CHAPTER –V
FINDINGS AND EDUCATIONAL IMPLICATIONS

The present chapter was devoted to main findings of the study, educational implications and suggestions for further research in the area.

5.1: Main Findings.

5.2: Educational Implications.

5.3: Suggestions for further research.

5.1 MAIN FINDINGS

The analysis and interpretation of the quantitative data collected from the various sources helped to draw out the following important findings:-

5.1.1 Effectiveness of Conventional Reading

1. Conventional Reading as learning strategy was found effective in terms of achievement and its all level viz knowledge, understanding and application.

2. Conventional Reading as learning strategy was not effective in terms of retention rather a significant decline in achievement w.r.t time was found.

Effectiveness of Concept Mapping.

3. Concept Mapping as Follow-up learning strategy was effective in terms of Achievement and at its all levels of learning viz knowledge, understanding and application.

4. Concept Mapping as Follow-up learning strategy was not effective in terms of retention. Rather a significant decline in achievement w.r.t time was found.

Comparative Effectiveness of Concept Mapping as Follow-up learning Strategy and conventional reading.

5. Concept mapping as a Follow-up strategy was more effective than conventional reading in terms of achievement and at its all levels of learning viz knowledge, understanding, and application.
6. Concept mapping as a Follow-up strategy was more effective than conventional reading in terms of retention and 83.1% of learning was retained by students who learnt through concept-mapping while those who studied through conventional reading only 58.4% of learning was retained.

5.1.4 Relationship of Concept Map characteristics with Achievement and Retention.

7. It was found that there was positive and significant relationship of nodes and link with achievement. Nodes and links were the main elements of concept maps and facilitates the achievement of students.

8. No significant relationship of crosslink’s with achievement in learning was found.

9. Unlabelled links has negative and significant relationships with achievement of students in learning chemistry

10. Similarly positive and significant relationship of nodes and link with retention was also found. Therefore it helps in retaining/integrating the learning.

11. Similarly no significant relationship of retention in learning was found

12. Unlabelled links had negative and significant relationships with retention of students in learning chemistry.

5.1.5 Relationship of Cognitive Processes with Achievement and Retention.

13. All the six cognitive processes viz remembering understanding, creating applying, analyzing and evaluating had positive significant relationship with achievement.

14. It was found that retention of learning was positively and significantly correlated and facilitated by four cognitive processes viz relationship, applying, analyzing and evaluating.
5.1.6- Relationship of Cognitive Processes with Concept Mapping.

15. A positive significant correlation found between remembering and nodes.

16. No significant relationship depicted between remembering and links, crosslinks and unlabelled links.

17. In case of understanding, a significant positive correlation for node and link a found.

18. A significant correlation between understanding, and unlabelled links could be seen though this relationship was negative.

19. No significant relationship seen between applying and all C-map characteristics seen.

20. The process of analyzing has significant positive relationship with nodes, links, and negative significant relationship with unlabelled links.

21. Evaluating has only significant relationships with nodes while No significant relationship of evaluating with links, cross-links and unlabelled links depicted.

22. Creating has positive significant relationship with nodes and negative significant relationship with unlabelled links.

23. Analyzing was significantly correlated with nodes & links

24. A negative significant correlation found between understanding and unlabelled links.

5.1.7- Identification of Mapping Styles.

25. Four mapping styles and they were labelled as MS1, MS2, MS3, and MS4.

26. Later on basis of their characteristic they are named as follows

MS1-Poor Mappers; MS2-Non-labelling Mappers; MS3-Good Mappers; and MS4 –Best Mappers.
5.1.8 **Effect of different mapping styles on achievement and retention.**

27. The mapping style clusters differ significantly with respect to achievement and retention collectively, on further analysis it was found that these styles while they differed significantly with respect to retention of learning whereas they didn’t differ significantly with respect to achievement.

28. Mean difference between MS 1 and MS 2 with respect to achievement was not significant. Therefore these two groups were similar with respect to achievement.

29. It was found that out of all four groups MS3 AND MS4 were similar on achievement although these outperformed MS1 and MS2.

30. It was found that out of four groups MS3 outperformed MS2 and MS1: MS4 outperformed MS2 whereas MS2 and MS4 were similar to each other with respect to retention of learning.

5.1.9 **Effect of different mapping styles on cognitive processes .**

31. All the four groups MS1, MS2, MS3, and MS4 were similar to each other with respect to process of remembering.

32. On understanding process MS3 and MS4 groups were similar and both these outperformed MS1 and MS2. But MS1 and MS2 were found similar with respect to process of understanding.

33. On applying process MS3 and MS4 groups were similar and both these groups outperformed MS1 and MS2 which were found similar with respect to process of applying.

34. On analyzing process MS3 and MS4 were found similar and outperformed MS1 and MS2 which were found similar with respect to process of understanding.

35. With respect to process of evaluating MS 4 outperformed MS1 and MS2 . in the same manner MS3 outperformed MS1 and MS2. But MS3 and MS4 were similar to each other with respect to process of evaluating.
On creating process MS4 outperformed MS1, MS2, MS3. MS3 outperformed MS2 and MS1 which were found similar.

5.1.10 Effect of different mapping styles on C-Map Characteristics.

Mean differences between all four groups MS1, MS2, MS3 and MS4 were significant. MS1 made least number of nodes whereas MS4 made maximum number of nodes in C-Maps.

MS4 group outperformed all the rest three groups viz. MS1 MS2 and MS3 in forming links while constructing C-Maps.

MS2 group scored lowest in forming cross links whereas MS4 group scored highest in forming crosslink while making C-Maps.

MS1 group made more unlabelled links than MS2 but the mean difference between two groups was not significant. MS3 and MS4 scored low in unlabelled links while MS4 scored lowest of all.

5.2 EDUCATIONAL IMPLICATIONS

The findings of the present study have number of important Educational Implications for administrators, teachers, curriculum planners... etc.

1. The results of study revealed that Concept Mapping as Follow-up strategy helps in understanding the concepts. Thus as a meaningful learning strategy it must be practiced in schools for developing understanding of students.

2. Concept mapping as a Follow-up strategy releases unnecessary burden on student’s memory as it was devoid of extra text which in turn improves achievement.

3. As revealed from study Concept Mapping helps in retaining concepts for longer period of time therefore it could be used to replace rote memorization of Concepts.

4. Those who made good C-Maps performed well on Retention test therefore students should be trained to construct C-Maps which help in further retention of learning.

5. Students and teachers should be trained through training sessions to find
relationships, analyze, and evaluate the Concepts to help them master
the art of Concept Mapping.

6. Learners must be instructed to pay careful attention to label the links
while constructing c-maps as it facilitates understanding of the concept.
Understanding helps in eliminating false concepts and Concept Mapping
involves understanding as process so Concept Mapping as false concept
elimination tool has its own importance.

7. For developing effective training program to train Concept Mapping
cognitive Processes should be kept in mind.

8. To implement Concept Mapping in science teaching students, teachers
must be trained in concept mapping so proper planned efforts to
organize training should be facilitated.

9. At school stage to implement Concept Mapping as Follow-up learning
strategy text books and study material should be developed in form of
concept maps.

10. Student’s style of Mapping along with their cognitive processes helps in
effective Concept Mapping so these must be kept in mind while
developing instructing program for Concept Mapping.

5.3 SUGGESTIONS FOR FURTHER STUDY.

1. Research studies can be carried out to develop and study the
effectiveness of Digitalized and Print Concept Mapping at various level
of education in different subjects of high school and college level.

2. Comparative effectiveness of Concept Mapping and Mind Mapping
strategy can be studied.

3. Evaluation studies related of Concept Mapping as a Diagnostic tool for
various subjects can be conducted.

4. Effectiveness of Concept Mapping can be studied in relation to different
variables such as intelligence, creativity, academic aspiration…..etc.

5. Similar studies can be studied on sample drawn from different
population.

6. Studies related to Effectiveness of Cyclic concept maps can be conducted.
SUMMARY

Education and Learning creates necessary and beneficial conditions for all people to make a common effort to meet the challenges that face the world today. Permanent and meaningful learning depends a lot on learning strategies that determine the approach for achieving the learning objectives and were usually tied to the needs and interest of students to enhance learning. One such strategy was concept mapping.

A concept map was a way of representing relation between ideas, images or words, in the same way that a sentence diagram represents the grammar of a sentence, a road map represents the locations of highways and towns, and a circuit diagram represents the workings of an electrical appliance. In a concept map, each word or phrase was connected to another and linked back to the original idea, word or phrase. Concept maps were a way to develop logical thinking and study skills, by revealing connections and helping students see how individual ideas form a larger whole.

Concept maps were developed to enhance meaningful learning in the sciences. There was research evidence that the knowledge was stored in the brain in the form of productions that act on declarative memory content which was also referred to as chunks or propositions. Because concept maps were constructed to reflect the organization of the declarative memory system, they facilitate sense-making and meaningful learning on the part of individuals who make concept maps and those who use them.

Concept mapping can be contrasted with the similar idea of mind mapping, which was often restricted to radial hierarchies and tree structures. Among the various schema and techniques for visualizing ideas, processes, organizations, concept mapping, as developed by Joseph Novak was unique in philosophical basis, which makes concepts, and proposition composed of concepts, the central elements in the structure of knowledge and construction of meaning.” Concept maps were freer from, multiple hubs and clusters can be created, unlike mind maps which fix on a single conceptual
The technique of concept mapping was developed by Joseph D. Novak and his research team at Cornell University as a means of representing the emerging science knowledge of students. It has subsequently been used as a tool to increase meaningful learning in the sciences and other subjects as well as to represent the expert knowledge of individuals and teams in education, government and business. Concept maps have their origin in the learning movement called constructions. In particular, constructivists hold that learners actively construct knowledge.

Novak’s work was based on the cognitive theories of David Ausuble (assimilation theory), who stressed the importance of prior knowledge in being able to learn new concepts:

“The most important single factor influencing learning was what the learner already knows. Ascertain this and teach accordingly.”

As babies, we begin to build up schema, which enable us to distinguish a human face from its background. More abstract conceptualization involves the same process of constructing meaning and pattern from a jumble of sensory information. These schemas then enable us to function with confidence in a complex environment (Bruillard & Baron, 2000). Effective learning depends on the creation of new schema, or existing schema being revised, extended or reconstructed. Concept maps were concrete representations of these schemas and their interrelationships that were intended to represent the knowledge structures that human store in their minds (Jonassen, Beissner & Yacci, 1993).

Concept mapping as a follow-up strategy in learning can have several important functions. We differentiate four main functions:

1. Elaboration function. Due to the affordance of expressing notions in nodes and relations in links, concept maps foster elaboration processes (Weinstein and Mayer 1986). This means that learners have to relate new information to their prior knowledge in order to determine what concepts were important and whether and how they interrelate.
2. Reduction function. Weaver and Kintsch (1991) found that macro propositions which contain the top-level information of a text were recalled in more detail. Learners have to appraise the importance of concepts in order to decide whether they should integrate them in their concept map. Thus, learners concentrate on the most relevant macrostructure information of their learning topic.

3. Coherence function. Concept mapping requires the externalization of knowledge and its structure. Thereby working memory was offloaded and the construction of coherence was facilitated (Kintsch 1998). Labeling the links connecting nodes emphasizes the kind. Similar colors can emphasize that certain concepts belong together. Thus, concept mapping fosters the building of a coherent structure of knowledge.

4. Metacognitive function. Metacognitive processes were supported through concept mapping. Knowledge and comprehension gaps can become obvious when constructing and explicating relations between concept (e.g. Chi et. Al. 1989). At best, learners can overcome these gaps when they become aware of them.

SIGNIFICANCE OF THE STUDY:

The reform of education through the use of new technology becomes an urgent task in view of the current reality that new learning environment taking place in the emerging knowledge-based society impinging on the roles of teachers. These were characterized by the paradigm shift in education from old concept of ‘education’ to learning, from the shift in the teaching-learning process as well as the emergence of new spaces of learning from school to work place, communities and mass media, from childhood to adulthood and from real to digital and virtual learning environments. These changes has generated new types of learner, new process of learning and new approaches to evaluation of learning, which in turn have contributed to the changed roles of teacher as well as learner from conventional ones to a serried of new roles. The teachers were no longer the
sole source of information. They were only one of the multiple sources of knowledge and thus work better as facilitator of knowledge.

Concept mapping have been used in educational studies in every subject area. For educational purpose concept-mapping fulfill many roles: they allow students to reflect on and demonstrate their knowledge of a topic covered in class, act as tools to aid study and comprehension of a domain or story, support idea generation and organization in preparation for prose composition, and were used as instructional material for learning new concepts and their interrelationship (Anderson Inman& Zeitz.1993). So as a learning strategy, concept mapping was likely to be effective if it was conducted on an ongoing basis over course of instruction (Bruillard & Baron. 2000). What was more, concept mapping has been used to promote positive self concepts, and positive attitudes towards science (Novak & Gowin, 1984) and increased responsibility for learning (Gurley,1982).

The theory of concept mapping was consistent with the theories of knowledge representation (Anderson, 1995, 1991). From a theoretical perspective Concept maps were important when one adopts a constructivist approach to learning. The theory behind it was that each individual develop mental schemas that serve to inform future thinking or action.

A variety of studies have demonstrated the effectiveness of concept mapping as a learning method. The effectiveness of concept mapping has been compared to several other learning techniques. Review of literature reveals that some research has been done on worked-out concept maps but the influence of constructing their own concept maps on learning outcome need to be explored. Not many studies have been done to explore effectiveness of concept mapping in terms of learning outcome and specially retention in learning. More over to develop a strategy for teaching concept mapping it was equally important to first explore the process that contribute to effective mapping.

So, in view of these facts investigator has decided to explore experimentally the effectiveness of concept-mapping as a follow-up strategy in learning chemistry in terms of achievement and retention in learning.
The following specific research question were addressed.

1. Does concept mapping have a positive effect on learning and retention?
2. To what extent the characteristics of the concept maps related to the learning outcome?
3. Were the learning outcomes associated with the quality of the cognitive processes during concept mapping?
4. What were different mapping styles that could be identified with respect to the learning outcome?

STATEMENT OF THE PROBLEM:

Selected research problem was stated as below:

EFFECT OF CONCEPT MAPPING AS A FOLLOW-UP LEARNING STRATEGY ON ACHIEVEMENT AND RETENTION OF UNDERGRADUATE STUDENTS IN CHEMISTRY

OPERATIONAL DEFINITION OF KEY TERMS:

1. Concept mapping as Follow-up strategy

Concept mapping as a Follow-up strategy means fostering learning by means of concept maps which were made by the learner himself. This process involves the identification of concepts in study materials and their organization from the most to the least general.

2. Achievement

Achievement connotes final accomplishment of something noteworthy after much effort and a particular phase of action. Here in the study it refers to score obtained by a student on Criterion Referenced test developed by the investigator herself.

3. Retention in learning

In learning it was the ability to retain facts and figures in memory. Here in the study it means scores obtained by a student on delayed Criterion referenced last developed by the investigator herself.
OBJECTIVES OF STUDY

Main Objectives
1. To study the effectiveness of conventional reading in learning chemistry in terms of achievement and retention.
2. To study the effectiveness of concept-mapping as a Follow-up strategy in learning chemistry in terms of achievement and retention.
3. To compare the effectiveness of concept-mapping strategy over the conventional reading in terms of achievement and retention.

Subsidiary Objectives
1. To study the relationship of concept map characteristics with achievement and retention.
2. To study the relationship of cognitive processes with achievement and retention.
3. To study the relationship between cognitive processes and concept map characteristics.
4. To identify different type of mapping styles.
5. To study the effect of different mapping styles on achievement and retention.
6. To study the effect of different mapping styles on cognitive processes.

HYPOTHESES

Main Research Hypotheses.
1. Conventional reading in learning chemistry was effective in terms of achievement.
2. Conventional reading in learning chemistry was not effective in terms of retention.
3. Concept mapping as a Follow-up strategy to learning chemistry was effective in terms of achievement.
4. Concept mapping as a Follow-up strategy to learning chemistry was effective in terms of retention.
5. Concept mapping as a Follow-up strategy to learning chemistry was more effective than learning through conventional reading in terms of achievement.

6. Concept mapping as a Follow-up strategy to learning chemistry was more effective than learning through conventional reading in terms of retention.

**Subsidiary Research Hypotheses**

7. There was significant relationship of concept map characteristics with achievement.

8. There was significant relationship of concept map characteristics with retention.

9. There was significant relationship of cognitive processes with achievement.

10. There was significant relationship of cognitive processes with retention.

11. There was significant relationship between cognitive processes and concept map characteristics.

12. Different styles of mapping differ significantly with respect to achievement.

13. Different styles of mapping differ significantly with respect to retention.

14. Different styles of mapping differ significantly with respect to cognitive processes.

15. Different styles of mapping differ significantly with respect to C-Map construction.

**DELIMITATIONS OF THE STUDY**

The study was delimited to

1. A sample of 60 under-graduate engineering students studying in one engineering college situated at Faridabad.
2. Concept mapping as a learning strategy in chemistry only

**RESEARCH METHODOLOGY:**

**Research Design:**

Keeping in mind the nature and need of the study the investigator adopted pretest quasi post test Follow-up test control group experimental research design. The following independent and dependent variables were delineated

**Independent Variable-**

Learning strategy at two levels.
1. Learning by conventional reading.
2. Learning by concept-mapping as a Follow-up strategy.

**Dependent Variables**

There will be two dependent variables.
1. Achievement in chemistry.
2. Retention in learning.

Intervening Variables and their control:

Concomitant variables or intervening variables These were those variables which directly or indirectly affect the dependent variables.

1. Academic Environment to control this, the sample was selected only from one college of engineering affiliated to Maharishi Dayanand University, Rohtak, because the academic environment remains almost same within a college to all the students.
2. Physical Environment of the class: physical environment of the classroom remains same in the entire college.
3. Grade to be taught: the sample of the study will be the students of undergraduate engineering course only.
4. Subject to be taught: Same topic in chemistry will be taught to both groups.
5. Socio-Economic Status: students will be randomly allocated to experimental and control group to control this variable.
6. Instructor Behavior: the investigator will conduct the experiment himself only. So the effect of inter-teacher variation will be eliminated. Selection of the study material, preparation of criterion referenced test, employment of the treatments, will be done only by the investigator herself which will help to control the inter-teacher behavior variations.

7. Maturation: subjects changes both biologically and psychologically in many ways over a period of time and those changes affect of the independent variables under consideration. To control this, the experiment will be conducted during the beginning of the session and will be finished in 28 days.

8. Prior knowledge of the subject: the criterion referenced test as a pretest will be administered to know the prior knowledge of the subject to be taught during the treatment.

9. Contamination effect: to control the contamination effect the students will be instructed separately about the concerned treatments.

10. Testing: the process of pre-testing at the beginning of an experiment can produce a change in the subjects. To control this, the parallel forms of criterion referenced tests will be used as a pre-test and post-test.

Sample

A purposive sample of sixty undergraduate engineering students were selected from 1 engineering college situated that Faridabad.

Present study was conducted on two intact groups of undergraduate engineering students. Each group will consist of twenty five students.

Tools:

Keeping in view the requirements of the study following tools was used in the research.

Instructional Tools

Instructional tools consisted of six lesson plans developed with objective of helping students to construct concept maps.
Measuring tools

1. Two parallel forms of criterion Referenced test in chemistry were developed by the investigator.
2. A lay-out developed by the investigator for categorizing statements of thinking session for cognitive processes.

MAIN FINDINGS

The analysis and interpretation of the quantitative data collected from the various sources helped to draw out the following important findings:-

Effectiveness of Conventional Reading

1. Conventional Reading as learning strategy was found effective in terms of achievement and its all level viz knowledge, understanding and application.
2. Conventional Reading as learning strategy was not effective in terms of retention rather a significant decline in achievement w.r.t time was found..

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20. The process of analyzing has significant positive relationship with nodes, links, and negative significant relationship with unlabelled links.

21. Evaluating has only significant relationships with nodes while No significant relationship of evaluating with links, cross-links and unlabelled links depicted.

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25. Four mapping styles and they were labelled as MS1, MS2, MS3, and MS4.

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