CHAPTER II
Chapter – II

REVIEW OF RELATED LITERATURE

2.0 Introduction

A research work is not meaningful without a thorough analysis of related works. Such related literature should be completed before proceeding with the actual conduct of the study. According to Best J. W. (1977) a familiarity with the literature in a problem area helps the research to discover what is already known, what others attempted to find out, what method attacks have been promising and what problems remain to be solved.

Practically all human knowledge can be found in books and library. So extensive use of the library and thorough investigation of related literature are essential in planning and carrying out the kind of searching involved.

It has been already stated in the previous chapter that the present study is an attempt to study the effect of concept mapping, problem solving, scientific aptitude and cognitive ability on science achievement of IX standard students. Hence, this chapter is devoted to the review of related literature. The studies have been grouped into the following topical sequence.

2.1 Studies Related to Concept Mapping

Moreira (1977) used concept maps with university students in physics. Concept maps were used together with typical reorganization in experimental classes and traditional method was used in control classes. Moreira found that students in the experimental classes performed significantly better in the tests requiring graphical structuring of physical concepts. This difference increased over the semester course of study. No significant difference between the groups was found in traditional course examinations onward.
association tests, but the students were increasingly positively about the value of concept maps as the semester progressed.

David Symington and Novak (1980) began using concept maps with children in grade I through IV, again with success and enthusiasm expressed by students and their teachers. These early effects were directed towards tryout of concept mapping strategies with various classes and in various subject matter area, primarily to assess and teacher reactions to the techniques and to workout techniques for introducing concept mapping in a variety of situations.

Sherris and Kahle (1984) used Concept maps with 282 high school biology students in a five-week unit of instructions, comparing achievement with 259 students receiving instructions in the same content, but without utilization of concept maps. They also administered the Norvicki-Strickland, Locus of control scale. Using three forms of a 25 items multiple choice test and 5 short answer item multiple choice test and 5 Short answers items requiring applications of concept and principles, they found no significant differences on post-test scores, nor on six week retention test scores, between the 2 treatment types. However, there was a different favoring internal locus of control students and a significant interaction effect on the retention test scores between treatment and locus of control, with 'external' students, benefiting more from the concept map aided instructions.

Basconas and Novak (1985) found that mean scores on problem solving test in High school philosophy were higher for students preparing concept maps, when compared with students preparing concept maps a traditional philosophy program and not using concept maps. The concept map group
excelled at all abilities levels based on Raven's progressive Matrices Test.

Cliburn (1987) found that students using concept maps during a 3 week on skeletal system showed significantly higher performance on retention post-test but not on an immediate post-test when other covariant were held constant.

Fledsine (1987) found a resistance in the vast majority of his students to prepare concept maps for the topic studied over as the course progressed and reluctant mappers began to see that different topics because conceptually clear using concept maps they mound toward preparation of good to excellent maps. More over, Fledsine found in a case after case, in his qualitative analysis the important misconceptions regarding Chemistry were recognized by students and subsequently altered with stable valued conceptions.

Merill William (1987) studied whether concept mapping improves the understanding of the mathematical concept 'division'. He selected elementary teachers and found that none of them could map the division map at 75% criterion level. He suggested recommendations for further studies which include trying other mathematical concepts and see whether reasoning abilities influence concept mapping abilities.

Nicolus, James Edward (1987) examined the use of concept mapping as a strategy to facilitate meaningful learning based on theoretical structure. The study involved 3 groups an experimental group which utilized the concept mapping process, a traditional group which was taught by traditional teaching strategy and a control group which was denied the experimental and traditional treatments.
The experimental and traditional groups did significantly better on the contents post-test than the control group. While mapping process was not a significant factor in affecting academic achievement, the study showed that males did significantly better than females on the mapping process. Females showed more improved attitude towards.

Pankratius and Keith (1987) compared concept mapping and text outlining and found 10% higher mean scores for the concept mapping group over an 18 week period. No test of significance was reported for this group.

For a group of 139 twelfth grade physics students Pankratius and Keith reported significantly higher mean achievement scores for those who prepared concepts maps only after they studied the unit. The authors also reported that test items requiring higher order thinking should wider difference with 19 out of 23 correct answers to one item given by the concept mappers.

Peter, Akinsola, Okebukola and Olugbehi Jegede (1988) in their studies wanted to explore whether cognitive preferences and learning mode are determinants of meaningful learning through concept mapping. They also wanted to investigate whether concept mapping is effective in bringing about meaningful learning.

Cognitive preference in an individual's stable mode of perpetual organization of the external environment (Health 1964 and Jamir 1985). It is an important processing strategy that characterizes a person's usual way of perceiving, remembering, thinking and problem solving. The four cognitive modes used in the study were Recall (R) Principles (P) Questioning (Q) and Application (A)
Since concept mapping strategy is fundamentally concerned with underlining principles, it has hypothesized that individuals with preference for principles will achieve best in a concept mapping exercise and attain meaningful learning when compared with individuals with A, Q and R cognitive preferences.

The second hypothesis was to find out the learning mode (cooperative and individualistic) under which students using the concept mapping strategy will achieve meaningful learning better.

It was hypothesized that students engaged in concept mapping activities in a cooperative basis will achieve meaningful learning better than students working individually on concept mapping tasks. Experimental evidences in the study provided an answer in the affirmative, which substantiates the conclusion of previous studies by Novak et al. (1983) on the same subject.

Allen, Jimmy Daniel (1989) examined the effects of concept maps as meaningful learning and achievement in Chemistry and tried to investigate if student's attitude towards mapping affects his/her abilities in acquiring meaningful learning.

The design allowed 53 students to participate and they were divided into two groups namely controlled and treatment groups. Both received instructions in traditional and concept mapping methods for 15 weeks.

Analysis of post test results revealed no significant difference between groups on measures for meaningful learning achievement at the P<0.05 level. But students recognized the importance of concept mapping which enhances meaningful learning.
Spaulding, Dan Travis's (1989) determined the effect on chemistry student achievement of the concept mapping tests. Average ability students of (107 biology and 44 chemistry). Public high schools in East Central Florida were selected. Students were administered pre test one week prior to study. The treatment group was taught concept mapping technique for one week. For next 3 weeks, all students received regular course instructions. The treatment group were asked to construct concept maps, while the control groups were asked to define the concepts.

After 3 weeks post-test were given over the material covered. There was no significant difference on achievement between students' assigned. Concept maps and students required to complete concept definitions.

Barbara Bayerbash and Joyce Smith (1990) observed the changes in the context organization of 17 pre service teachers' concept maps for the topic of effective teaching. Pre-service teachers in their senior year of an early childhood teacher education program constructed and revised concept maps with a partner. They entered reflection and in each mapping experience into their reflective journals, developing implications for teaching.

The study illustrated how concept mapping can be useful on describing students evolving construction of knowledge in a particular subject data and in promoting reflection.

James Wandersce (1990) revealed that concepts and principles from cartography and applies them to concept mapping. He invites researchers to conduct studies that investigate the graphic representation of scientific knowledge in order to create, evaluate and improve the graphics and graphic metacognitive tools such as concept mapping which is used in science teaching.
Jane, Heinze, Fry and Novak Joseph in their study wanted to investigate the use of concept mapping as a tool to enhance meaningful learning in college auto tutorial Biology students over a three instructional unit exposure, and also students attitudes towards concept mapping.

Although there were no statistically significant differences between the mapping and control groups on the evaluation instruments, both multiple choice and interview data showed higher measures for the mapping group. Errors analysis indicates that mapping helped to clarify learning by reducing errors. Similarly to the open-ended final evaluation on the thinking, feeling and acting. Questionnaire the students responded that mapping helped more in the long run than in the short run, and that they were more an active than a passive learner. When using concept mappings. Mapping appeared to enhance integration and retention of knowledge as supported by analysis of cross links, a comparison of students, map with initial and post interviews and student claims.

Josephine Wallace and Joel Mintzer (1990) examined the concurrent validity of concept maps as vehicles for documenting and exploring conceptual change in biology students (N-91), who enrolled in Elementary science mathematics Course were randomly assigned to one of two treatment groups. Subjects in both groups were administered a multiple choice/free response inventors which assessed their knowledge of 'Life Zone' in the ocean and they were asked to construct a concept map on the same topic. Those in the experimental group subsequently received 45 minutes of computer assisted instruction on Marine life Zones. While those in the control group received an equivalent exposure to an unrelated topic (Body Defenses).
Upon completing the instructional sequence, subjects were again administered the 'life Zones' inventory and asked to develop post-instruction. Concept mapping on marine life zones, the data analysis employed a Split half Factorial design with repeated measures. Differences among treatment groups were documented by analysis of variance and Chi-square procedures. Subjects in the experimental group showed evidence of significant and substantial changes in the complexity and prepositional structure of knowledge base, as revealed in concept maps. No such changes were observed in the control group. Results suggest that concept mapping offers a valid and potentially useful technique for documenting and exploring conceptual change in biology.

Mark Sidney Stenvold and John Wilson (1990) wanted to study the interaction of verbal ability with concept mapping in learning from a chemistry laboratory activity.

They used a quasi-experimental design in which treatment groups received instruction in concept mapping and were asked to construct concept maps before and after completion of a series of laboratory activities. The control group completed the same laboratory activities but did not construct concept maps. After completing the laboratory activities all students were administered a comprehensive test which was constructed by the authors to measure knowledge and comprehension of the laboratory related chemical concepts.

Qualitative, natural science and Vocabulary subject scores from the lower test of education. Development (ITED) from the proceeding semester were obtained from students records. After completing the laboratory activities all students were given a 33 item comprehensive test.
The Cochran-Cox test indicated the difference in means of comprehensive test was not significant. Significant regression equations were found between both map links and links per word and the comprehensive test. While the number of words a student wrote on the map was not related to performance on the comprehensive test, the number of valid links made as a map predicted comprehension test performance.

Olugbemiro Jegede and Lusho Alaiyemola (1990) studied to find out if the meta-cognitive strategy of concept mapping reduces anxiety and thereby enhances achievement in Biology. A total of 51 (30 boys and 21 girls) Senior Secondary (grade X) students participated in the experiment. Two instruments Zukerman Affect Adjective Checklist and the Biology Achievement test were used in pre and post-test administration to measure the treatment effect on anxiety and achievement not respectively. Findings support the stand, that concept mapping is significantly more effective than traditional expository strategy or anxiety was noticed for male subjects.

Genetics and Ecology are considered as two important branches of biology, because of their significance to man’s understanding himself and his environment. Hence there is a need to inquire into ways of ensuring the students attain meaningful learning of genetics and Ecology rather than learning by rote.

Peter Akinsola Okebukola (1990) experimented the efficacy of the concept mapping was tried out in this study with 138 pre Degree biology students. The results showed that the 63 students in the experimental group who employed the concept mapping technique performed significantly better in the test of meaningful learning in genetics, than their control groups counter
parts. The pre prediction of the study was, that meaningful learning of genetics and Ecological concepts will be promoted, when students are exposed to the concept mapping strategy.

Pankratius (1990) conduct a study titled 'Building an Organized base Concept Mapping and Achievement in the Secondary School Subject Physics' found that Concept Mapping in a key to organizing an effective knowledge base. Six intact school physics classes taught by this investigator took part in the study. Two classes were control group and received standard instruction. Four classes received six weeks of concepts mapping instruction prior to the unit under study. A one way analysis of covariance indicated a significant main effect for the treatment level at the P<0.05 level.

Jegde, Alaiyemola and Okesbukola (1990), studies the effect of concept mapping on students anxiety and achievement in biology. The effects of the meta- cognitive strategy of concept mapping on anxiety and achievement in biology among 30 boys and 21 girls (aged 14-18 years) in Nigeria. Ss in the experimental group became familiar with concept mapping strategy over 3 wks: the controls were introduced to the treatment’s science concepts via expository teaching. The Affect Adjective Checklist and a biology achievement test were used in pre-and post test administrations to measure the treatment effect concept mapping was significantly more effective than expository teaching in enhancing learning in biology, particularly in males. Overall, females had higher anxiety scores that did males. A significant reduction of anxiety was noticed for males.

Jegede, Olugbemiro and Alaiyemola, Folusho (1990) studied the effects of the metacognitive strategy of concept mapping on anxiety and
achievement in biology among 30 boys and 21 girls (aged 14-18 yrs) in Nigeria. Concept mapping was significantly more effective than expository teaching in enhancing learning in biology. In addition, concept mapping reduced anxiety toward the learning of biology, particularly in males. Overall, females had higher anxiety scores than did males. A significant reduction of anxiety was noticed for males.

Wallace, Josephine and Mintzes, Joel (1990) examined the concurrent validity of concept maps as vehicles for documenting and exploring conceptual change in biology. 91 university students enrolled in an elementary science methods course were assigned to 1 of 2 treatment groups. Ss completed an inventory that assayed knowledge of life zones in the ocean and then constructed a concept map on the same topic. Ss in the experimental group subsequently received 45 min of computer-assisted instruction on marine life zones; controls received equivalent exposure to an unrelated topic. Upon completing the instructional sequence, Ss again completed the inventory and developed a postinstruction concept map on marine life zones. Experimental Ss showed significant and substantial changes in the complexity and propositional structure of the knowledge base, as revealed in concept maps; no such changes were found in controls.

Heinze-Fry, Jane and Novak, Joseph (1990) investigated the use of concept mapping (CM) as a tool to enhance meaningful learning (ML) in college autotutorial biology students over a 3-instructional unit exposure. 20 students were introduced to CM, and 20 students served as controls. CM appeared to move students slowly toward more meaningful learning. Although this short exposure to mapping, with comparatively small groups, resulted in
no statistically significant differences between mappers and controls in measures of initial learning, retention, and learning efficiency, all differences favored the mappers. CM interacted with Scholastic Aptitude Test scores. CM appeared to enhance clarity of learning as supported by 2 error analyses and student claims. CM appeared to enhance integration and retention of knowledge as supported by analysis of cross links, a comparison of student maps with initial and post interviews, and student claims.

Stensvold, Mark and Wilson, John (199C) investigated among 104 9th-graders in 7 science classes the use of concept mapping (CM) and science instructional laboratories. The study measured several student skills and aptitudes and applied aptitude vs. treatment interactions to investigate interactions between a CM treatment and student aptitudes. High ability Ss performing CM achieved lower scores on the comprehension test than did able Ss who did not construct concept maps.

Bris Coe Carol, La Master and Sarah Uleric (1991) experimented the use of Concept Mapping coupled with assessments oriented towards problem solving used to facilitates meaningful learning is examined in this study. How student make and use concept maps in studying and the factors that influence the way they are made and used are also discussed.

Willerman and MacHarg (1991) conducted the study of the concept maps as an advance organizer. 40 of 82, 10th grade students in 4 Science classes completed a concept map at the beginning of a 2-week Science unit under the teacher's supervision. At the end of the unit, a test was administered to the experimental and control groups. Al-tailed 't' test indicated that the use of concept mapping as an advance organizer produced a
significant academic gain. Three possible explanations are suggested
1. Students may have been helped by the organization and visual relationship of the advance organizer.
2. Its construction by a teacher may have made the concept map more complete and accurate, or
3. A concept map development by teacher may have the provided the students with greater direction for learning the concepts and facts that overlapped with the teacher's final test.

Willerman and Harg (1991) studied the concept map as an advanced organizer. Eighty-two eighth grade students in four science classes. The experimental group completed the concept map at the beginning of the science units under the teacher's supervision. At the end of the two-week unit science test was administered to the experimental and the conventional group. The result of one tailed 't' test indicate that there was significant difference between the two groups.

Novak, Joseph and Musonda, Dismas (1991) examined the Audio-tutorial science lessons to 191 1st- and 2nd-grade children (instructed), and interviews were conducted periodically to assess changes in science concept understanding from Grades 1 through 12. 48 Ss not receiving audio-tutorial lessons in Grades 1 and 2 (uninstructed) were also interviewed periodically from Grades 1 through 12. Instructed Ss showed more valid concept understandings and fewer invalid concepts (misconceptions) than uninstructed Ss in Grades 2, 7, 10, and 12. Concept maps prepared from interview transcripts showed wide variation in knowledge for both groups, and concept maps scored using a scoring algorithm also showed significant
differences favoring instructed Ss. A discussion of concept maps as a tool to represent knowledge structures is included.

Mason (1992) experimented on the use of Concept Mapping as a tool to develop reflective science instruction. The subjects of this study were science majors enrolled in two courses designed specifically to address the aforementioned concerns. The use of Concept mapping as a tool to learning was introduced to the participant at the beginning. These potential teachers were presented with selected concept. The result shows that the Concept Mapping is an effective tool in conceptual restructuring and encouraging reflective science learning and teaching.

Okebukola and Akimola (1992) studied 'the Concept mapping with cooperative learning Flavour'. They compared teaching senior secondary school biology student with (n=149) with Concept Mapping as tool alone, with Concept Mapping in conjugation with cooperative learning groups and with lecture/demonstration methods. Group utilizing Concept mapping with cooperative learning scored significantly higher than other groups.

Okebukola, Peter (1992) investigated on 40 Nigerian college students who had cooperative and individualistic concept-mapping experiences for 6 mo with 20 Ss who had no such experience. Ss were asked to solve 3 biology problems. Written and think-aloud procedures and interviews were conducted as part of the administration of the tests. Ss with a concept-mapping experience were significantly more successful than controls. No statistically significant difference was found between students who mapped concepts cooperatively and those who mapped individually. There were mixed results for gender.
Sharma and Pushpalata (1992) studied the effect of differences in educational status and social groups of tribe members and nontribe members on their scientific aptitudes. 400 tribal students in Grade 10 and 200 tribal students in their 2nd year of science college were matched with equal numbers of nontribal students at both educational levels. Tribal Ss earned lower scores on a comprehensive scientific aptitude test than nontribal Ss, especially in Grade 10. Nontribal Ss were superior in terms of detecting illogical conclusions, ability to deduce conclusions, accuracy of interpretation, and ability to reason and solve problems.

In the past decade there has been rapid increase in instruction that helps students learn how to learn.

This activity derived impact from advances in cognitive learning psychology and the increase in cognitive learning research in school setting. Meta-cognitive learning occurs whenever person acquires some general strategy that facilitates learning or understanding of knowledge. Ideally, the most powerful learning would be acquisition of strategies that apply any grade level and to any subject matter.

The intelligent construction and use of concept map is a widely applicable meta-cognitive strategy. It serves as a tool to help, learners organize their cognitive framework into more powerful integrated patterns, the heuristic of understanding concept and relationships between them and in being the hierarchical conceptual, prepositional nature of knowledge. A few selected studies related to the use of Concept Mapping as a meaningful tool at different levels of learning is given below:
A study titled "Concept Mapping", a useful tool for science education was reported by Novak (1990). The article describes the genesis and development of Concept mapping as a tool for science education. It also offers an overview of the contents of this special issue and comment on the current state of knowledge representation.

Roth and Roy Choudhary (1992) studied the social construction of scientific concept or concept map as conscription device and tool for social thinking in high school science. The methodology was based on constructivist inquiry and constant comparative analysis data sources for the study consisted of direct observation video recordings and their transcripts and concept maps produced during group activities. This results show that concept maps can be used as tool for social thinking, a conscription device and an inscription method help us more in planning for appropriate group experiences and in working to better adopt the heuristic for interactive classrooms.

Roth, Wolff-Michael and Anita Roy Choudhary (1993) investigated concept mapping as a means of assessing the quality of students understanding from two perspectives. The analysis of the process of constructing meaning and the analysis of the products of their cognitive activity.

Twenty nine students from two sections of a senior level High School physics courses participated in the study. The data sources include video tapes, their transcripts and all concept maps produced. Students worked in collaborative groups during all of the concept mapping sessions. Individual concept mapping was assessed twice, once delayed by a week, another time
delayed by 6 weeks. They used a tracer to assess what happened to the
cognitive achievement as the context of concept mapping changed from
collaborative to individual authority. A tracer is some bit of knowledge,
procedure or actions that allows the researcher to follow a task through
various settings.

On the basis of the outcomes of their study, they formulated specific
recommendations for the use of concept maps in the classroom. These
include continued instruction in establishing proper hierarchies and cross-links
to increase the quality of the concept maps structure.

Roth, Michael and Others (1993) conducted a study using Vee and
Concept Maps in collaboration setting at elementary education majors to
construct meaning in physical science courses. It presents a study to
investigate elementary education majors (n=27) use of the Vee heuristic and
concept mapping for the construction of knowledge, attitudes towards
learning science in collaborative groups, and knowledge of the process of
learning science.

Horton, McConney and Others (1993) reported the investigation of the
effectiveness of Concept mapping as an instructional tool. The data sources
for this study were the dissertation abstracts international psychological
abstracts. The average sample size of 19 studies under analysis was 95
students. The result of this Meta analysis was showed that the top-down
instructional strategy of Concept Mapping has had generally medium positive
effects on students' achievement and large positive effects on student's
attitudes.
Markham and Mintzes (1994) studied the Concept Map as a research and Evaluation Tool: Further evidence of validity, describes a study that examines the extent to which differences exist in the concept map of advanced college biology majors (n=25) and beginning non-majors (n=25) in the domain of mammals, results indicate that the concept maps of biology majors are structurally more complex than those of non-majors.

Roth, Wolff and Michael (1994) found student views of collaborative concept mapping in an emancipatory research project. 46 students enrolled in a high school physics course participated in this study, which designed to portray students' view on, and understanding of collaborative Concept mapping students demonstrated a good understanding of concept maps and emphasized their usefulness as learning tool.

Roth, Wolff-Michael (1994) studied the student's attitudes toward collaborative concept mapping in a high school physics class. 46 Ss, juniors in a Canadian private school, designed activities and experiments, negotiated the terms and modes of evaluation, and negotiated the structure of classroom interactions. Ss engaged in 5 activities: (1) experiments (the core activities), (2) reading relevant chapters in main text and additional available texts, (3) preparing weekly textbook questions and word problems, (4) writing essays on special topics not covered in the text, and (5) constructing concept maps that included the key ideas of the relevant chapter of the main text. Student evaluations largely supported the efficacy of concept mapping. The major implications of this project for teaching and research address how students use ideas to make sense of content presented, research design (by students), and the metaphor of cognitive design apprenticeships.
Austin Lydia et. al. (1995) studied the 'Using Concept Mapping for Assignment in Physics', in which concept maps drawn by high school students (n=12) were evaluated using quantitative measures. Results indicate that the concept maps are useful in assessing the understanding of relationship between the concepts required for multiple step problems solving in physics.

Esiobu Gladys and Others (1995) conducted a study on the effect of concept and Vee mapping under three learning modes on students' cognitive achievement in Ecology and Genetics. The study verified the efficiency of concept and Vee mapping heuristic under co-operative, co-operative competitive and individualistic, whole class learning condition in improving tenth grader’s achievement in Ecology and Genetics. Experimental groups achieved significantly better than the control groups.

Cavallo (1996) conducted study on the meaningful learning, reasoning ability and students' meaningful learning or imitation reasoning ability, understanding and problem solving in genetics 189 school students took the learning approach questionnaire the classroom test of scientific reasoning and several measures of genetics knowledge. The assessment instruments were designed to measure students in three related understanding of microsis concepts in genetics and ability to solve and interpret problem. The interaction of meaningful learning orientation and reasoning ability did not predict significantly problem solving.

The study conducted by Gail and Elizabeth (1996) to investigate the changes in the organization of pre-service teachers, pedagogical knowledge revealed the changes in the organization of pre-service teachers knowledge
about teaching 23 senior in middle grade teacher education drew concept maps, completed card sorting task and participated in structural interviews four times during the same year. The findings indicate that the student teachers constructed their knowledge related to teaching during middle of student learning and attributed these changes in the knowledge organization primarily to student teaching experiences.

Ruiz-Primo, Maria Araceli and Shavelson, Richard (1996) revealed that concept map is a graph consisting of nodes representing concepts and labeled lines denoting the relation between a pair of nodes. A student’s concept map is interpreted as representing important aspects of the organization of concepts in his or her memory (cognitive structure). The purpose of this article is to examine the validity of claims that concept maps measure an important aspect of students’ knowledge structures in a subject domain such as science. The review led to the following conclusions: (a) an integrative working cognitive theory is needed to limit the current variation in concept-mapping techniques for assessment purposes; (b) before concept maps are used for assessment and before map scores are reported to teachers, students, the public, and policy makers, research needs to provide reliability and validity information on the effect of different mapping techniques; and (c) research on students’ facility in using concept maps, on training techniques, and on the effect on teaching is needed if concept map assessments are to be used in classrooms and in large-scale accountability systems.

Bayram, Servet (1996) studied the effectiveness of concept and software mapping for representing student data and process schema in
The purposes of the study were: (1) to investigate the relationships between concept mapping and software mapping techniques, (2) to show that software mapping is as effective as concept mapping as a vehicle for defining students' science achievement schemata, and (3) to provide a basis for "standardization" in the assessment of science schema with software use. The study showed that there is a positive relationship (.84) between concept mapping and software mapping. The results showed that there is no significant difference between Group I and Group II on concept mapping and software mapping scores. The protocol analysis showed that an interaction with computer software provided more cognitive activation and stimulation than concept mapping for children.

Huffman, Douglas (1997) studied the effect of explicit vs textbook problem-solving (PS) instruction on 145 high school students' conceptual understanding of physics. In terms of conceptual understanding, there was no overall difference between the 2 groups; however, there was a significant interaction between the Ss' sex and strategy group.

Passmore Gregory Gene (1997) studied the qualitative analysis of the learning intervention was conducted. The student Vee diagrams and concept maps were successfully utilized as interaction guides in order to identify student misconceptions, and to successfully facilitate remediation in the form of a cognitive congruence between the student and the instructor.

Harwood (1997) studied the effects of integrated video media on student achievement and attitudes in high school chemistry. It reveals that the effects of an integrated video media curriculum enhancement on achievement and attitude towards chemistry. The study conducted on 450 students of high
school. Results reveal that there are significantly higher achievement scores on standardized measures of achievement and or micro unit researcher designed criterion referenced test correlation of achievement with logical thinking ability revealed that subjects with high levels of logical thinking ability benefited most.

Osisioma and Ngozi (1997) conducted the study on ‘Remediation of Gender in Equity in Science in a Developing Country:’ An Experiment with Co-operative Concept Mapping. Results showed that the cooperative Concept Mapping strategy significant by improved the achievement of girls in the selected science concepts.

Thangachan Suja (1997) conducted a study to find the effect of Concept mapping technique in the attainment of science concepts among the pupil of standard six and found the concept mapping technique as an effective tool in improving the achievement of science concepts.

Rice, Diana and Ryan, Joseph (1998) investigated the method of scoring concept maps was developed to assess knowledge and comprehension levels of science achievement in students in 7th-grade life science classes with the students’ regular teacher serving as teacher/researcher. Results suggest that a concept map might be used in assessing declarative and procedural knowledge, both of which have a place in the science classroom. Results suggest that science curriculum and its corresponding assessment need not be dichotomized into knowledge / comprehension vs higher-order outcomes.

Markow, Peter and Lonning, Robert (1998) studied the 1st-yr college chemistry students learn little of the conceptual material associated with the
chemistry experiments they perform. No significant differences were found between treatment groups with respect to students' conceptual understanding as determined by the multiple choice achievement tests. Students responded very positively toward the use of concepts maps in the laboratory. They felt strongly that constructing prelab and postlab concept maps helped them understand the conceptual chemistry of the experiments.

DeMars (1998) conducted studies the gender differences in mathematics and science on a high school proficiency exam. Scores from a total of 5328 students from mathematics and science sections of pilot forms of the Michigan high school. Proficiency test were examined for evidence of all ability levels were considered, the interaction was small in science and non existent in mathematics. Make students either scored higher on the constructed response section correlations between the formats were high and did not vary by the gender. Standard errors for measurements were similar across gender.

Rice, Ryan and Samson (1998) conducted a study on "Using Concept mapping to access student learning in the science classroom; must different methods. Report on a year study implemented in grade seven life science classes with the student regular teacher serving as a teacher researcher. Result suggests that Concept Mapping may be useful in assessing declarative and procedural knowledge.

Maitaland (1999) investigated that the effects of gender and academic program on learning styles and attitudes of undergraduate students using multimedia, web based anatomy labs. The study reveals that the gender and academic program relationship to attitude and learning styles of
undergraduate students. Science students taking an anatomy course used multimedia computer software simulating functional anatomy and dissection as part of the curriculum. In comparing learning style with computer. There was a tendency for visual learners to be more at ease with computers. No difference was found regarding the motivation to do well or the perceived amount of time required. Women reported significantly less comfort using computers yet they viewed the computer as more useful than men. Men were significantly more confident that they would do well in the course.

McClure, Sonak, and Suen (1999) conducted a study on ‘Concept Map Assessment of Class-room Learning, Validity and Logistic practicality’. The study describes the evaluation of the characteristics and practicality of Concept mapping techniques for classroom assessment. Finding suggests that the time required to provide training in Concept Mapping, produces concept, and score concept map as compatible with the adoption of Concept mapping as a classroom assessment technique.

Minagawa (1999) studies Effect of making in concept mapping, examined the effect on concept mapping of instructions to make linking labels using the “atom” unit of senior high school chemistry. Human Ss were 34 male and 30 female high school students (sophomores) in Japan. Ss were divided into 2 groups and given 14 chemistry Concepts and told to make concept maps, but only 1 group was instructed to make liking labels. Multiple-choice tests, with 12 equivalent items were given to the Ss before and after the mapping. After the pretest, SS in each group were reassigned into 2 groups according to their scores on a test administered before the pretest. A2 factorial analysis of covariance was carried out to find the interaction between
differences due to the instruction to make linking labels and scores on this test. In the uninstructed condition, the mean ANCOVA score and scores on this test were consistent whereas in the condition instructed to make linking labels, the S's with lower scores on this test improved as 11,401 students. The 2nd sample included data on 15,663 students who dropped out of school. Findings indicate that parental involvement is generally a salient factor in explaining behavioral but not cognitive outcomes with greatest support for parent-child discussion and involvement in parent-teacher organizations, findings also indicate that specific dimensions of involvement have greater effects for more affluent and White Students providing empirical evidence to support. A. Lareasu's (1989) contention that the greater level of Cultural Capital possessed by members of the Upper class magnify parental involvements effect for advantaged students.

Jolly, Anju (1999) the purpose of this study was to analyze the relationship of concept mapping to science problem solving in sixth grade elementary school children. The study proposes to determine whether the students' ability to perform higher cognitive processes was a predictor of students' performance in solving problems in science and whether gender and socioeconomic status are related to performance in solving problems. Results from the analysis of covariance showed that the group receiving instruction in the concept mapping format performed significantly better than the group receiving instruction in traditional format. Also the Ross Test of Higher Cognitive Processes emerged to be a predictor of performance on problem solving. There was no significant difference in the analysis of the performance of males and females. No pattern emerged regarding the influence of
socioeconomic status on problem solving performance. In conclusion, the study showed that concept mapping improved problem solving in the classroom, and that gender and socioeconomic status are not predictors of student success in problem solving.

Minagawa, Jun (1999) examined the effect on concept mapping of instructions to make linking labels using the "atom" unit of senior high school chemistry. Ss were divided into 2 groups and given 14 chemistry concepts and told to make concept maps, but only 1 group was instructed to make linking labels. Multiple-choice tests with 12 equivalent items were given to the Ss before and after the mapping. After the pretest, Ss in each group were reassigned into 2 groups according to their scores on a test administered before the pretest. A 2-factorial analysis of covariance was carried out to find the interaction between differences due to the instruction to make linking labels and scores on this test. The Ss with lower scores on this test improved as much as the Ss with higher scores.

Kinchin Ian and Hay, David (2000) This paper describes a qualitative approach to analyzing students' concept maps. The classification highlights 3 major patterns which are referred to as "spoke", "chain" and "net" structures.

Schau, Candace and Mattern, Nancy (2001) developed and explored the validity of a select-and-fill-in (SAFI) concept map as a measure of students' connected understanding of science (CUS) in 2 studies. Study 1, specifically, addressed concerns related to the assessment format and the cognitive processes required by students to complete the SAFI assessments. Studies 1 and 2 both addressed aspects of internal consistency (IC) and the relationships of map scores to those from other measures such as multiple-
choice (MC) and relatedness rating (RR) assessments. The results show that scores for both studies possessed high IC and exhibited large mean increases with increased domain exposure.

Tsai and others (2001) conducted study on the use of web based concept map testing and strategies for learning. Investigation develops and evaluates a web based concept map testing system for science students. Subjects were 28 of 17 years old high school students. The study reveals that the student’s performance on the System was not significantly related to their achievement as measured by traditional standard test. The r views about the use of the system, in general, were positive. An analysis of students’ future use of the system and their motivation and learning strategies reveals that those with more critical thinking meta-cognitive activities and an effort regulation management strategy showed more willingness to use the online testing system. Moreover, students with high test anxiety also showed a preference to be tested through the system.

Snead, Donald and Young, Barbara (2003) investigated the effectiveness of concept mapping on science achievement of 182 African American middle grade science students, distributed into eight intact earth science classes. Analyses of covariance indicated no significant overall effects of treatment on science achievement. A statistically significant effect was found between concept mapping and student achievement among the average students measured by combined performance assessment items. The results suggest that concept mapping has a positive effect on average (lower) ability level African American science students.
Ledger, Antoinette Frances (2003) examined the achievement test consisted of 10 multiple choice and two open-response questions and used questions from state-wide and national assessments as well as teacher-constructed items. The analysis of data showed that experimental group females showed significantly higher gains in achievement than control group females. The analysis of science self-efficacy data showed that neither experimental nor control group females increased their scores pre to posttest, both showed small decreases in scores. However, scores of the control group females declined from pre to posttest.

Liu, Xiufeng (2004) studied on the Grade 12 chemistry class using collaborative computerized concept mapping on an ongoing basis during a unit of instruction. Analysis of progressive concept maps and interview transcripts of representative students and the teacher showed that ongoing and collaborative computerized concept mapping is able to account for student conceptual change in ontological, epistemological, and social/affective domains.

Papanastasiou, Elena and Zembylas, Michalinos (2005) the purpose of this study was to compare the relationships that exist between computer use and science achievement for 15-year-old students in the USA and Germany, based on data from the Program for International Student Assessment (PISA).

Uzuntiryaki, Esen and Geban, Omer (2005) investigated the effect of conceptual change texts accompanied with concept mapping instruction, compared to traditional instruction, on 8th grade students’ understanding of solution concepts and their attitudes toward science as a school subject. The results showed that conceptual change text accompanied with concept mapping instruction caused a significantly better acquisition of scientific
conceptions related to solution concept and produced significantly higher positive attitudes toward science as a school subject than the TI. In addition, logical thinking ability and prior learning were strong predictors for the concept learning related to solution.

Hardy, Ilonca and Stadelhofer, Beate (2006) investigated the effects of differently structured concept maps for students' comprehension of science texts and for their self-construction of concept maps in a new domain. In the first phase of the investigation, learners either constructed concept maps themselves from texts, worked with fill-in-the-gap concept maps, or used expert concept maps for text comprehension. In the second phase, participants of all groups constructed concept maps in a new domain. The application of the strategy of concept mapping, the active construction either with fill-in-the-gap concept maps or with self-constructed concept maps was especially important. A balance of self-construction and structural support, as given in the fill-in-the-gap concept map, thus led to a focusing of students' attention on both represented content and affordances and constraints of the visualization strategy.

Liu, Min and Hsieh, Peggy (Pei-Hsuan) (2006) examined the effect of a computer-enhanced problem-based learning (PBL) environment on middle school students' learning, investigating the relationship among students' self-efficacy, attitude toward science, and achievement.

2.2 Need and Significance of the Study

Since the recommendations of secondary education commission report and other education commissions, we are teaching science on compulsory basis throughout the school stages from primary to secondary level because
of its multifarious and many sided values to human beings. N.P.F. 1986 remarkable suggests that science subject should be virtualized as the vehicle to train the child to think, reason out, analyse and articulate logically. Attainment or achievement in science is based on mastery of various fundamentals, concepts, principles and facts in science. The curriculum in science at secondary school level demands for rapid learning and clear understanding of new curriculum (Trimester system of education) which is newly introduced program in the field of education. In this curriculum more concepts, theories in Biological science have to be taught and students have to be trained and learn in attaining the teaching of objectives.

It is a matter of common experiences of many science teacher's and researchers that the actual achievement in science of the students of secondary schools is less when compared with their potential and also other following reasons such as:

- The traditional or conventional method of teaching may not help the student to attain the objectives of teaching science.
- Students do not have the attitude towards the study of science.
- Students are not taking interest or curiosity towards study of science.
- No proper evaluation procedure is used for evaluation of science to see the achievement of science.
- No proper use of medians related to teaching of science subject by science teachers.

In the present study the researcher has considered some of the psychological factors such as cognitive ability, problem solving ability and scientific aptitude and teaching pedagogy that may effect the achievement in
science of secondary students. Hence the present study is undertaken with a view to examine various psychological factors effecting on science achievement.

In the modern classroom situation, the influence of science teaching is given vital importance and innovative instructional technology. Hence teaching science is a challenging task on the part of science teacher. These new innovative practices especially new pedagogies, strategies, self instructional materials, in individualized instructional materials and new electronic gadgets in teaching science brought significant changes in the process of teaching and learning science subjects to motivate the students for better performance in turn total academic achievement. Hence the present study is undertaken with a view 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 cognitive ability, problem solving ability and scientific aptitude. Hence the present study has been taken for investigation. Hope that the findings of the present study would help classroom practitioners, researchers, teacher educators, school practitioners and policy makers in modifying the structure of pedagogies in science theoretically.

Ruman (1987). The result from the study indicated that concept mapping ability is positively correlated with level of intelligence.

Jane, Henizz (1990), The study revealed that concept mapping advance meaningful learning and also students have positive attitude towards concept mapping.
Starr, Mary and Others (‘990) conducted study titled concept map as a heuristic for science curriculum development, toward improvement in process and product. It outlines the use of concept map as a tool for science curriculum development and discusses the changes that occur in the teachers' view of the curriculum revisions of the maps.

The elaboration of concept in three biology textbook facilitating student learning has been conducted by Lloyd and Carol (1990). It describes how three biology textbooks present context related to photosynthesis through construct of elaboration. Concept Maps were created for each textbook. Results arc discussed in terms of quantity of elaboration, relevance of idea used to elaborate major concept, relationship of nature of elaboration to intended readers and general relationship between how texts present information and student learning.

Richard, Macharz (1991). The study revealed that there was no significant difference among boys and girls in concept mapping ability.

McDonalds, Jacquenline and Others (1994) conducted a study titled developing interdisciplinary unit's strategies and examples. A theme of sharks is used to illustrate the process of developing interdisciplinary units for middle school instruction, including a model for team o^ teacher to follow. As activities evolve, a concept map is created to illustrate relationship and integration of ideas and activities for various disciplines.

Martin and David (1994) investigated the effectiveness of Concept Mapping as an aid to lesson planning. They reported that 'students in general science oriented curriculum courses used Concept Mapping as the basis for developing lesson plan after having first learned the technique through a fast
track approach developed by the author. Resulting lesson plans were high in quality with few, if any sequencing errors.

Gladys, Esiobu and Kola Sayibo (1998). The result shows that cooperative mode of learning achieved significantly better than individual mode of learning in concept mapping.

Riley (2004) studies the use of ICT based concept mapping techniques on creativity in literacy tasks, the key research in this small-scale study focuses on the effects that on ICT (Information and Communications technologies)-based concept mapping interventions has on creativity and writing achievement in 10-11 year old primary age groups. The data shows that pupils using a concept mapping interventions has on creativity and writing achievement in 10-11 year-old primary age pupils. The data shows that pupils using a concept mapping intervention significantly improve their NFER non verbal reasoning age-standardised scores over a control group with a higher baseline whose scores remain constant. Evidence linking this with using ICT-based concept mapping remains in conclusive. Correlation studies show that writing achievement and concept mapping connectivity are linked. However, there is no conclusive evidence for linking concept mapping connectivity with creativity. Findings show that concept mapping components increase post-test and that concept mapping ability can be evaluated using a connectivity index that may have some predictive value in assessing writing achievement. The findings suggest that ICT-based concept mapping provides a reliable framework from which to structure writing and that ICT enhances learning and use of this representational technique and provides opportunities for developing innovative and educationally valid practices.
2.3 Conclusion

If we glance through the above studies, these studies related to Concept Mapping revealed the number of aspect; Concept Mapping has been a useful technique for meaningful learning at various school levels. Studies conducted by Bris Coe Carol, Lam Aster (1991) proved that Concept Mapping has been used as a tool for meaningful learning at college level. Studies conducted by Okebukola and Akinsola (1992), Novok (1990), Manson (1992), Willerman and Herg (1991) and Horton McConney (1993) revealed the use of Concept Mapping as a meaningful learning tool at high school level.

Studies also revealed that Concept Mapping can be used as an effective tool to increase the achievement of student (Pancratius, 1990, Osisioma and Ngozi, 1997).

Concept Mapping can be developed among students both individual and in group. Group learning helps the student to widen their knowledge. Concept Mapping in conjunction with co-operative learning group was found to be more effective than teaching with Concept Mapping alone with lecture and with lecture demonstration method (Roth and Roy Choudhary, 1992).

The above studies were conducted at different school level and in different subject. Most of the studies were conducted in science as a whole or in biology. Hence the investigator used concept mapping technique in developing Living Things among the pupils of standard tenth. This is specially designed instructional material for developing Living Things was prepared and tried out among the pupils of standard 9th to bring about favourable changes in their Living Things.
Since hardly in Indian context few studies were conducted on concept mapping. Thus research on concept mapping should be done to study the effectiveness.

The findings of the above studies were not covered some of the components like science achievement in biological science, effect of science achievement on concept mapping, problem solving, cognitive ability and scientific aptitude.

From the above reviews related studies, it can be observed that most of all investigators have conducted only the effect of concept mapping strategy on the achievement of secondary schools. But findings of all above studies were not found significant results. Very few studies were conducted in India.

Hence, the investigator has chosen the present study. Hope that findings of the present study would help the system of a classroom instruction.

From the above stated reviews of related studies, it can be observed that most of the investigators have conducted only concept mapping in science instructions such as advanced organizers, means of assessing quality in secondary schools, but findings of all the above studies were not having significant results. Many studies were conducted abroad. Hence, the investigator has chosen the present study. Hoping that the findings would help the system of classroom instruction through concept mapping strategy.