Chapter VI

SUMMARY AND CONCLUSION

6.1 SUMMARY OF THE STUDY

Education has been undergoing a revolutionary change in recent times in almost every part of the world this is partly due to the explosion of knowledge, partly due to every country having had to face new problems in all spheres of life and partly due to the development of new tools of teaching and learning under the influence of variety of forces like these, systems of education to be remodeled.

Our society is in the process of developing scientific ways of thinking and acting, it is enjoying the material benefits of the applications of science to our problems. Progress in developing critical thinking is seemingly slow, but the development of material benefits is re-emphasized enlightenment and critical thought conflicts occur; as the products of advancing technology change our patterns of living, other conflicts occur. The resolution of such conflict is brought about most satisfactorily through planned educational processes.

Education has been considered in all times to be an instrument of social change. This objective cannot be obtained without having improved the classroom practices. Teaching is an activity, designed and performed for the attainment of a larger number of objectives in terms of changes in pupil’s behaviour, which is also a complex set of attitudes, knowledge, skills, motivation and values. Effective teaching varies from mere teaching. There is no single method for effective teaching learning and effective teaching leads to engage and intelligence learning. It may be differed as showing or helping students to learn how to do something, giving instructions, guiding in the study of something, providing with knowledge, besides causing to know and understand. It is also guiding and facilitating learning, enabling the learner to learn, setting conditions for learning.
Effective teaching consists of those teaching decisions about actions, routines and techniques that increase the decision making capabilities of students. Effective teaching is much more than an incentive process holistic appreciation, active knowledge, team work, critical thinking, creative thinking and problem solving are the major outcomes of effective teaching.

Effective teaching is only possible with the effective teachers, teachers who inspire and motivate the students. According to Kothari Commission, “the destiny of a nation is being shaped in the classrooms”. The teacher has the responsibility to shape that destiny. He is an educational leader and decision maker who directly affects and indirectly influences students.

At present, explosion of knowledge is being achieved through development of science and technology. The prosperity of any country depends on the effective use of man power resources, which can be cultivated only by the study of science and its application. A proper well taught science education programme would help to inculcate those scientific and technical skills which are required for the development of a country. The task of creating scientific temper is a vital necessity for development (planning commission, 1981 6th five year plan).

Modern science has acted as a spring board for the progress of mankind and enabled us to conquer time, distance and many more things. It has improved the conditions of quality of life. Therefore, in the present age of rapid scientific advancement, it is a must that each individual has sufficient knowledge about science to make his own life comfortable and meaningful for the development of any nation there is need of efficient scientists, engineers and doctors and this creates the necessity of providing strong basic knowledge about science and develop scientific temper among future citizens i.e., students. The basic knowledge of science also would help some of them to choose their career related to science comp up according to the expectation of
the nation. Keeping in mind the above facts, science is taught as a compulsory subject right from the elementary stage.

**Importance of Science Teaching:**

The structure of science with promoting reason over suppression, health over diseases, affluence over poverty, education over ignorance. Science development depends on the scientists' imagination and his deep desire to pursue science education. Science is stable and fluid. It attempts to provide an objective body of knowledge through objectives as well as subjective procedures. Science is more than puzzle solving or an exercise at abstracting and re-instructing with a view to approach and understands the unknown through the so-called scientific methods, techniques, and approaches. Science is an international activity which strengthens national economics, creates new resources, accelerates employment and attempts to build global outlook. On problem which affects man, his life and society.

Science implies not only content or subject matter classified and organized, but also a method of investigation or problem solving, including observation and measurement, experimentation and logical influence, both inductive and deductive by means of which the subject matter is organized and used in prediction, discovery and invention. That its subject matter is constantly growing in volume and being brought under simpler and more comprehensive forms of descriptions, that all human experience in legitimately material for its investigation, that it grows out of the problems related to human needs, physical, industrial, social, emotional and intellectual and that it is so intimately connected with industrial development is a matter of common.

The government of India's scientific policy resolution (1958), correctly visualized the key role that science its education and its application, had for our programme towards national prosperity and for securing minimum standard of living for our people. Kothari Commission (1966) proposed that the prosperity and strength
of a country directly depends on the level of scientific and technical knowledge cultivated in the country and on its capacity to make use of the knowledge to serve practical ends.

Instructional technology has come out with bubbling ideas, pupils have varied personalities, which need different styles of learning. The common implication of both facts is that teacher should use such strategies of teaching which would match the instructional objectives of learning styles.

Ausubel (1960) has pointed out that a key to all cognitive process is one highly important concept meaningfulness. New information is meaningful when it can be related to what is already known. One of the important cognitive functions related to meaningfulness is “Met Cognition”. It means literally thinking about thinking. It is defined as having knowledge (cognition) and having understanding control over and appropriate use of knowledge (Tei and Steward, 1985). It is a process that occurs in the working memory over past few years, research on how pupils think about their own thinking has given considerable insight in to the human information processing system.

Decision making regarding instructional strategies requires teachers to focus on curriculum, the prior experiences and knowledge of students, learner interests, student learning styles and the developmental levels of the learner. Such decision making relies on ongoing student assessment that is linked to learning objectives and processes.

From Wikipedia Encyclopedia A concept map on a diagram showing the relationships among concepts. Concepts are connected with labeled arrows, in a downward-branching hierarchical structure. The relationship between concepts is articulated in linking phrases, eg. “gives rise to”, ‘result in’, ‘is required by’ or ‘contributes to’. Concept mapping is a technique for visualizing the relationships among different concepts.

191
Novak (1980) first time developed the use of ‘concept maps’ as a teaching strategy in 1980. It is based on Ausubel’s meaningful learning theory, which stressed on the importance of prior knowledge to learn about new concepts. He also stressed that learning takes place y the assimilation of new concepts and propositions in to existing concept propositional frameworks held by the learner. Meaningful learning requires three conditions.

Concept maps are very useful to meet the material to be learned must be conceptually clear and presented with language and examples related to the learner’s prior knowledge. Concept maps are graphical tools for organizing and representing knowledge. They include concepts, usually enclosed in circles or boxes of some types and relationships between concepts indicated by a connecting line linking two concepts. Words on the line, referred to as linking words or linking phrases, specify the relationship between the two concepts. According to Novak, “concept as a perceived regularity in events, or objects, or records of events designated by a Label.” The Label for most concepts is a word, although sometimes symbols such as ‘+’ or % and sometimes more than one word is used.

Important characteristic of concept maps is that the concepts are represented in a hierarchical fashion with the most inclusive, most general concept at the top of the map and the more specific, less general concepts arranged hierarchically below. The hierarchical structure for a particular domain of knowledge also depends on the contacts in which that knowledge is being applied or considered. Therefore it is best to construct concept maps with reference to some particular question seek to be answered, which has called a focus question. The concept map may pertain to some situation or event that we are trying to understand through the organization of knowledge in the form of a concept map, thus providing the context for the concept map.

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

Advantages of Concept Mapping:

1. Concept mapping helps creative thinking.
2. It is used for brainstorming.
3. It clearly defines the central ideas by positioning it at the centre.
4. It allows emphasis on each idea.
5. It allows figuring out the links among the key idea more easily.
6. It allows basic information on one page.
7. It makes recall and review more efficient.
8. It allows addition of new information.
9. It enables viewing of information in different ways, from different viewpoints, because it does not lock it into specific positions.
10. It allows complex relationship among ideas.
11. It allows one to see contradictions, paradoxes, gaps in the material and provides foundation for questioning which in turn encourage discovery and creativity.

The desire to improve science achievement through more effective instructional strategies and the increasing awareness in recent years of the teaching learning situation has directed a lot of attention to understanding how learners learn and how to help them learn concepts. According to Novak (1987), research has shown that few students at the
secondary school or college level have had any formal instruction in learning how to learn. The efforts in assisting the learner to learn have led to the development of metacognitive strategies to enhance meaningful learning (Thomas et al 2000).

Concept maps were developed in 1972 in the course of Novak’s research program at Cornell where he sought to follow and understand changes in children’s knowledge of science. Since then, researchers in the broad aspects of this strategic approach have been introduced during their studies. A concept map is a diagram showing the relationships among concepts. It is a graphical tool for organizing and representing knowledge. In fact, these are instruments that help with organizing and structuring knowledge. Conceptual maps are very effective; it lets students represent their understanding of domain knowledge in a well-organized format. In concept mapping, users construct a two-dimensional, Visually-based representation of concepts and their relationships. The concept map representation encodes propositions describing two or more concepts and their relationships, in implied natural language sentences. In educational settings, concept mapping exercises have been used to encourage students to actively construct an understanding of concepts and relationships within domains of interest. It was designed to support the learner’s effort by externalizing concepts and propositions known to the student, making them visually apparent to facilitate their connection with newly acquired concepts. Concept maps have been used by teachers to assess students’ understanding, by students to compare their knowledge and collaboratively renew their understanding, and by experts as a vehicle for modeling and sharing their knowledge.

Improving educational quality requires placing learners in active rather than passive roles. Knowledge that empowers and increases the learner’s self-confidence is that which results from the coming together of individual actions, feelings and conscious thoughts (Novak, 1998). Thus the goal of education should be to develop educational experiences that facilitate meaningful learning and that reduce the need for
rote learning. An important teaching goal is to help students understand the main concepts in a subject rather than just memorizing isolated facts. Concepts represent a major portion of school curriculum, and much of teachers' efforts are directed at teaching them (Klausmeier, 1992). Individuals think in terms of concepts (Schaefer, 1979). Concepts are mental structures that categorize sets of objects, events or ideas (Eggen, 2001).

They are elements of cognition that help to simplify and summarize information. Concepts also aid the process of remembering, making it more efficient. When students group objects to form a concept they can remember the concept, and then retrieve the concepts’ characteristics.

Concept mapping is a teaching and learning strategy that enables learners to organize concepts and their relationships a hierarchical manner from the most general, most inclusive concepts to most specific, least inclusive concepts (Novak, Gowin & Johansen, 1984). The main concept is located at the top of the map followed by concepts subordinate to it. The concepts are highlighted in circles or boxes and are connected by suitable linking lines with words that characterize the relationship between them. Experiential learning refers to learning and development that are achieved through personally determined experience and involvement (Thompson, 2008). Lessons in experiential learning are arranged so that every student participates completely in the learning process and has control over its nature and direction (Rogers & Freiberg, 1994).

In other word, Concept maps are graphical tools for organizing and representing knowledge. They include concepts, usually enclosed in circles or boxes of some type, and relationships between concepts indicated by a connecting line linking two concepts. Words on the line referred to as linking words or linking phrases, specify the relationship between the two concepts. 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.

Concept mapping as a metacognitive instructional strategy is based on Ausubel-
Gowin, 1981; Novak,1977; Novak& Gowin 1984) It relates directly to such theoretical
principles as prior knowledge, subsumption, progressive differentiation, cognitive
bridging and integrative reconciliation. Concept mapping is based upon a major
psychological theory in science education and designed to help students ‘learn how to
learn’ science. Making a concept map for a piece of scientific knowledge is the ability
of the mapper to identify and relate its salient concepts to a general, super ordinate
concept. Concepts may be defined as regularities in objects or events designated by
some label, usually a term (Wandersee, 1990). Whether a process (e.g. precipitation), a
procedure (e.g. titration), or a product (e.g. carbohydrate), concepts are what we think
with in science.

Concept mapping serves as a tool to help learners organize their cognitive
frameworks into more powerful integrated patterns. In this way, it serves as a
metaknowledge and a metalearning tool. The heuristic of concept mapping - a kind a
meta cognitive strategy assists learners in understanding concepts and relationships
between them, and in seeing the hierarchical, conceptual, propositional nature of
knowledge (Klausmeier, Ghatala & Frayer, 1974; Derbentseva et al 2004; Hibberd et al
strategy posit that meaningful learning ensues when a learner is aware of, and can
control, the cognitive processes associated with learning. Indeed, some research on
concept mapping seems to demonstrate that meaningful learning results from its use in
science classrooms

Research has shown that poor performance in sciences is largely due to the use
of conventional teaching methods (Johnson & Johnson, 1991; Wachanga & Mwangi,
These teaching approaches are mainly expository in nature hence makes learners to be passive recipients rather than active participants in the construction of knowledge (Tsuma, 1998). When students are not actively involved in learning, their knowledge of science is often characterized by lack of coherence and majority of them engage essentially in rote learning. These problems are quite serious in Biology, which is widely perceived as a difficult subject because of its specialized language, mathematical and abstract conceptual nature and amount of content to be learned (Moore, 1989). The prevailing teaching practices do not actively involve students in the learning process and seem to deprive them from taking charge of their learning (Boujaode & Attieh, 2008).

Literature on concept mapping (Turkmen et al., 2005; Cardak and Dikmenli, 2008; Tastan et al., 2008), cooperative learning and learning cycle show that they all share complimentary objectives of engaging students in the learning process and promoting higher thought processes and more authentic behaviours required for scientific and technological development. It was this finding which propelled this study with the sole purpose of identifying the most appropriate strategy among them which best suits the teaching and learning of biology. Over the years, research and curriculum development have shown that effective instruction is much more than the presentation of a concept, process, or skills (Trowbridge and Bybee, 1996). The major concern of science education researchers is the identification of the best instructional methods/strategies which will enable all learners to learn effectively. Wise and Okey (1983) stated that effective science classroom appears to be one in which students are active, kept aware of instructional objectives and receive feedback on their progress towards the stated objectives. In classroom where elements of constructivism are incorporated in teaching and

The learner therefore, requires different methods of presenting learning tasks such that the alterations in their processing of information will not interfere with the
understanding of the tasks being presented (Clarke, 1980). The relative implication, therefore, is that the teacher of slow learners requires pedagogical competencies to cope with the attendant problems associated with slow learning. Two such competencies are as follows.

i. Developing a rationale which permits consistent interpretation of the slow learners’ behavior and

ii. Generating a repertoire of techniques by which learning tasks can be presented in a variety of ways.

To successfully teach science concepts to slow learners there is the need to dedicate substantial time to instruction, use more hands-on-methods and incorporate extensive practical. There is therefore a need to find out if concept mapping could enhance learning for poor learners. The researcher is unaware of any evidence in India which shows that secondary biology teachers in the country make use of related methods of combating the problems associated with slow learning of biology. Most of these teachers continue to teach all biology learners with the same methods and instructional materials as if all these students study and understand at the same rate.

Need and Significance of the Study:

There are varying instructional goals for different classes and different subjects we can refer Bloom’s taxonomy of educational objectives or goals, which is categorized in to three domains: Cognitive, affective and psychomotor. To achieve these educational objectives or goals, the teacher must practice different teaching strategies.

Concept mapping has been sued by the science educators, researchers and curriculum maker to track student’s learning patterns to assess students understanding and to redesign curriculum. Concept maps are based on the assumption that hierarchical concept relationships are building blocks of knowledge. Analysis of
student’s concept maps may allow teachers to gain insight into both content and organization of student’s knowledge.

Raghavan (1991) studied the concept mapping in learning physical science and its relation to scholastic performance, cognitive ability and attitude towards concept mapping and science interest among standard IX students. It can be said that concept mapping strategy had a significant positive influence over scholastic performance.

Kumuda (1999) studied a comparative study on the effects of traditional lecture method and concept mapping on achievement in physics of higher secondary students. It can thus be said that the concept mapping method is very effective in achievement of standard XII studies.

Palnakas, Baviskas and Padmini (2005) studied concept mapping, A new technique for science education, they stated that the hierarchical structure for a particular domain of knowledge depends on the context in which that knowledge is being applied or considered. They emphasized that it is best to construct concept maps with reference to the question that we seek to answer through the organization of knowledge in the form of concept maps.

The analysis of the above studies reveals that concept mapping strategy acts as a useful tool for enhancing the performance of the students in any subject. It helps to motivate the students to continue their learning process interesting. Hence concept mapping strategy can be applied to all the subjects for example, Structure of cell, digestive system, circulatory system etc.

Since many studies have been made on concept mapping, no one has conducted a study on effectiveness of concept mapping on achievement in science and problem solving ability in science separately. Therefore the researcher is interested to know to what an extent concept mapping influences on achievement in science and problem
solving ability in science of students of Bangalore city. Hence present study is taken up.

6.1.1 Statement of the Problem and Purpose of Study

The study sought to investigate the effects of Concept Mapping Teaching Strategy on students’ Science Achievement in Biology and Problem Solving Ability in Science of secondary school students of Bangalore city. Hence the study has been entitled as “Effectiveness of Concept Mapping Strategy of Teaching Science on Problem Solving Ability and Achievement in Science of Secondary School Students”

6.1.2 Objectives of the Study

In order to achieve the purpose of the study, the following objectives were stated:

1. To compare the achievement in biology of students who are taught through Concept Mapping Strategy (CMS) with that of those who are taught through Conventional Teaching Method (CTM).

2. To determine whether students’ achievement in biology is affected by sex, when they are taught through Concept Mapping Strategy.

3. To compare the problem solving ability of students who are taught through Concept Mapping Strategy (CMS) with that of those who are taught through Conventional Teaching Method (CTM).

4. To determine whether students’ problem solving ability is affected by gender, when they are taught through Concept Mapping Strategy.

5. To determine the effectiveness of concept mapping strategy and control group in terms of enhancement of retention of the achievement and problem solving ability in biology of the subjects.

6. To evaluate the concept mapping strategy from the subjects
6.1.3 Scope of the Problem

The subject biology is being selected for the study, as it is always leads an individual’s life to be more systematic and disciplinary. For better achievement of goals as he/she desires with the difficulty involved in teaching learning of biology. During the course of study lesson transcripts on selected units from biology of IX standard would be prepared by the researcher based on concept mapping strategy in teaching biology. Further with the help of concept mapping strategy researcher intended to enhance the achievement in biology and problem solving ability in biology among IX standard students by administering achievement test and problem solving ability test prepared by the researcher.

6.1.4 Research design

The one-group pretest posttest non-equivalent experimental design was adopted in conducting this study. The study involved experimental group and controlled group of students who were tested before and after treatment.

6.1.5 Variables of the Study

In the present study the following variables have been considered :

Dependent Variables

  a) Achievement in Biology
  b) Problem-Solving Ability in Biology
  c) Delayed Retention Test in Achievement in Biology
  d) Delayed Retention Test in Problem Solving Ability in Biology

Independent Variable

  1. Treatment (Concept Mapping Strategy)

Moderate Variable

  Gender
6.1.6 Statement of Hypotheses

1. There is no significant difference between the pre test and post test mean scores of Achievement in Biology of control group by Conventional Teaching Method.

2. There is no significant difference between the pre test and post test mean scores of Achievement in Biology of experimental group after intervention of Concept Mapping Teaching Strategy.

3. There is no significant difference between the pre test and post test mean scores of Problem Solving Ability in Biology of control group by Conventional Teaching Method.

4. There is no significant difference between the pre test and post test mean scores of Problem Solving Ability in Biology of experimental group after intervention of Concept Mapping Teaching Strategy.

5. There is no significant difference between secondary school boys and girls mean scores of Achievement in Biology of experimental group by Concept Mapping Teaching Strategy.

6. There is no significant difference between secondary school boys and girls mean scores of Problem Solving Ability in Biology of experimental group after intervention of Concept Mapping Strategy.

7. There is no significant difference in the Retention Post Test scores of Achievement in Biology between control and experimental groups.

8. There is no significant difference in the Retention Post Test scores of Problem Solving Ability in Biology between control and experimental groups.

9. There is no significant association between opinion of secondary school boys and girls about effectiveness of concept mapping strategy.
6.1.7 Sample Selection

Participants in this study were 60 grade IX biology students from coeducational state secondary school students from two classes of a general science course taught by the same teacher. For the purposes of the study, one of two instructional methods was randomly assigned to each class. This study is a comparative research that employed an experimental group and a second group that was taught in a more conventional teacher-centered manner (called the control group). The subjects were 60 students. One class \((n = 30, 16 \text{ boys and 14 girls})\) was assigned as a concept mapping group and the other \((n = 30, 16 \text{ boys and 14 girls})\) as the control group. The students were similar in socioeconomic status with the majority of them coming from middle- to upper-class families.

6.1.8 Research Instruments.

The researcher self prepared Science Achievement in Biology and Problem Solving Ability Tests were employed in this study.

Content preparation and validation. Using the State Syllabus Class IX standard biology syllabus as a guide, the required content materials for the theory of development were extracted from Karnataka secondary school biology textbooks and many relevant advanced biology textbooks. The extracted content materials were used in preparing Student-and teacher-centred Concept-mapping Instructional Strategy. This strategy consists of lesson notes, concept maps on evolution and other relevant instructional materials such as charts on life process.

The validation of the content as well as the Student-and-teacher-centred Concept-mapping Instructional Strategy was carried out through the assistance of three validators. The validators were asked to determine the appropriateness of the content material and whether the instructional strategy can achieve the purpose for which it was designed. The recommendations of the validators were used to revise the content
material and the instructional package. This was followed by a trial testing of the instructional package through a pilot study.

**Pilot study.** The main objective of this pilot study is to enable the researchers to detect any weakness in the research design and determine appropriate corrective measures that would improve the research instruments and the treatment fidelity of the study. The pilot study was conducted among a small set of students. This set of students was not used for the main study. Weaknesses observed in the instructional strategy during the pilot study led to the final revision of the package to improve its reliability.

**Instrument:** A 30-item multiple choice test for Science Achievement Test in Biology and 40 item multiple choice test for Problem Solving Ability in Science of internal consistency 0.80 and 0.82 measured through Cronbach alpha was developed by the researcher and administered to the subjects prior to the experiment and after the intervention of concept mapping instructional strategy. The test items were derived from Karnataka State board IX standard biology content such as Life Process.

**The Instructional Techniques**

The concept mapping technique was used to present the concept of Life Process for three weeks to learners. Brief descriptions of the techniques are given below.

Concept mapping is a systematic device for presenting a set of concept meanings embedded in a framework of propositions (Novak and Gowin, 1984). Concept maps are two dimensional hierarchical diagrams which illustrate the connectedness between and among individual concepts. It is based on the premise that concepts do not exist in isolation but depend upon others for meaning. The steps in concept-mapping as elucidated by Ault (1985) are:

i. Select an item for mapping. This could be an important text, passage, lecture notes for laboratory background material.
ii. Choose and underline key words or phrases; include objects and events in the list.

iii. Rank the list of concepts from the most abstract and inclusive to the most concrete and specific.

iv. Cluster the concepts according to two criteria: concepts that function at a similar level of abstraction and concepts that interrelate closely.

v. Arrange the concepts as a two-dimensional array analogous to a road map. Each concept is in effect, a potential destination for understanding. Its route is defined by other concepts in the neighbouring territory.

vi. Link related concepts with lines and label each line in propositional or prepositional form.

The concept map prepared by the teacher to aid the instructional process. At the end of the treatment period, the slow learners prepared their own maps which were used for diagnosing learning difficulties and clearing misconceptions. A completed map represents an understanding of the relationship between important sets of concepts and efficiently communicates this understanding to others. It is the contention of the researcher that if biology slow learners are encouraged to prepare concept maps after a given period of instruction, meaningful learning will prevail and performance will be buttressed. This contention was put to test in this study. It is hoped that the findings will provide enlightenment as regards the quest for ways of discouraging rote learning and encouraging higher-level understanding of biological concepts by students.

6.1.9 Statistical Techniques Applied in the Present Study

The data obtained was analyzed descriptively and inferentially by calculating percentages, mean, Standard Deviation, ‘t’ values and ANOCOVA.
6.2 MAJOR FINDINGS OF THE STUDY

By the analysis of data, the following findings emerged. The details are as under:

1. There is no significant difference between the pre test and post test mean scores of Science Achievement in Biology of control group (‘t’= 0.65; P>0.05).

2. There is a significant difference between the pre test and post test mean scores of Science Achievement in Biology of experimental group (‘t’=3.38; P=<0.01) after intervention of Concept Mapping Strategy.

3. There is no significant difference between the pre test and post test mean scores of Problem Solving Ability in Science of control group (‘t’=0.73; P>0.05)

4. There is a significant difference between the pre test and post test mean scores of Problem Solving Ability in Science of experimental group (‘t’=5.80; P<0.01) after intervention of Concept Mapping Strategy.

5. There is no significant difference between secondary school boys and girls mean scores of Science Achievement in Biology of control group.

6. There is no significant difference between secondary school boys and girls mean scores of Science Achievement in Biology of experimental group after intervention of Concept Mapping Strategy.

7. There is no significant difference between secondary school boys and girls mean scores of Problem Solving Ability in Science of control group.

8. There is no significant difference between secondary school boys and girls mean scores of Problem Solving Ability in Science of experimental group after intervention of Concept Mapping Strategy.

9. There is a significant difference in the students’ Delayed Retention Post Test Scores of Achievement in Biology between control and experimental groups.

10. There is a significant difference in the students’ Delayed Retention Post Test Scores of Problem Solving Ability in Biology between Control and Experimental groups.

11. There is no significant association between opinion of secondary school boys and girls about effectiveness of concept mapping strategy.
6.3 CONCLUSION

Keeping in view the statistical analysis of data and findings of the study, the following conclusion was drawn:

1. Concept Mapping Instructional Strategy was more effective than lecture based instructional strategy in increasing average Science Achievement in Biology of IX grade students.

2. Concept Mapping Instructional Strategy was more effective than lecture based instructional strategy in increasing problem solving ability in Biology of IX grade students.

3. Both boys and girls had similar improvement in Science Achievement in Biology instructed by Concept Mapping Instructional Strategy.

4. Both boys and girls had similar improvement in Problem Solving Ability in Science instructed by Concept Mapping Instructional Strategy.

6.4 DISCUSSION OF RESULTS

This empirical study showed that concept mapping is more effective teaching learning strategy than the traditional method, to improve science achievement and problem solving ability in science of IX standard students. The results of the study extend the findings of Ahmad Bilal Chcema (2013) and Yunus Karakyu (2010) recommended that concept mapping should be used in elementary classes for teaching general science and also stated that concept maps also be incorporated in the textbooks of science subjects at school level. The present results have implications for biology teacher preparation, especially in the area of identifying slow learners and adopting effective methods of tackling their problems. Biology educators would need to be aware of the utility value of the concept mapping approach to teaching and learning. A schedule for learning about and using the concept mapping strategy for instructional purposes should be built into the training programmes for pre service biology teachers.
6.5 IMPLICATIONS AND SUGGESTIONS OF THE STUDY

In the light of the findings and conclusion of the study, following implications and suggestions made by the researcher:

The findings and educational implications are made to improve secondary school teaching-learning process in biology.

1. The present study revealed that concept mapping strategy of teaching is superior to conventional teaching method.

2. From this point of view the implications of the study are in terms of remoulding the secondary school biology curriculum.

3. Concept maps on every topic covered in the respective chapters are to be included in biology text book.

4. The textbook writers are to be given training on the technique of developing concept maps for any given topic. They should be well versed with theory and practice related to concept maps. Hence it is essential that curriculum developers should take efforts to prepare concept maps for every given unit of content which the teachers can utilize for the day-to-day teaching with minor adaptation to specific need of learning.

5. The finding of the present investigation has not only shown that with concept mapping strategy of teaching achievement of students would increase but also problem solving ability has increased.

6. Concept mapping strategy helps the students to explore the creative thinking, creative talent and overall learning capabilities. The curriculum designers should encourage application of the study not only in biology but also all other subjects with given topic.
7. Besides this study provide enormous opportunity to develop cooperation, tolerance, respect for others’ point of view among the target group equipping them to be successful in the future life. Teacher should encourage a very child to apply this concept mapping in classroom.

8. Teachers teaching at any level of education must plan the lessons very well in terms with the principles of concept mapping strategy.

9. Concept mapping strategy provides individual to attain initiative collaborative learning, encourage the students to bring solid experiences and link with concepts and ideals related to the content.

10. The findings support that the development concept maps strengthens theoretical and thinking and promote acquisition of processing skills and competencies.

11. The result of this investigation assesses the need to practice in teaching-learning secondary school science to integrate the spirit of effective learning and promote academic excellence by means of strategy of learning.

12. Text book being a primary tool to deliver the concept to the students lays a heavy responsibility on the textbook writers to develop a balanced textbook in terms of content; methodology, practical activities and assessment exercises. The textbook writers are urged to include more concept maps and concept mapping activities in the textbooks.

13. Since the concept mapping strategy had significant positive effect on the Science Achievement in Biology of the students so the faculty development program should be started for the preparation of teachers as a facilitator.

14. Concept mapping is an emerging teaching learning strategy. Pre service and in service teacher education programs ought to incorporate it in the curriculum to prepare teachers with respect to its philosophical background, theoretical based and practical usage.
15. Concept mapping Instructional Strategy is a new strategy in classroom setting; the heads of the institutions must organized seminars and training programs for the teachers and provide them with opportunities for understanding and implementation of Concept Mapping Strategy, so that the teachers may be able to teach the students through Concept Mapping Strategy.

16. Studies may be launched with students from different locality backgrounds such as urban and rural areas with a larger sample and different type of management such as government, private aided and private unaided.

17. This study was carried out in the subject of Biology for IX grade students and proved concept mapping as a beneficial teaching learning strategy for cognitive development of students. It is suggested to conduct such research studies for other grades and subjects.

18. In this study whole classes were taken as experimental groups. The students in each grade belong to mixed ability levels. It is suggested that research may be conducted to find out the effect of concept mapping on students with different ability levels.

6.6 LIMITATIONS OF THE STUDY

In spite of all possible precautions taken up to arrive at valid and reliable results, certain limitations have crept in to the studies which are inevitable in the case of study of the present type:

1. The present study is conducted only for the IX standard students.

2. The study is limited to Bangalore District.

3. The present study includes limited variables only.

4. The study is conducted only for of Karnataka State syllabus.
6.7 SUGGESTIONS FOR FURTHER RESEARCH

1. The effectiveness of Concept mapping Technique in another subject area can be studied.

2. The effectiveness of Concept Mapping Technique in elementary and college levels can be studied.

3. A study can be conducted to understand the attitude of teachers and students in secondary school level towards the introduction of new strategies and techniques and the effects may be conducted.

4. The effectiveness of Concept Mapping Technique in different domains.

5. Comparative study of Achievement in Science in Biology of students in rural and urban areas can be conducted.