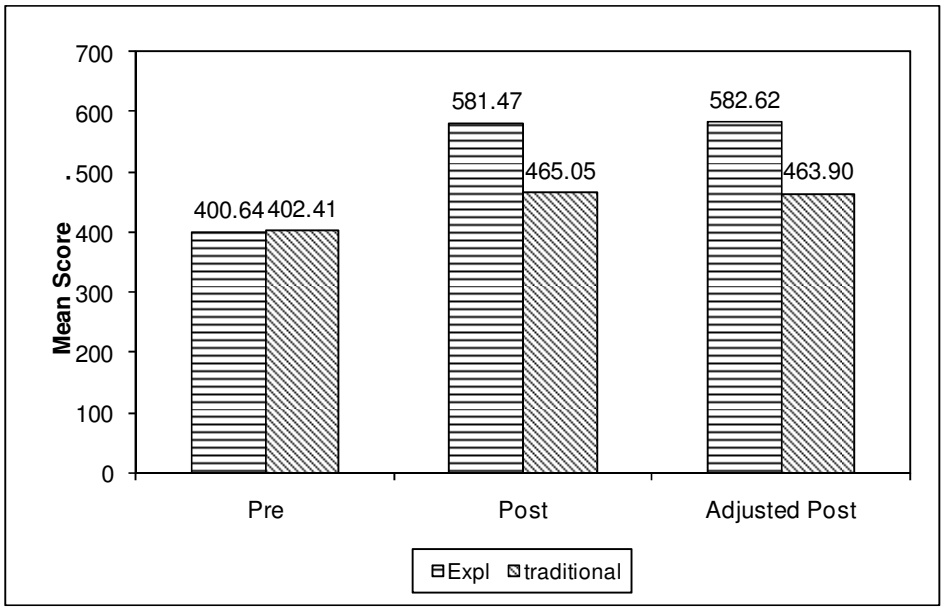
Summary of ANCOVA of pretest and posttest scores of creative thinking ability of students in experimental and control group

Source of variance	df	SSx	SSy	SSy.x	MSy.x	Fy.x	p	Level of Sig.
Between groups	1	113.49	490718.33	510131.90	510131.90	131.796	0.00	0.01
Within groups	142	374292.26	1180469.23	549629.64	3870.63			

The Calculated value of Fy.x was tested for significance. The calculated value of Fy.x (Fy.x=131.796; p<0.01) is significant at 0.01 level. This indicates that the final mean scores of creative thinking ability of students in experimental and control group differ significantly after they have been adjusted for initial difference in the pretest scores. So it can be concluded that digital concept mapping is more effective than the lecture method in developing creative thinking ability of high school students. The comparison of pretest, posttest and adjusted posttest scores of experimental group and control group is presented in figure 4.6.

Figure 4.6

Comparison of pretest, posttest and adjusted posttest scores of creative thinking ability of experimental and control group for the total sample



4.13.2 Comparison of adjusted means of posttest

The adjusted means of posttest scores of students in experimental and control groups were computed and the difference between the adjusted posttest means were tested for significance. The data and results of test of significance of difference between the adjusted means of posttest scores of students in experimental and control groups are given in table 4.42.

Table 4.42

Results of the test of Significance of difference between the adjusted means of posttest scores of students in experimental and control group

Group	Adjusted Mean	$SD_{(yx)}$	$SE_{D(yx)}$	t	p	Level of Sig.
Experimental	582.62	62.21	10.52	11.29	0.000	0.01
Control	463.90					

The obtained t value 11.29 ($p<0.01$) is significant at 0.01 level. This shows that the experimental and control group differ significantly in their adjusted posttest scores of creative thinking ability. Since the adjusted mean scores of the experimental group (582.62) is greater than that of the control group (463.90), the experimental group is superior to control group in their creative thinking ability. Therefore it may be concluded that the digital concept mapping is more effective than the lecture method in developing creative thinking ability of high school students.

4.13.3 Comparison of effectiveness of digital concept mapping and lecture method on creative thinking ability for boys

The details of analysis of variance of pretest (x) and posttest (y) scores of boys in experimental and control groups taken separately are given in the table 4.43.

Table 4.43

Result of summary of ANOVA of pretest and posttest scores of creative thinking ability of boys in experimental group and control group

Source of variance	df	SSx	SSy	MSx	MSy	Fx	Fy
Between groups	1	382.65	112256.92	382.65	112256.92	0.215	16.551
Within groups	65	115617.14	440859.52	1778.73	6782.45		

The obtained Fx and Fy ratios were tested for significance. The obtained Fx (Fx =0.215; p>0.05) is not significant at any level. This indicates that there is no significant difference between the pretest scores of boys in experimental and control groups. The obtained Fy (Fy =16.551; p<0.01) is significant at 0.01 level. So it can be concluded that there is significant difference between the posttest scores of boys in experimental and control groups. After correcting the final achievement score for difference in initial scores, ANCOVA was applied to the final score. The results of ANCOVA are presented in Table 4.44.

Table 4.44

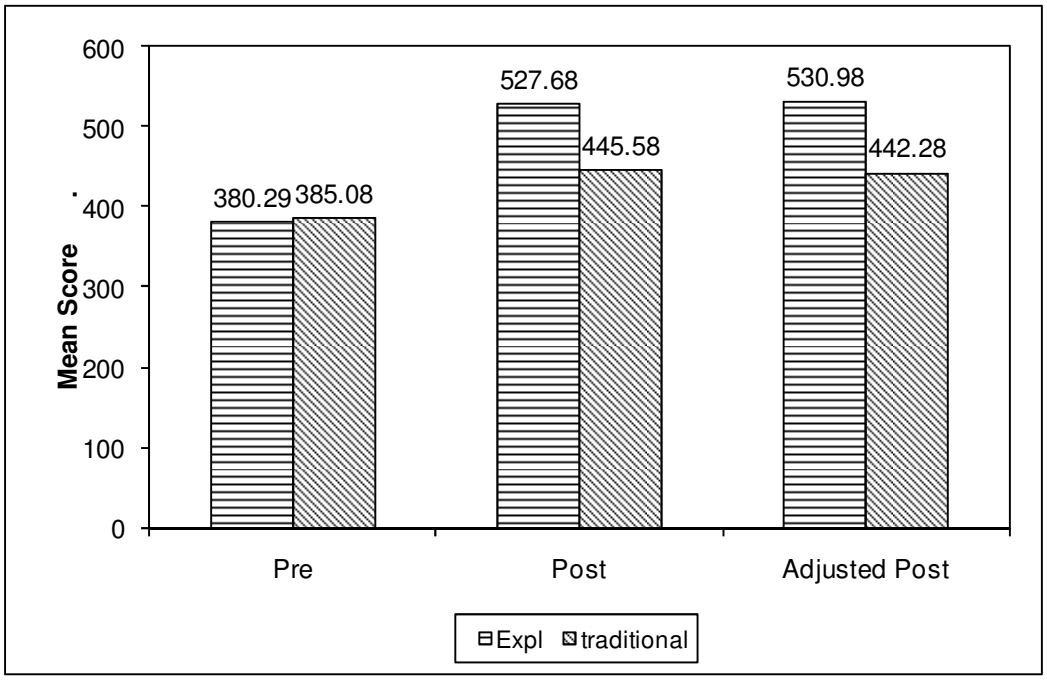
Summary of ANCOVA of pretest and posttest scores of creative thinking ability of boys in experimental group and control group

Source of variance	df	SSx	SSy	SSy.x	MSy.x	Fy.x	p	Level of Sig
Among groups	1	382.65	112256.92	130636.76	130636.76	37.865	0.000	0.01
Within groups	64	115617.14	440859.52	220806.56	3450.10			

The Calculated value of Fy.x was tested for significance. The calculated value of Fy.x (Fy.x=37.865; p<0.01) is significant at 0.01 level. This indicates that the final mean scores of creative thinking ability of boys in experimental group and control group differ significantly after they have been adjusted for initial difference in the pretest scores. So it can be concluded that digital concept mapping is more effective than the lecture method in developing creative thinking ability of boys. The comparison of pretest, posttest and adjusted post test scores of boys in experimental group and control group is presented in figure 4.7.

Figure 4.7

Comparison of pretest, posttest and adjusted posttest scores of creative thinking ability of boys in experimental group and control group



4.13.4 Comparison of adjusted means of posttest

The adjusted means of posttest scores of boys in experimental and control groups were computed and the difference between the adjusted posttest means were tested for significance. The data and results of test of significance of difference between the adjusted means of posttest scores of boys in experimental and control groups are given in table 4.45.

Table 4.45

Results of the test of Significance of difference between the adjusted means of posttest scores of boys in experimental and control group

Group	Adjusted Mean	$SD_{(yx)}$	$SE_{D(yx)}$	t	p	Level of Sig.
Experimental	530.98	58.74	14.92	5.95	0.000	0.01
Control	442.28					

The obtained t value 5.95($p<0.01$) is significant at 0.01 level. This shows that the boys in experimental and control group differ significantly in their adjusted posttest scores of creative thinking ability. Since the adjusted mean scores of the boys (530.98) in experimental group is greater than that of the control group (442.28), the boys in experimental group is superior to control group in their creative thinking ability. Therefore it may be concluded that the digital concept mapping is more effective than the lecture method in developing creative thinking ability of boys.

4.13.5 Comparison of effectiveness of digital concept mapping and lecture method on creative thinking ability for girls

The details of analysis of variance of pretest (x) and posttest (y) scores of girls in experimental and control groups taken separately are given in table 4.46.

Table 4.46

Result of summary of ANOVA of pretest and posttest scores of creative thinking ability of girls in experimental and control group

Source of variance	df	SSx	SSy	MSx	MSy	Fx	Fy
Between groups	1	49.28	388808.32	49.28	388808.32	0.017	53.497
Within groups	76	214835.18	552351.90	2826.78	7267.79		

The obtained Fx and Fy ratios were tested for significance. The obtained Fx (Fx =0.017;p>0.05) is not significant at any level. This indicates that there is no significant difference between the pretest scores of girls in experimental and control group.

The obtained Fy (Fy =53.497;p<0.01) is significant at 0.01 level. So it can be concluded that there is significant difference between the posttest scores of girls in experimental and control groups. After correcting the final achievement score for difference in initial scores, ANCOVA was applied to the final score. The results of ANCOVA are presented in Table 4.46.

Table 4.46

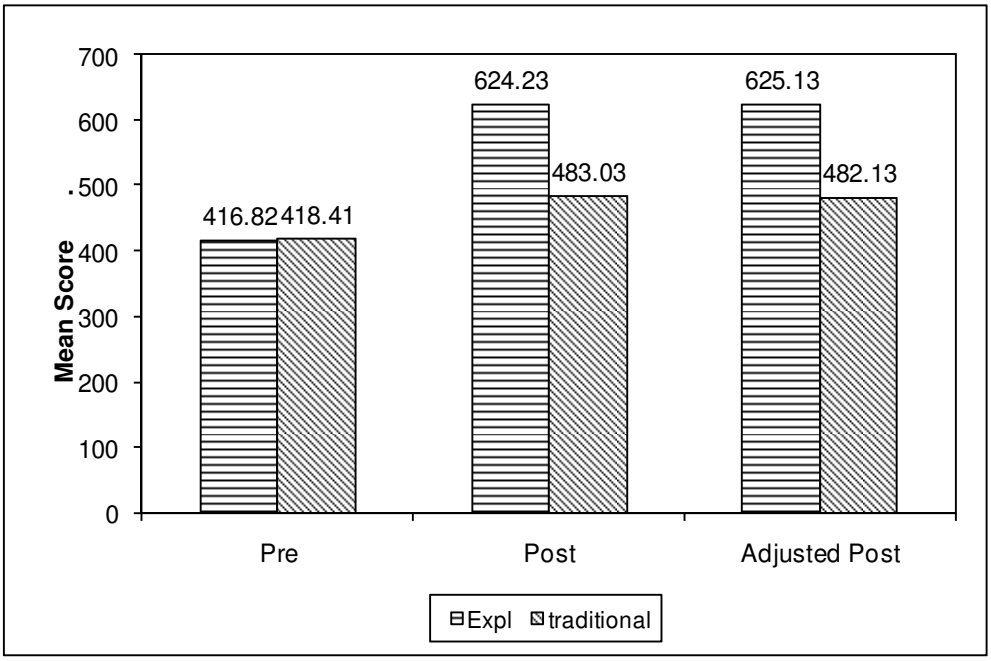
Summary of ANCOVA of pretest and posttest scores of creative thinking ability of girls in experimental and control group

Source of variance	df	SSx	SSy	SSy.x	MSy.x	Fy.x	p	Level of Sig.
Between groups	1	49.28	388808.32	398646.78	398646.78	106.993	*0.000*	*0.01*
Within groups	75	214835.18	552351.90	279443.03	3725.91			

The Calculated value of Fy.x was tested for significance. The calculated value of Fy.x (Fy.x=106.993; $p<0.01$) is significant at 0.01 level. This indicates that the final mean scores of creative thinking ability of girls in experimental and control group differ significantly after they have been adjusted for initial difference in the pretest scores. So it can be concluded that digital concept mapping is more effective than the lecture method in developing creative thinking ability of girls. The comparison of pretest, posttest and adjusted post test scores of girls in experimental group and control group is presented in figure 4.8.

Figure 4.8

Comparison of pretest, posttest and adjusted post test scores of creative thinking ability of girls in experimental and control group



4.13.6 Comparison of adjusted means of posttest

The adjusted means of posttest scores of girls in experimental and control groups were computed and the difference between the adjusted posttest means were tested for significance. The data and results of test of significance of difference between the adjusted means of post test scores of girls in experimental and control groups are given in table 4.47.

Table 4.47

Results of the test of Significance of difference between the adjusted means of post test scores of girls in experimental and control group

Group	Adjusted Mean	$SD_{(yx)}$	$SE_{D(yx)}$	t	p	Level of Sig.
Experimental	625.13	61.04	13.82	10.34	0.000	0.01
Control	482.13					

The obtained t value 10.34 ($p<0.01$) is significant at 0.01 level. This shows that the girls in experimental and control group differ significantly in their adjusted posttest scores of creative thinking ability. Since the adjusted mean scores of the girls (625.13) in experimental group is greater than that of the control group (482.13), the girls of experimental group is superior to control group in their creative thinking ability. Therefore it may be concluded that the digital concept mapping is more effective than the lecture method in developing creative thinking ability of girls.

4.13.7 Comparison of effectiveness of digital concept mapping and lecture method on creative thinking ability for government school students

The details of analysis of variance of pretest (x) and posttest (y) scores of government school students in experimental and control groups taken separately are given in table 4.48.

Table 4.48

Result of summary of ANOVA of pretest and posttest scores of creative thinking ability of government school students in experimental and control group

Source of variance	df	SSx	SSy	MSx	MSy	Fx	Fy
Between groups	1	8027.12	194157.69	8027.12	194157.69	3.701	25.911
Within groups	77	167011.81	576987.40	2168.98	7493.34		

The obtained Fx and Fy ratios were tested for significance. The obtained Fx (Fx =3.701;p>0.05) is not significant at any level. This indicates that there is no significant difference between the pretest scores of government school students in experimental and control group.

The obtained Fy (Fy =25.911; p<0.01) is significant at 0.01 level. So it can be concluded that there is significant difference between the posttest scores of government school students in experimental and control group. After correcting the final achievement score for difference in initial scores, ANCOVA was applied to the final score. The results of ANCOVA are presented in Table4.49.

Table 4.49

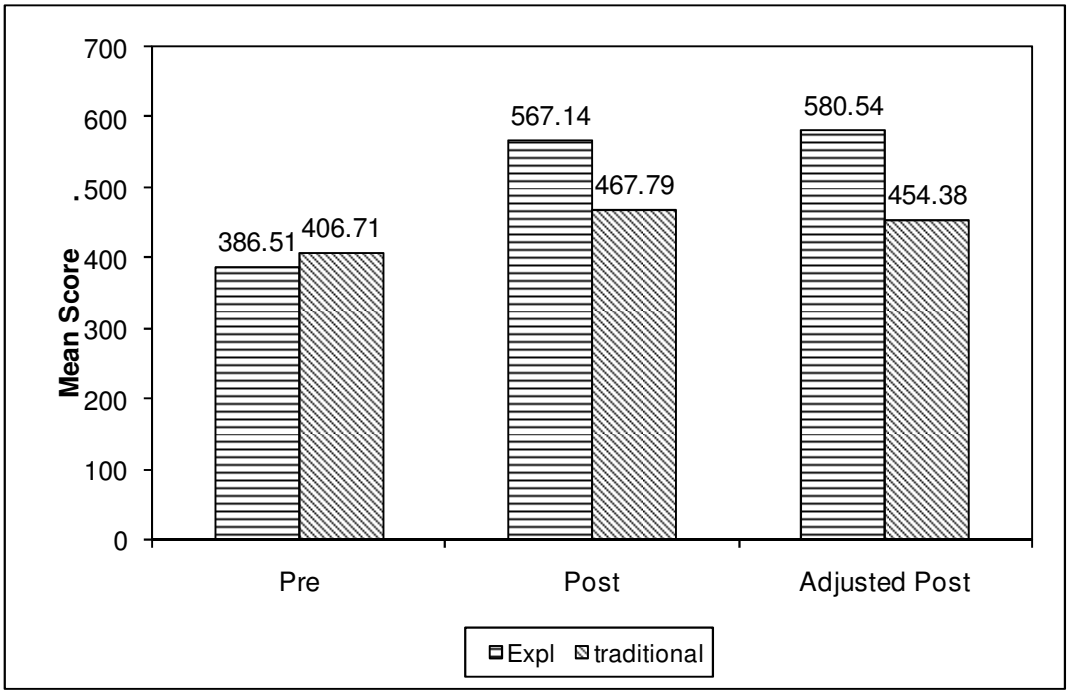
Summary of ANCOVA of pretest and posttest scores of creative thinking ability of government school students in experimental and control group

Source of variance	df	SSx	SSy	SSy.x	MSy.x	Fy.x	p	Level of Sig
Between groups	1	8027.12	194157.69	298724.85	298724.85	80.272	*0.000*	*0.01*
Within groups	77	167011.81	576987.40	282827.26	3721.41			

The Calculated value of Fy.x was tested for significance. The calculated value of Fy.x (Fy.x=80.272; $p<0.01$) is significant at 0.01 level. This indicates that the final mean scores of creative thinking ability of government school students in experimental and control group differ significantly after they have been adjusted for initial difference in the pretest scores. So it can be concluded that digital concept mapping is more effective than the lecture method in developing creative thinking ability of government school students. The comparison of pretest, posttest and adjusted post test scores of experimental group and control group is presented in figure 4.9.

Figure 4.9

Comparison of pretest, posttest and adjusted posttest scores of creative thinking ability of government school students in experimental and control group



4.13.8 Comparison of adjusted means of posttest

The adjusted means of posttest scores of government school students in experimental and control groups were computed and the difference between the adjusted posttest means were tested for significance. The data and results of test of significance of difference between the adjusted means of post test scores of government school students in experimental and control groups are given in table 4.50.

Table 4.50

Results of the test of significance of difference between the adjusted means of posttest scores of government school students in experimental and control group

Group	Adjusted Mean	$SD_{(yx)}$	$SE_{D(yx)}$	t	p	Level of Sig.
Experimental	580.54	61.00	14.18	8.90	0.000	0.01
Control	454.38					

The obtained t value 8.90, ($p<0.01$) is significant at 0.01 level. This shows that the government school students in experimental and control group differ significantly in their adjusted posttest scores of creative thinking ability. Since the adjusted mean scores of the government school students (580.54) in experimental group is greater than that of the control group (454.38), the government school students in experimental group is superior to control group in their creative thinking ability. Therefore it may be concluded that the digital concept mapping is more effective than the lecture method in developing creative thinking ability of government school students.

4.13.9 Comparison of effectiveness of digital concept mapping and lecture method on creative thinking ability for self financing school students

The details of analysis of variance of pretest (x) and posttest (y) scores of self financing school students in experimental and control groups taken separately are given in table 4.51.

Table 4.51

Result of summary of ANOVA of pretest and posttest scores of creative thinking ability of self financing school students in experimental and control group

Source of variance	df	SSx	SSy	MSx	MSy	Fx	Fy
Between groups	1	6303.41	305048.02	6303.41	305048.02	2.125	33.280
Within groups	64	189846.12	586638.24	2966.35	9166.22		

The obtained Fx and Fy ratios were tested for significance. The obtained Fx (Fx =2.125; p>0.05) is not significant at any level. This indicates that there is no significant difference between the pretest scores of self financing school students in experimental and control group. The obtained Fy (Fy =33.280; p<0.01) is significant at 0.01 level. So it can be concluded that there is significant difference between the posttest scores of self financing school students in experimental and control group.

After correcting the final achievement score for difference in initial scores, ANCOVA was applied to the final score. The results of ANCOVA are presented in Table 4.52.

Table 4.52

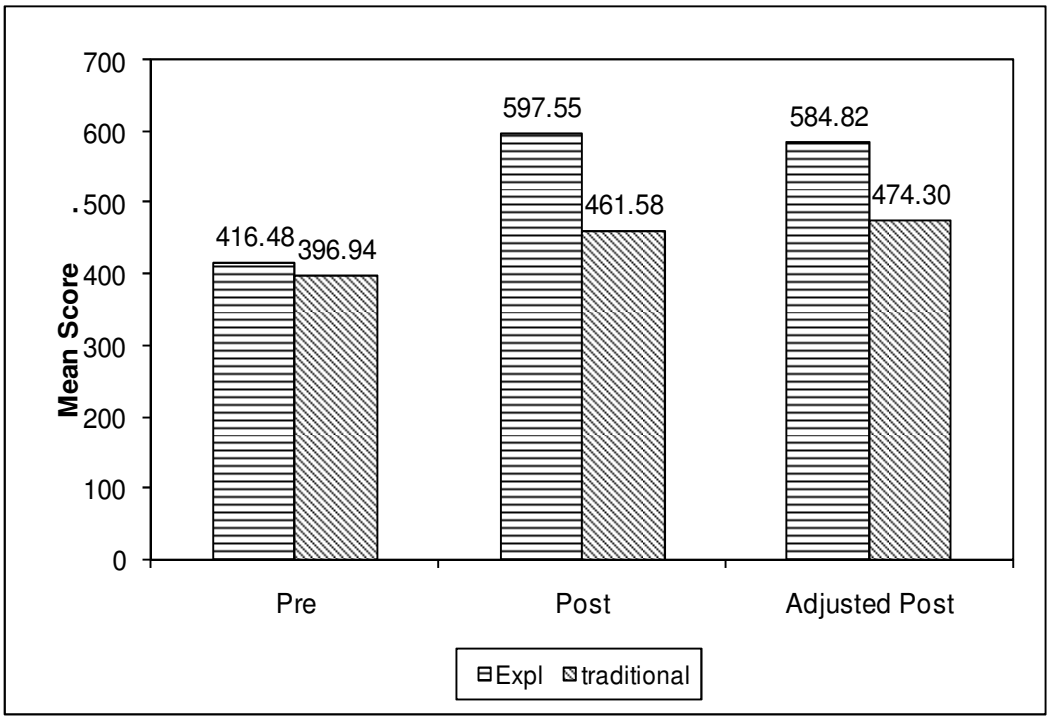
Summary of ANCOVA of pretest and posttest scores of creative thinking ability of self financing school students in experimental and control group

Source of variance	df	SSx	SSy	SSy.x	MSy.x	Fy.x	p	Level of Sig
Between groups	1	6303.41	305048.02	195044.62	195044.62	46.435	*0.000*	*0.01*
Within groups	63	189846.12	586638.24	264623.41	4200.37			

The Calculated value of Fy.x was tested for significance. The calculated value of Fy.x (Fy.x=46.435; p<0.01) is significant at 0.01 level. This indicates that the final mean scores of creative thinking ability of self financing school students in experimental and control group differ significantly after they have been adjusted for initial difference in the pretest scores. So it can be concluded that digital concept mapping is more effective than the lecture method in developing creative thinking ability. The comparison of pretest, posttest and adjusted posttest scores of self financing school students in experimental group and control group is presented in figure 4.10.

Figure 4.10

Comparison of pretest, posttest and adjusted posttest scores on creative thinking ability of self financing school students in experimental and control group



4.13.10 Comparison of adjusted means of posttest

The adjusted means of posttest scores of self financing school students in experimental and control groups were computed and the difference between the adjusted posttest means were tested for significance. The data and results of test of significance of difference between the adjusted means of posttest scores of self financing school students in experimental and control groups are given in table 4.53.

Table 4.53

Results of the test of significance of difference between the adjusted means of posttest scores of self financing school students in experimental and control group

Group	Adjusted Mean	$SD_{(yx)}$	$SE_{D(yx)}$	t	p	Level of Sig.
Experimental	584.82	64.81	15.96	6.93	0.000	0.01
Control	474.30					

The obtained t value 6.93, ($p<0.01$) is significant at 0.01 level. This shows that the self financing school students in experimental and control group differ significantly in their adjusted posttest scores of creative thinking ability. Since the adjusted mean scores of the self financing school students (584.82) in experimental group is greater than that of the control group (474.30), the self financing school students of experimental group is superior to control group in their creative thinking ability. Therefore it may be concluded that the digital concept mapping is more effective than the lecture method in developing creative thinking ability of self financing school students.

4.14 Comparison of ratings of students in experimental group on the comparative efficacy of the digital concept mapping technique and lecture method in realizing educational outcomes in Social Science

Ho 25 There exists no significant difference in the mean rating score on the efficacy of the digital concept mapping technique and lecture method in realizing the learning outcomes in Social Science.

Table 4.54

Comparison of the rating scores of students in experimental group on digital concept mapping technique and lecture method

Method	Mean	SD	N	Mean Difference	Paired t	p	Level of Sig.
Digital Concept Mapping	102.84	10.75	70	29.85	14.43	0.000	0.01
Lecture	72.99	12.84	70				

From the above table, it is clear that the obtained t value 14.43 ($p<0.01$) is significant at 0.01 level. Hence the null hypothesis "there exists no significant difference in the mean rating score on the efficacy of the digital concept mapping technique and lecture method in realizing the learning outcomes in Social Science" is rejected. The mean rating score on digital concept mapping technique (102.84) is higher than that of the lecture method (72.99). It indicates that the digital concept mapping technique is superior to the lecture method in realizing the learning outcomes in Social Science.

4.15 Responses of teachers regarding various aspects of using Digital Concept Mapping technique in teaching Social Science at high school level

4.15.1 Use of digital concept mapping technique in teaching Social Science

All the teachers (N=25) reported that they are not using digital concept mapping technique in teaching Social Science.

4.15.2 Training related to digital concept mapping technique

20% of the teachers reported that they got training in digital concept mapping technique and 80% of the teachers reported that they didn't get any training in digital concept mapping technique for teaching Social Science.

4.15.3 Suitability of digital concept mapping technique for teaching Social Science syllabus at high school level in the terms of existing syllabus

Regarding the suitability of digital concept mapping technique in terms of the existing syllabus, 84% of the teachers reported that the digital concept mapping technique is suitable to the existing Social Science syllabus at high school and 16% the of teachers reported that the digital concept mapping technique is not suitable to the existing Social Science syllabus at high school.

4.15.4 Learning outcomes of teaching Social Science using digital concept mapping technique at high school level

The percentage of responses of high school teachers regarding the learning outcomes of teaching Social Science using digital concept mapping technique at high school level are given in the table 4.55.

Table 4.55

Learning outcomes of teaching Social Science using digital concept mapping technique

Sl. No	Educational Outcomes	Great Extent		Some Extent		Not at all	
		Count	%	Count	%	Count	%
a	Enables to learn the concepts meaningfully	21	84	4	16	0	0
b	Helps to retain the learned concepts	15	60	10	40	0	0
c	Develops creative thinking among students	22	88	3	12	0	0
d	Improves skill of using computer	20	80	5	20	0	0
e	Develops skill in designing maps	15	60	10	40	0	0
f	Helps to summarize information	20	80	5	20	0	0
g	Promotes independent thinking	18	72	7	28	0	0
h	Promotes better achievement in Social Science	23	92	2	8	0	0
i	Helps in systematic organization of ideas.	15	60	10	40	0	0

Regarding the learning outcomes of teaching Social Science using digital concept mapping technique92% of the Social Science teachers reported that digital concept mapping technique is suitable to a great extent in promoting better achievement in Social Science. It is followed by develops creative thinking among students (88%), enables to learn the concepts meaningfully (84%), improves skill of using computer (80%), helps to summarize information (80%), promotes independent thinking (72%), helps to retain the learned concepts (60%), develops skill in designing maps (60%), helps in systematic organization of ideas (60%).

4.15.5 Suitability of digital concept mapping for attaining the objectives of teaching Social Science

Table 4.56

Suitability of digital concept mapping for attaining the objectives of teaching Social Science

Sl. No	Objectives of Teaching	Great Extent		Some Extent		Not at all	
		Count	%	Count	%	Count	%
1.	To develop understanding of facts and concepts in Social Science	23	92	2	8	0	0
2.	To develop practical skills	21	84	4	16	0	0
3.	To develop interest in Social Science	20	80	5	20	0	0
4.	To develop healthy social attitude	15	60	10	40	0	0
5.	To develop the power of imagination	20	80	5	20	0	0
6.	To develop the power of judgment	17	68	8	32	0	0

Regarding the suitability of digital concept mapping technique for attaining the objectives of teaching Social Science, 92% of the teachers reported that the digital concept mapping technique is suitable to a great extent for attaining the objective of developing understanding of facts and concepts in Social Science. 84% of the teachers reported that it helps to develop practical skills.80% of the teachers reported that it helps to develop interest in Social Science. 80% of the teachers reported that it helps to develop the power of imagination, 68% of the teachers reported that it helps to develop the power of judgment and 60% of the teachers reported that it is suitable to a great extent in developing healthy social attitude.

40% of the teachers reported that digital concept mapping technique is suitable to some extent for attaining the objective; to develop healthy social attitude. It is followed by to develop the power of judgment (32%), to develop interest in Social Science (20%), to develop the power of imagination (20%), to develop practical skills (16%) and to develop understanding of facts and concepts in Social Science (8%).

4.15.6 Practical difficulties in using digital concept mapping technique for teaching Social Science

Table 4.57

Practical difficulties in using digital concept mapping technique

Sl. No	Practical difficulties	Great Extent		Some Extent		Not at all	
		Count	%	Count	%	Count	%
1.	Lack of computer knowledge	6	24	8	32	11	44
2.	Lack of knowledge in the preparation of digital concept maps	22	88	3	12	0	0
3.	Lack of training	20	80	0	0	5	20
4.	Lack of computer facilities in schools	2	8	4	16	19	76
5.	Rigid timetable	17	68	6	24	2	8
6.	Overcrowded classroom	14	56	5	20	6	24
7.	Lack of co-operation from school authorities	7	28	6	24	12	48
8.	Difficulty in maintaining discipline	8	32	3	12	14	56

Regarding the practical difficulties in using digital concept mapping for teaching Social Science 88% of the teachers reported that the main practical difficulty is lack of knowledge in the preparation of digital concept maps. 80% of the teachers

reported that the practical difficulty to a great extent for them is lack of training, 68% of the teachers reported that the practical difficulty to a great extent for them is rigid timetable, 56% of the teachers reported that the practical difficulty to a great extent for them is overcrowded classroom, 32% of the teachers reported that the practical difficulty to a great extent for them is difficulty in maintaining discipline, 28% of the teachers reported that the practical difficulty to a great extent for them is lack of co-operation from school authorities, 24% of the teachers reported that the practical difficulty to a great extent for them is lack of computer knowledge and 8% of the teachers reported that the practical difficulty to a great extent is lack of computer facilities in schools.

32% of the teachers reported that the practical difficulty to some extent for them is lack of computer knowledge. It is followed by rigid timetable (24%), lack of co-operation from school authorities (24%), overcrowded classroom (20%), lack of computer facilities in schools (16%), lack of knowledge in the preparation of digital concept maps (12%) and difficulty in maintaining discipline (12%).

4.15.7 Suggestions for the effective use of digital concept mapping technique for teaching Social Science at high school level

The suggestions given by the teachers for the effective use of digital concept mapping technique for teaching Social Science at high school level are the following.

i. Provide training in the preparation and use of digital concept maps in teaching.
ii. Provide suitable reference materials related to digital concept mapping technique in the school library.

iii. Reduce the strength of the class.

iv. Reduce the work load.

v. Provide two consecutive periods in the time table.

vi. Make the time table flexible.

vii. Provide more smart class rooms.

viii. Provide Computer with internet facilities individually.

4.16 Tenability of Hypothesis

In this section an attempt has been made to examine the tenability of various null hypotheses set for the study.

Null Hypothesis: 1 “there exists no significant difference in the mean pretest scores of achievement in Social Science of experimental group and control group for the total sample” is accepted.

Null Hypothesis: 2 “there exists no significant difference in the mean pretest scores of achievement in Social Science of experimental group and control group with respect to gender” is accepted.

Null Hypothesis: 3 “there exists no significant difference in the mean pretest scores of achievement in Social Science of experimental group and control group with respect to type of management of the school” is accepted.

Null Hypothesis: 4 “there exists no significant difference in the mean posttest scores of achievement in Social Science of experimental group and control group for the total sample” is rejected.

Null Hypothesis: 5 “there exists no significant difference in the mean posttest scores of achievement in Social Science of experimental group and control group with respect to gender” is rejected.

Null Hypothesis: 6 “there exists no significant difference in the mean posttest scores of achievement in Social Science of experimental group and control group with respect to type of management of the school” is rejected.

Null Hypothesis: 7 “there exists no significant difference in the mean gain scores of achievement in Social Science of experimental group and control group for the total sample” is rejected.

Null Hypothesis: 8 “there exists no significant difference in the mean gain scores of achievement in Social Science of experimental group and control group with respect to gender and type of management of the school” is rejected.

Null Hypothesis: 9 “there exists no significant difference between the means of pretest and posttest scores of achievement in Social Science of students in experimental group’ is rejected.

Null Hypothesis: 10 “there exists no significant difference between the means of pretest and posttest scores of achievement in Social Science of students in experimental group with respect to gender and type of management of the school’ is rejected.

Null Hypothesis: 11 “there exists no significant difference between the means of pretest and posttest scores of achievement in Social Science of students in control group’ is rejected.

Null Hypothesis: 12 “there exists no significant difference between the means of pretest and posttest scores of achievement in Social Science of students in control group with respect to gender and type of management of the school’ is rejected.

Null Hypothesis: 13 “there exists no significant difference in the mean pretest scores of creative thinking ability of experimental group and control group for the total sample” is accepted.

Null Hypothesis: 14 “there exists no significant difference in the mean pretest scores of creative thinking ability of experimental group and control group with respect to gender” is accepted.

Null Hypothesis: 15 “there exists no significant difference in the mean pretest scores of creative thinking ability of experimental group and control group with respect to type of management of the school” is accepted.

Null Hypothesis: 16 “there exists no significant difference in the mean posttest scores of creative thinking ability of experimental group and control group for the total sample” is rejected.

Null Hypothesis: 17 “there exists no significant difference in the mean posttest scores of creative thinking ability of experimental group and control group with respect to gender” is rejected.

Null Hypothesis: 18 “there exists no significant difference in the mean posttest scores of creative thinking ability of experimental group and control group with respect to type of management of the school” is rejected.

Null Hypothesis: 19 “there exists no significant difference in the mean gain scores of creative thinking ability of experimental group and control group for the total sample” is rejected.

Null Hypothesis: 20 “there exists no significant difference in the mean gain scores of creative thinking ability of experimental group and control group with respect to gender and type of management of the school” is rejected.

Null Hypothesis: 21 “there exists no significant difference between the means of pretest and posttest scores of creative thinking ability of students in experimental group’ is rejected.

Null Hypothesis: 22 “there exists no significant difference between the means of pretest and posttest scores of creative thinking ability of students in experimental group with respect to gender and type of management of the school” is rejected.

Null Hypothesis: 23 “there exists no significant difference between the means of pretest and posttest scores of creative thinking ability of high school students in control group” is rejected.

Null Hypothesis: 24 “there exists no significant difference between the means of pretest and post test scores of creative thinking ability of high school students in control group with respect to gender and type of management of the school” is rejected.

Null Hypothesis: 25 “there exists no significant difference in the mean rating score on the efficacy of the digital concept mapping technique and lecture method in realizing the learning outcomes in Social Science” is rejected.

CHAPTER- V

CONCLUSION

This chapter deals with the summary of the study conducted followed by the findings and conclusions. This chapter includes the major findings of the study, conclusions, discussion of the findings, educational implications of the present study and suggestions for further research.

5.1.0 THE STUDY IN RETROSPECT

Present study has been designed to investigate the effect of digital concept mapping on achievement in social science and creative thinking ability of high school students.

5.1.1 Objectives of the Study

The objectives framed for the present study are given below:

1. To prepare digital concept maps for teaching selected topics in Social Science of standard IX.
2. To study the effectiveness of digital concept mapping on achievement in Social Science of high school students for the total sample and sub samples based on sex and type of management of the school.
3. To study the effectiveness of digital concept mapping on creative thinking ability of high school students for the total sample and sub samples based on sex and type of management of the school.

4. To find out whether there is any significant difference in the ratings of students on the efficacy of digital concept mapping technique and lecture method in realizing the learning outcomes in Social Science.
5. To find out the extent of use of digital concept mapping technique by the high school teachers for teaching Social Science.
6. To find out the suitability of digital concept mapping for teaching Social Science in terms of existing syllabus.
7. To find out the extent of learning outcomes get through the use of digital concept mapping technique.
8. To find out the suitability of digital concept mapping technique for attaining the objectives of teaching Social Science.
9. To identify the practical difficulties in using digital concept mapping technique by the high school Social Science teachers.
10. To collect suggestions of teachers for the effective use of digital concept mapping technique for teaching Social Science at high school level.

5.1.2 Hypotheses Formulated

The following are the major hypotheses formulated for the present investigation.

- ***H 1*** There will be significant difference in the mean posttest scores of achievement in Social Science of digital concept mapping group and lecture method group with respect to the total sample and sub samples based on gender and type of management of the school.
- ***H 2*** There will be significant difference in the mean gain scores of achievement in Social Science of digital concept mapping group and lecture method group with respect to the total sample and sub samples based on gender and type of management of the school.

- ***H 3*** There will be significant difference between the means of pretest and posttest scores of achievement in Social Science of digital concept mapping group with respect to the total sample and sub samples based on gender and type of management of the school.
- ***H 4*** There will be significant difference between the means of pretest and posttest scores of achievement in Social Science of lecture method group with respect to the total sample and sub samples based on gender and type of management of the school.
- ***H 5*** There will be significant difference in the mean posttest scores of creative thinking ability of digital concept mapping group and lecture method group with respect to the total sample and sub samples based on gender and type of management of the school.
- ***H 6*** There will be significant difference in the mean gain scores of creative thinking ability of digital concept mapping group and lecture method group with respect to the total sample and sub samples based on gender and type of management of the school.
- ***H 7*** There will be significant difference between the means of pretest and posttest scores of creative thinking ability of digital concept mapping group with respect to the total sample and sub samples based on gender and type of management of the school.
- ***H 8*** There will be significant difference between the means of pretest and posttest scores of creative thinking ability of lecture method group with respect to the total sample and sub samples based on gender and type of management of the school.

- ***H 9*** There will be significant difference in the mean rating scores on the efficacy of the digital concept mapping technique and lecture method in realizing the learning outcomes in Social Science.

5.1.3 Method and Design Adopted

Experimental method was adopted for conducting this study. The investigator selected quazi experimental design for this study. The design adopted for the present study was the non-equivalent pretest posttest design.

5.1.4 Variables of the study

The independent variables selected for the study were methods of teaching. The investigator used digital concept mapping technique for the experimental group and the lecture method for the control group. The dependent variables are achievement in Social Science and creative thinking ability.

5.1.5 Sample for the study

The study was conducted on a sample of 145 ninth standard students selected from two schools viz. Government Higher Secondary School, Munchirai and Mar Gregorious Matriculation School, Kirathoor in Kanyakumari district. The experimental group consisted of 70 students and the control group consisted of 75 students.

5.1.6 Tools Used for the Study

The following tools were used in the present study:

- Lesson transcripts and Digital concept maps developed by the investigator.
- Achievement Test in Social Science prepared by the investigator.

- Verbal and Non-Verbal test of Creative Thinking developed by Baqer Mehdi (2015).
- Rating Scale on the Comparative efficacy of Digital Concept Mapping Technique and Lecture Method, developed by the investigator.
- Questionnaire for Teachers, developed by the investigator.

5.1.7 Statistical Techniques Used

The statistical techniques used for the analysis of data were t test, ANCOVA and Percentage.

5.2 FINDINGS OF THE STUDY

5.2.1 Comparison of pretest scores of achievement in Social Science of digital concept mapping group (Experimental group), and lecture method group (Control group)

1. No significant difference exists between the mean pretest scores of achievement in Social Science of digital concept mapping group and lecture method group for the total sample ($t = 0.545$; $p>0.05$).

2. Boys ($t = 1.403$; $p>0.05$), girls ($t = 0.504$; $p>0.05$), government school students ($t = 0.411$; $p>0.05$) and self-financing school students($t = 1.812$; $p>0.05$) in digital concept mapping group and lecture method group do not differ significantly in their mean pretest scores of achievement in Social Science.

5.2.2 Comparison of posttest scores of achievement in Social Science of digital concept mapping group and lecture method group

3. Significant difference exists between the mean posttest scores of achievement in Social Science of digital concept mapping group and lecture method group for the total sample ($t = 6.129$; $p<0.01$).

4. Boys ($t = 2.295$; $p<0.01$), girls ($t = 7.853$; $p<0.01$), government school students ($t = 6.219$; $p<0.01$) and self-financing school students ($t = 2.793$; $p<0.01$) in digital concept mapping group and lecture method group differ significantly in their mean posttest scores of achievement in Social Science.

5.2.3 Comparison of gain scores of achievement in Social Science of digital concept mapping group and lecture method group

5. Significant difference exists between the mean gain scores of achievement in Social Science of students in digital concept mapping group and lecture method group for the total sample ($t =8.639$; $p<0.01$).

6. Boys ($t = 4.060$; $p<0.01$), girls ($t = 10.569$; $p<0.01$), government school students ($t = 8.881$; $p<0.01$) and self-financing school students ($t = 4.197$; $p<0.01$) in digital concept mapping group and lecture method group differ significantly in their mean gain scores of achievement in Social Science.

5.2.4 Comparison of pretest and posttest scores of achievement in Social Science of digital concept mapping group

7. Significant difference exists between the means of pretest and posttest scores of achievement in Social Science of digital concept mapping group for the total sample ($t = 17.78$; $p<0.01$).

8. Significant difference was found between the means of pretest and posttest scores of achievement in Social Science of boys ($t = 9.30$; $p<0.01$), girls ($t = 22.38$;

p<0.01), government school students (t = 15.83; p<0.01) and self-financing school students (t = 10.46; p<0.01) in digital concept mapping group.

5.2.5 Comparison of pretest and posttest scores of achievement in Social Science of lecture method group

9. Significant difference exists between the means of pretest and posttest scores of achievement in Social Science of lecture method group for the total sample (t = 16.68; p<0.01).
10. Significant difference was found between the means of pretest and posttest scores of achievement in Social Science of boys (t = 8.99; p<0.01), girls (t = 17.80; p<0.01), government school students (t = 12.17; p<0.01) and self-financing school students (t = 13.33; p<0.01) in lecture method group.

5.2.6 Comparison of adjusted means of posttest scores of achievement in Social Science of digital concept mapping group and lecture method group for the total sample and sub-samples

11. Significant difference exists between the adjusted means of posttest scores of achievement in Social Science of students in digital concept mapping group and lecture method group for the total sample (t = 8.70; p<0.01).

12. Boys (t = 3.74; p<0.01), girls (t = 10.55; p<0.01), government school students (t =8.58; p<0.01) and self-financing school students (t = 4.43; p<0.01) in digital concept mapping group and lecture method group differ significantly in their adjusted means of posttest scores of achievement in Social Science.

5.2.7 Comparison of pretest scores of creative thinking ability of digital concept mapping group and lecture method group

13. No significant difference exists between the mean pretest scores of creative thinking ability of digital concept mapping group and lecture method group for the total sample ($t = 0.208$; $p>0.05$).
14. Boys ($t = 0.464$; $p>0.05$), girls ($t = 0.132$; $p>0.05$), government school students ($t = 1.924$; $p>0.05$) and self-financing school students ($t = 1.458$; $p>0.05$) in digital concept mapping group and lecture method group do not differ significantly in their mean pretest scores of creative thinking ability.

5.2.8 Comparison of posttest scores of creative thinking ability of digital concept mapping group and lecture method group

15. Significant difference exists between the mean posttest scores of creative thinking ability of digital concept mapping group and lecture method group for the total sample ($t = 7.710$; $p<0.01$).

16. Boys ($t = 4.068$; $p<0.01$), girls ($t = 7.314$; $p<0.01$), government school students ($t = 5.090$; $p<0.01$) and self-financing school students ($t = 5.769$; $p<0.01$) in digital concept mapping group and lecture method group differ significantly in their mean posttest scores of creative thinking ability.

5.2.9 Comparison of gain scores of creative thinking ability of digital concept mapping group and lecture method group

17. Significant difference exists between the mean gain scores of creative thinking ability of students in digital concept mapping group and lecture method group for the total sample($t = 11.139$; $p<0.01$).

18. Boys ($t = 5.867$; $p<0.01$), girls ($t = 10.335$; $p<0.01$), government school students ($t =8.485$; $p<0.01$) and self-financing school students ($t = 7.125$; $p<0.01$) in digital

concept mapping group and lecture group method group differ significantly in their mean gain scores of creative thinking ability.

5.2.10 Comparison of pretest and posttest scores of creative thinking ability of digital concept mapping group (Experimental Group)

19. Significant difference exists between the means of pretest and posttest scores of creative thinking ability of digital concept mapping group for the total sample ($t = 17.47$; $p<0.01$).

20. Significant difference was found between the means of pretest and posttest scores of creative thinking ability of boys ($t = 10.10$; $p<0.01$), girls ($t = 15.74$; $p<0.01$), government school students ($t = 13.02$; $p<0.01$) and self-financing school students ($t = 11.52$; $p<0.01$) in digital concept mapping group.

5.2.11 Comparison of pretest and posttest scores of creative thinking ability of lecture method group (Control Group)

21. Significant difference exists between the means of pretest and posttest scores of creative thinking ability of lecture method group for the total sample ($t = 18.23$; $p<0.01$).

22. Significant difference was found between the means of pretest and posttest scores of creative thinking ability of boys ($t = 10.80$; $p<0.01$), girls ($t = 15.53$; $p<0.01$), government school students ($t = 12.04$; $p<0.01$) and self-financing school students ($t = 14.49$; $p<0.01$) in lecture method group.

5.2.12 Comparison of adjusted means of posttest scores of creative thinking ability of digital concept mapping group and lecture method group

23. Significant difference exists between the adjusted means of posttest scores of creative thinking ability of students in digital concept mapping group and lecture method group for the total sample ($t = 11.29$; $p<0.01$).

24. Boys ($t = 5.95$; $p<0.01$), girls ($t = 10.34$; $p<0.01$), government school students ($t = 8.90$; $p<0.01$) and self-financing school students ($t = 6.93$; $p<0.01$) in digital concept mapping group and lecture method group differ significantly in their adjusted means of posttest scores of creative thinking ability.

5.2.13 Comparison of ratings of students in experimental group on the comparative efficacy of the digital concept mapping technique and lecture method in realizing educational outcomes

25. From the ratings of the students it was found that the mean rating score on digital concept mapping technique (102.84) is higher than that of lecture method (72.99). This result indicates that the digital concept mapping technique is superior to the lecture method in realizing the educational outcomes.

5.2.14 Usage of digital concept mapping technique in teaching Social Science

26. Analysis of the responses of teachers regarding the use of digital concept mapping technique in teaching Social Science revealed that, the teachers are not using digital concept mapping technique for teaching Social Science.

5.2.15 Training related to digital concept mapping technique

27. Analysis of the responses of teachers regarding training related to digital concept mapping technique revealed that only 20% of the teachers got training regarding digital concept mapping technique and 80% of teachers didn't get any training in digital concept mapping technique for teaching Social Science.

5.2.16 Suitability of digital concept mapping technique to the existing syllabus of Social Science at high school

28. Regarding the suitability of digital concept mapping technique in terms of existing syllabus 84% of the teachers reported that the digital concept mapping technique is suitable to the existing Social Science syllabus at high school level and 16% of the teachers reported that the digital concept mapping technique is not suitable to the existing Social Science syllabus at high school level.

5.2.17 Learning outcomes of teaching Social Science using digital concept mapping technique at high school level

29. Regarding the learning outcomes of teaching Social Science using digital concept mapping technique 92% of the Social Science teachers reported that digital concept mapping technique is suitable to a great extent in promoting better achievement in Social Science. It is followed by develops creative thinking among students (88%), enables to learn the concepts meaningfully (84%), improves skill of using computer (80%), helps to summarize information (80%), promotes independent thinking (72%), helps to retain the learned concepts (60%), develops skill in designing maps (60%), helps in systematic organization of ideas (60%).

5.2.18 Suitability of digital concept mapping for attaining the objectives of teaching Social Science

30. Regarding the suitability of digital concept mapping technique for attaining the objectives of teaching Social Science, 92% of the teachers reported that the digital concept mapping technique is suitable to a great extent for attaining the objective of developing understanding of facts and concepts in Social Science. 84% of the teachers reported that it helps to develop practical skills. 80% of the teachers

reported that it helps to develop interest in Social Science. 80% of the teachers reported that it helps to develop the power of imagination, 68% of the teachers reported that it helps to develop the power of judgment and 60% of the teachers reported that it is suitable to a great extent in developing healthy social attitude.

5.2.19 Practical difficulties in using digital concept mapping technique for teaching Social Science

31. Regarding the practical difficulties in using digital concept mapping technique for teaching Social Science at high school. majority of the teachers (88%) reported that the main practical difficulty is lack of knowledge in the preparation of digital concept maps. It is followed by lack of training (80%), rigid timetable (68%), overcrowded classroom (56%), difficulty in maintaining discipline (32%), lack of co-operation from school authorities (28%), lack of computer knowledge (24%) and lack of computer facilities in schools (8%).

5.2.20 Suggestions for the effective use of digital concept mapping technique for teaching Social Science at high school level

32. The suggestions given by teachers regarding the effective use of digital concept mapping technique for teaching Social Science at high school level are the following: Provide training in the preparation and use of digital concept maps in teaching, Provide suitable reference materials related to digital concept mapping technique in the school library, Reduce the strength of the class, Reduce the work load, Provide two consecutive periods in time table, Make the time table flexible, Provide more smart class rooms and Provide Computer with internet facilities individually. These findings indicated that the above mentioned suggestions may be implemented.

5.3 CONCLUSIONS

The present study was basically intended to explore the effect of digital concept mapping on achievement in Social Science and creative thinking ability of high school students. The major conclusions that emerged from the study are given below.

1. Digital concept mapping is more effective than the lecture method in enhancing achievement in Social Science of high school students. The students in experimental group scored better than the control group in achievement test in Social Science.
2. Digital concept mapping is more effective than the lecture method in developing creative thinking ability of high school students. The mean pretest scores of creative thinking ability of the experimental group was found to be greater than that of control group.
3. The study revealed that teachers are not using digital concept mapping for teaching Social Science. The main practical difficulty in using digital concept mapping for teaching Social Science reported by the majority of the teachers are lack of knowledge in the preparation of digital concept maps and lack of training.
4. Digital concept mapping technique is superior to lecture method in realizing the learning outcomes in Social Science.
5. The suggestions given by majority of the teachers for the effective use of digital concept mapping technique for teaching Social Science are:
    - Provide training in preparation and use of digital concept maps in teaching.
    - Provide more smart class rooms.
    - Reduce the strength of the class.
    - Make the time table flexible.
    - Reduce the work load.

- Provide suitable reference materials related to digital concept mapping technique in the school library.
- Provide two consecutive periods in the time table.
- Provide Computer with internet facilities individually.

5.4 DISCUSSION

The present study is an attempt to investigate the effect of digital concept mapping on achievement in Social Science and creative thinking ability of high school students. Experimental method was adopted for conducting the study. The investigator selected Non equivalent pretest posttest design. The experimental group was taught through digital concept mapping technique and the control group was taught through lecture method. From this study it was found that the digital concept mapping is more effective than the lecture method in enhancing achievement in Social Science of high school students. The students in experimental group scored better than the control group in achievement test. This finding is consistent with the findings of the studies conducted by Divya and Usha (2014), Amma (2012) and Asan and Akin (2007).

The study revealed that digital concept mapping is more effective than the lecture method in developing creative thinking ability of high school students. The mean posttest scores of creative thinking ability of the experimental group was found to be greater than that of control group. This finding is consistent with the findings of the studies of Yeh, and Shih (2016), Widiana, Jampel, and Nyoman (2016).

From this study it was also found teachers are not using digital concept mapping for teaching Social Science, because they do not have awareness about digital concept mapping technique. But they have suggested that if they were given

proper training and reference materials they would implement digital concept mapping technique in their teaching learning process. If digital concept mapping is implemented in teaching of Social Science definitely it would help to enhance achievement in Social Science and creative thinking ability of high school students.

5.5 EDUCATIONAL IMPLICATIONS

The findings of the study have a number of educational implications which will provide the basis for the improvement of Social Science education. The educational implications of the present study are as follows:

1. From the present study it is obvious that digital concept mapping is an effective technique for enhancing achievement in Social Science of high school students. This finding would help educators and teachers to include such innovative techniques in the teaching learning process for enhancing achievement of students.
2. The present educational system is bookish and still teachers are following lecture methods. It is hoped that that the present study would help to bring about a change in the methodology of teaching.
3. Another implication of the study is that the digital concept maps prepared by the investigator for teaching Social Science at high school level can be a great help to Social Science teachers for teaching Social Science.
4. The study implies that lecture method of teaching is inadequate for the realization of many objectives of teaching Social Science. The result of the present study shows that teaching through digital concept mapping technique is more effective in the realization of objectives of teaching Social Science. Hence it is necessary to change the methodology of teaching for the realization of objectives of teaching Social Science.

5. The findings of the study indicated that the digital concept mapping technique is effective in developing the creative thinking ability of high school students. When the students were taught through digital concept mapping technique they developed creative thinking ability. Hence Digital concept mapping technique can be used for developing the creative thinking ability of students.
6. In the present age creative thinking is essential for educational excellence. Hence schools should give more emphasis on the development of creative thinking ability of students. Teachers should encourage divergent thinking on the part of students for fostering creative thinking ability.
7. The study highlights the need for developing a healthy atmosphere in schools favourable for the development of creative thinking ability among students.
8. The curriculum must be properly organized for the development of creative thinking ability among students. For this curriculum should cater to the individual needs of each student rather than to the generalized needs of all students.
9. Another implication of this study is that it contributes greatly towards Ausbel's theory of meaningful learning. In digital concept mapping students are made to organize and represent knowledge in a meaningful way. They also understand the hierarchical relationship of concepts.
10. The study revealed that teachers are not using digital concept mapping technique for teaching Social Science. The study highlights the need to make the teachers aware of such innovative techniques and to use them in their teaching learning process.
11. The study highlights the need for arranging suitable training programme in the preparation and use of digital concept maps for teaching Social Science. For

this professional development programmes like refresher courses, orientation courses, workshops and seminars should be arranged for teachers so as to enable them to use digital concept mapping technique in teaching.

5.6 SUGGESTIONS FOR FURTHER RESEARCH

In order to make the present study more meaningful similar studies in this area could be carried out. The desirable areas of further research are the following.

1. The effectiveness of digital concept maps was tested experimentally on selected topics in Social Science. Digital concept maps for teaching other topics in Social Science may be prepared and its effectiveness may be tested.
2. The effectiveness of digital concept mapping technique in the development of cognitive, affective and psycho-motor outcomes can be studied extensively.
3. Effectiveness of digital concept mapping technique can be studied in comparison with other methods of teaching.
4. Similar studies can be conducted in other school subjects like Science, English, Mathematics etc.
5. The present study is confined only to high school students similar studies can be undertaken at primary and higher secondary levels.

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