CHAPTER - II

REVIEW OF THE RELATED STUDIES

For the present study, an attempt has been made to view relevant information about the problem from books, researches conducted in the field of education, educational abstracts and journals etc. The systematic and logically structured review of literature brings together the past researches, which reveals relationship of present study with past studies. The search for related literature, done in the past in associated area is extremely important in the research process. It helps the investigator in identifying the problem; provide a background for the development of study in terms of method, tools, study design, and what has been investigated. The related literature abreast the investigator in the respective field. Also the previous researches help to eliminate the duplication of what has been done and provides a useful hypothesis and helpful suggestions for investigation. It also helps the investigator in safeguarding the work from pitfalls and weaknesses with which some of the earlier researches have suffered. The search for related literature is one of the step in the research process. For any work, a comprehensive study of the related literature is an essential and indispensable prerequisite.

According to Best “A familiarity with literature in any problem area, helps the students to discover what is already known, what others have attempted to find out, what methods to attack have been promising and disappointing and what problems remain to be solved”.

Citing studies that show substantial and those that seem to present conflicting conclusions help to find and sharpen the scope of the study. It also helps in defining the problem to be undertaken. Review of existing Knowledge in the problem area provided a background for the research project and makes the investigator aware of the status of the issue. It enables the investigator to decide how far the selected problem is novel enough and does not have any chance of duplication.
Thus, the review of literature suggests some area for further study. The researcher might find some gap while reviewing the literature related to a particular area and therefore may consider that for research.

1. Review of related literature helps in stating the objectives clearly and correctly. It defined the limits of his field.
2. By review unfruitful and useless problems area can be avoided.
3. By review unintentional or duplication of well-established finding can be avoided.
4. It gives clear understanding of research methods, tools, and instruments to be used.
5. It helps in utilizing suggestions of previous research and utilizes it for further research.

2.0 RELATED STUDIES

In order to seek some guidelines from the earlier studies in this specific area of research, the findings of some relevant and representative studies are discussed as under.

Miller and Jones (2015) conducted a study on Using concept mapping as a planning tool: Child welfare citizen review panels. The study reports on the use of concept mapping (CM) to outline a framework for planning and subsequently evaluating the CRP in one southeastern state. CM is a mixed-method research approach that uses multi-dimensional scaling and hierarchical cluster analyses to explore an area of study. Through these analyses, the method creates visual depictions of conceptual relationships between ideas. Data yielded a seven cluster concept map that CRP members (N = 36) utilized for planning processes, and subsequently for developing an internal evaluation tool. Results from this study offer a unifying framework by which CRPs, and similar groups in other areas can utilize for planning and evaluation purposes. After a review of pertinent literature on CRPs, this article explicates CM processes utilized in this study, describes results, discusses lessons learned, and outlines apposite areas for future CRP research.
Richbourg J. A. (2015) conducted the study; ‘Concept Mapping as a Tool for Enhancing Self-Paced Learning in a Distance Scenario’ Researchers have determined that concept maps serve as effective tools in the traditional science classroom. The purpose of this experimental study was to investigate concept mapping as a tool for student knowledge acquisition in 10th grade science for students in distance learning situations. Research questions were designed to investigate the influence of concept mapping on rate and quality of student knowledge acquisition and retention. This study was a pretest-posttest 2-group comparison study, constructivist in nature and based on the theory of cognitive learning. Participants included 36 students in the 10th grade at an inner-city school in the United States. Control and treatment groups participated in completing pre and post testing to establish standards for initial understanding and knowledge acquired. Pretest scores were used in a 2-tailed t test to establish equivalence between groups at the beginning of the study. ANOVA was used with test gains to determine differences between treatment and control groups. Cronbach’s alpha was conducted to test for concept map reliability. A 2-tailed t test for matched groups was used with concept map scores and treatment group test gains to determine any relationship. No statistically significant relationship between the use of concept maps and distance learning was found.

Schwendimann, B. A. (2015) conducted the study on, ‘Concept maps as versatile tools to Integrate complex ideas: From kindergarten to higher and professional education. The present study explored the range of studies that investigated concept maps as learning, metacognitive, collaborative, and assessment tools to support integrating complex ideas. Research suggests that Concept maps can be successfully implemented in a wide variety of settings, from K12 to Higher and professional education. However, the effectiveness of concept maps depends on different factors, such as concept map training and choosing a suitable form of Concept map to match the task and learner. Developing proficiency in concept mapping Takes time and practice and should not be first introduced in higher education. Concept Map training could start as early as Kindergarten and include concept map
generation, Interpretation, and revision. This study concludes that, if implemented thoughtfully, Concept maps can be versatile tools to support knowledge integration processes towards a deeper understanding of the relations and structures of complex ideas and facilitate Life-long learning.

Martens, L.A.M. Goor, Holsappel, Kuunders, Bruggen, Brake, Oers (2014) conducted a study to explore the suitability of this method as a tool to integrate practical knowledge with scientific knowledge in order to improve theory development as a sound basis for practical decision-making. Following a short introduction to the method of concept mapping, five Dutch studies, serving different purposes and fields in public health, will be described. The aim of these studies was: to construct a theoretical framework for good regional public health reporting; to design an implementation strategy for a guideline for integral local health policy; to guide the evaluation of a local integral approach of overweight and obesity in youth; to guide the construction of a questionnaire to measure the quality of post disaster psychosocial care; and to conceptualize an integral base for formulation of ambitions and targets for the new youth healthcare programme of a regional health service. The studies showed that concept mapping is a way to integrate practical and scientific knowledge with careful selection of participants that represent the different perspectives. Theory development can be improved through concept mapping; not by formulating new theories, but by highlighting the key issues and defining perceived relationships between topics. In four of the five studies, the resulting concept map was received as a sound basis for practical decision-making.

Vadlapatla, Kaur and Zhao (2014) conducted a study to incorporate a concept mapping assignment as an active learning strategy in a pharmaceutics course and evaluate student perceptions about this new activity. A total of 67 students were given an individual and group concept mapping assignments to analyze the interrelationships of physicochemical properties, formulation factors, and requirements of a specific dosage form. A student satisfaction survey was administered to collect student perceptions
about the activity anonymously. All students and student groups successfully completed concept maps based on the rubric provided by the faculty. A total of 46 students (69%) completed the satisfaction survey. Overall, students reported that the use of concept mapping improved their understanding of the course material. The concept map assignment allowed students to visualize how different properties of individual dosage forms are interrelated. It is a useful tool for integrating instructional concepts in a pharmaceutics course and beyond. Concept maps enhance learning experiences and lead to a better understanding of the fundamental concepts.

Bilal, Munawar & Mirza (2013) studied the effect of Concept mapping on students’ academic achievement. The study aimed to analyze effect of concept mapping, a constructivism based learning strategy, on academic performance of 7th grade students in the subject of general science. This quasi experimental research, based on 2x2 factorial research design, involved 167 students from two single sex schools. Major objectives of the study were to; (i) find out the effect of concept mapping as a learning strategy on the academic achievement of students (ii) study differential effect of concept mapping on academic achievement of male and female students (iii) to find out the interaction effect of concept mapping as a learning strategy and gender on students’ academic achievement. Researcher’s developed achievement test was used as pre test and post test. During the treatment of five months, experimental group was trained to develop concept maps for three weeks. Subsequently students developed concept maps of general science content individually, shared those in groups and were compared by teacher with scientifically accepted concept maps for possible correction and improvement. Data on gain achievement scores were analyzed through 2-way ANOVA. Results showed that the male and female students taught through concept mapping performed better than the students taught through traditional teaching method. However male students taught through concept mapping performed significantly better than the female students.
Kilic, Keleş and Sağlam (2012) conducted a study on Examination of Elementary Teachers’ Views about Concept Maps and found it as one of the teaching methods that are carried out to make teaching-learning process more effective is concept mapping. Learners can incorporate new knowledge into their prior knowledge framework by utilizing concept mapping. Furthermore, representation and organization of the knowledge through concept maps, helps retention and recall. Thus concept maps facilitate meaningful learning by organizing knowledge in cognitive structure and encourage creative thinking. Concept maps constructed by the teachers, enable students identify and explore the structure and the nature of knowledge. The use of concept maps can also assist teachers in evaluating the process of teaching. This study aims to investigate the elementary teachers’ views on concept maps by using an open-ended questionnaire which is carried out with 24 elementary teachers. Before conducting the questionnaire teachers have been instructed about concept maps and they constructed concept map examples. The findings indicate that elementary teachers generally perceive concept maps as a useful, effective, practical tool and they highlighted concept maps as important since they provide feedback. An important implication of this study is that there is a need for teachers to know how to teach concept map construction, to associate the concept maps into their lessons and into the evaluating process.

Koc (2012) of Suleyman Demirel University investigated Pedagogical knowledge representation through concept mapping as a study and collaboration tool in teacher education. This study explored (a) pre-service teachers’ perceptions of using concept mapping (CM) in one of their pedagogical courses, (b) the predictive power of such implementation in course achievement, and (c) the role of prior experience with CM, type of mapping, and gender on their perceptions and performances in CM and achievement. The subjects were 89 pre-service teachers majoring in technical education in Turkey. Each participant developed five concept maps and shared them with classmates. The data sources included assessments of concept maps, midterm exam scores, and student feedback questionnaires.
Overall, participants had positive perceptions about CM. They indicated that CM helped them prepare for class lessons and examinations, understand complex issues, and reflect on their (mis)understandings. CM significantly predicted course achievement. Gender, prior experience with CM, and type of mapping were found to be insignificant factors in their perceptions and performa

**Leauby and Szabat (2012)** studied experimental uses of concept mapping in an introductory financial accounting course. This study tests the hypothesis that student learning in an introductory financial accounting course increases, as measured by examination scores, when traditional methods of instruction is supplemented by concept mapping activities. Extraneous variables, such as gender, SAT scores, major, and extra-credit work are tested. As a result, no differences in the control and experimental groups potentially contributing to differences in learning outcomes observed. The results of the study show no statistically significant evidence supporting the stated hypothesis. A survey administered to the experimental group shows that concept mapping provides a positive student experience and is a useful learning tool. Two significant results arise from the survey response: (1) Concept Mapping is rated as a valuable learning tool by good concept map creators; and (2) better students indicate preference for mapping software rather than creating maps manually.

**Shih-Chieh Chine (2012)** University of Cambridge worked on, ‘A Cognitive Analysis of the Relationships between Chinese EFL Writers Strategy Use and Writing Achievement Performance.’ The purpose of this study was to explore writing strategy use in Chinese EFL student writers in relation to their achievement in L2 (English) writing. This research takes a cognitive approach to the process of writing in a second language as a skilled performance in production. Forty Chinese EFL student writers in Taiwan took part in this study. The strategies used by high- and low-achievers in writing revealed through the concurrent think-aloud protocols and immediate retrospective interviews with the students were investigated.
analyzed, and compared. The results showed that in comparison with low achieving student writers, high achieving student writers focused more on clearly formulating their position statement in planning, generating texts, and revising and editing such as making meaning changes, and fixing grammatical and spelling errors during reviewing. The findings in the light of cognitive process-oriented writing strategy research and implications for L2 writing pedagogy suggest that for teaching, teachers may need to think about the problems that low achieving students were encountered and then try to figure out a way to help them. The lack of clear global-level planning processing activities among these low achieving students denotes a call for instruction in which strategies to raise awareness in writing

Patricia (2009) studied the concept mapping as study skill and its effect on achievement in life science. This study is significant in the sense that it has affirmed the relevance of concept mapping in improving learning when used as a study skill. Although the literature on concept mapping is wide, it must be stressed that most of the studies centered on its use as an instructional strategy rather than as a study skill. The results of this study indicated that learning did occur that there was no significant difference in learning outcomes as measured with immediate post-test between students who studied content materials with concept maps and those who summarized the materials after reading.). This finding of learning occurring tend to suggest that the construction of pre-instruction concept maps and their use in studying have influenced the students’ in the experimental group understanding of concepts in the biology topics. The non-significant difference in immediate post achievement test scores between those who used concept maps as study skill and those who summarized- after review can be explained on basis of lack of enough experience on construction and use of concept maps in studying.

Dammani (2009) conducted an experimental study to study the effectiveness of Concept Mapping for improving Reasoning. Non Equivalent Control group design was employed for the experimentation. Sample of 75
students of class VIII were selected for reasoning development program. The intact groups as existed in the school were taken for experimentation. One of the groups was taught reasoning through Concept Mapping Strategy. The findings of study are:

1. Concept Mapping was found to be effective in developing reasoning when Intelligence was taken as covariate.
2. Concept Mapping was found to be effective in developing reasoning when Pre-reasoning scores were taken as covariate.
3. Reasoning was found to be independent of Intelligence when Pre-reasoning scores were taken as covariate. Thus it can be said that Concept Mapping was found to be effective for both high and low intelligent students.
4. Reasoning was found to be independent of Interaction between Intelligence and Treatment when Pre-reasoning scores were taken as covariate.

Boujaoude and Attieh (2008) American University of Beirut, Beirut, Lebanon worked on, and ‘The Effect of Using Concept Maps as Study Tools on Achievement in Chemistry’ the purposes of the study were to:

(1) Examine whether or not the construction of concept maps by students improves their achievement and ability to solve higher order questions in chemistry,
(2) Investigate the differential effect of the treatment by gender and achievement level, and
(3) Explore the relationships between performance on concept maps and chemistry achievement. Participants were 60 tenth-grade students randomly divided into two groups. The study spanned six weeks in a class that met five times a week. The material covered was acid-base titration and equilibrium in weak acids. The students were pre- and post-tested using a teacher-constructed chemistry test. Results showed that while there were no significant differences on the achievement total score, there were significant differences favoring the
experimental group for scores on the knowledge level questions. Moreover, there were sex-achievement interactions at the knowledge and comprehension level questions favoring females and achievement level –achievement inter-actions favoring low achievers. Finally, there were significant correlations between students’ scores on high level questions and the convergence and total concept map scores. The results of the study support using concept mapping as homework to engage students in constructing and altering their own knowledge structures, with the understanding that there is a need to help males become more engaged in using the technique because of its possible benefits. In addition, concept maps were successful tools in helping low achievers improve their grades. Nevertheless, concept mapping may become effective for high achievers too if they are encouraged to periodically check their maps during the learning process. Moreover, there is a need for longer training sessions and direct feedback to give learners the opportunity to master concept mapping the technique.

**Dogusoy (2008)** Middle East Technical University / Faculty of Education, Department of Computer Education and Instructional Technology, Ankara, Turkey worked on the ‘Experts & Novices Concept Map Formation Process: An Eye-Tracking Study.’ The purpose of this study was to explore how concept maps formation process carried out by individuals who are designated experts and novices. As a group of novice participants, 73 prospective teachers and 5 experts were participated to the study. Data collected by using open ended questionnaires, and retrospective review and eye tracking sessions. These data were used to explore the cognitive process of users during concept map development process. The preliminary results showed that participants tended to follow a deductive approach and in terms of concept map building strategy, there is a pattern among participants starting map with writing links after the concepts.

**Villalon and Calvo (2008)** Studied Concept Maps as Cognitive Visualizations of Writing Assignments Motivated by the pedagogical value
of Concept Maps as cognitive visualizations, this study presents a new Concept Map Mining (CMM) tool, and evaluates it using a collection of human annotated essays written by undergraduate students. The results show that the automatic generation of CMs from documents is feasible, despite the complexities of noisy data such as student-produced text. Humans tend to agree when summarizing a document using a CM (intercoder agreement of 77% for Lexical Precision and 85% for Taxonomical Precision). Available OLT tools and the CMM reliably identified concepts, averaging 94% for LP with human coders. The tool has been integrated into an e-learning environment, and future work involves designing pedagogical activities in which the impact on student learning will be assessed. As the motivation of the CMM is to support writing activities, it was also integrated into a tool for enhanced feedback on writing activities called Glosser. The tool supports writing activities by scaffolding authors' reflection during the process of writing, to encourage them to revise their work. At any time during their writing authors can gloss their documents by clicking a link that will take them to the Glosser website. Glosser can then present several issues related to the quality of the essay with provoking questions on how to assess them. Automatically generated features from the text are also presented for the student to guide and facilitate the answering of the questions.

Asan (2007) Department of Instructional and Learning Technologies, Sultan Qaboos University, Sultanate of Oman conducted a study on ‘Concept Mapping in Science Class: A Case Study of fifth grade students’. The purpose of this research project was to determine the effects of incorporating concept mapping on the achievement of fifth grade students in science class. The study was conducted with twenty-three students at Ata Elementary School, Trabzon, Turkey. The students were tested with teacher-constructed pre- and post tests containing 20 multiple-choice questions. The pupils in the experimental and control groups were exposed to the same teaching techniques covering a unit on heat and temperature. They were given the same pretest after the initial lessons. However, after the pretest,
the control group was given a traditional oral review of the material and the experimental group was exposed to the review by the use of Inspiration, which is computer based concept mapping tool. After these reviews, the students on both groups were given the posttest. Test scores were analyzed for any statistically significantly difference in the scores on the test. The results from present study indicate that concept mapping has a noticeable impact on student achievement in science classes.

Keraro, Wachanga and Oraro (2007) studied effect of cooperative concept mapping teaching approach on secondary school student motivation in biology. The present study investigated the effect of using the cooperative concept mapping teaching approach on secondary school student motivation in biology. A non equivalent control group design under the quasi experimental research as used in which random ample of four co educational secondary school a used. The result chow that student exposed to the CCM approach have significantly higher than those taught through regular methods. The result further indicated that there is no significant difference in motivation of boy and girl toward learning of biology.

Hubbard (2007). This study proposed that a concept map be used to support a shared understanding of a software system. The concept maps were used to provide a common context to be used throughout the software development lifecycle. In order to explore the use of concept map based software engineering, the concept mapping technique was integrated into the development process of the senior/graduate level COMP-190 Software Engineering Project course. A document describing the concept map based software engineering method was created which included a tutorial on the creation on concept maps. The tutorial was presented to the COMP-190 class on February 6, 2007 for approximately 45 minutes. The portion of the presentation dedicated to the creation of concept maps lasted approximately 20 minutes. Feedback from the class during the concept map training indicated that the students would like a guide for defining relationships between concepts A key goal of the thesis was to enable a shared understanding between various stakeholders using concept maps for software
engineering. Evidence that this goal was achieved can be seen from significant mean gain scores.

**Yen, Lee, & Jung (2007)** investigated the effects of image-based concept mapping on the learning outcomes and cognitive processes of mobile learners. The purpose of this study was to investigate the effects of different teaching strategies (text-based concept mapping vs. image-based concept mapping) on the learning outcomes and cognitive processes of mobile learners. Eighty-six college freshmen enrolled in the “Local Area Network Planning and Implementation” course taught by the first author participated in the research. This study randomly selected one class as the experimental group and the other as the control group. Students in the experimental group used image-based concept mapping to finish assigned tasks and those in the control group used text-based concept mapping to complete the same tasks. Quantitative analysis combined with qualitative analysis was used to examine the learning outcomes and cognitive levels of the students, as defined by the revised Bloom's taxonomy. The results showed that (1) there was no significant difference in students' learning achievements, (2) the group using image-based concept mapping showed higher level than the text-based group in the dimension of understanding and creating and (3) the image-based concept mapping strategy was more complete and diverse than the text-based concept mapping strategy. Students in the group using image-based concept mapping performed better than the group using text-based concept mapping on the cognitive level of understanding learners in the group using image-based concept mapping exhibited more complete and diverse map structures than those in the group using text-based concept mapping. The teaching strategy of image-based concept mapping could potentially assist students in learning meaningfully in the context of mobile learning.

**Hauser, Nuckles, and Renkl (2006)** this study compared a control group to several groups using CMs in four ways: constructing CMs from scratch, constructing CMs from a list of concepts, constructing CMs from
spatially arranged concepts, and finally studying previously built CMs. The results showed that constructing maps from scratch and studying previous constructed ones led to significantly better learning outcomes than the other conditions. The vagueness is not caused by natural language, but by the fact that people seldom have a clear idea of what they want to say before the analysis has been completed. Engineers have a pithy characterization of the phenomenon: “Customers never know what they want until they see what they get.” Plato's dialogs illustrate the kind of analysis that is required. Similar dialogs are necessary when programmers or engineers analyze a vague wish list (also called a requirements document) in order to generate a formal specification. Those dialogs always take place in natural languages, often supplemented with hastily scribbled diagrams, but not in any version of logic, fuzzy or precise. This talk discusses a range of representations from informal to formal and compares four notations that are being used in various stages of knowledge acquisition, analysis, and representation: the informal Concept Maps, the semi formalized Topic Maps, the formal Conceptual Graphs, and the formal, but highly readable Common Logic Controlled English (CLCE). These and other similar notations have found useful niches in the process of analysis and representation, but it is important to recognize their different characteristics and areas of applicability.

Otting & Zwaal (2006) conducted a study to determine the use of concept mapping in a problem-based learning (PBL) curriculum. The first study was conducted with four PBL groups, with two groups using concept mapping. In the second study, three of seven groups were assigned to use concept mapping. All PBL groups were audio- and videotaped. Results show that concept mapping did not lead to more or better matching learning goals. Neither did it affect the time spent on step 4 of the seven-step method. When evaluating the PBL session, students working with concept mapping were more satisfied with the execution of step 4, the decision-making process, and the communication within the group. Though indications exist that concept mapping might be a useful tool to enhance the process of PBL, further
research is needed, controlling for the impact of the quality of the problems and the tutor interventions

Sowa (2006) presented the research findings in his slides on concept mapping in the track on Technology, Instruction, Cognition, and Learning (TICL) at the AERA Conference, San Francisco. The study concluded the task of knowledge representation has two parts: the first is to analyze some body of knowledge and identify the relevant concepts, relations, and assumptions; the second is to translate the result of the analysis into some notation that can be processed by computer. Neither part is easy, but the first is far more difficult. Natural languages are capable of expressing anything that can be stated in any artificial language with the same level of detail and precision, but they can tolerate any degree of vagueness during the process of analysis. Artificial languages, such as the many variants of symbolic logic, are valuable because they do not tolerate vagueness, but what they say so precisely may have no relationship to what the author intended. The various notations for logic are designed to represent the final precise stage, but they provide no intermediate forms that can bridge the gap between an initial vague idea and its ultimate formalization. Natural languages can represent every stage from the vaguest to the most precise, but no version of fuzzy logic or related variants can come close to the flexibility of natural languages.

Valerio and Leake (2006) analyzed the requirements for generating CMs from text for educational purposes. These requirements can be summarized into the three principles of Educational utility, Simplicity, and Subjectivity findings are, elaborated below:

1) Educational utility: There is scientific evidence for the educational utility of concept mapping following Novak's method. CMs must include concepts, which should be connected by linking words to form propositions. They must also have a topology where more general concepts are placed higher in the map and specific concepts lower.
Concepts with the same level of generalization should be placed at the same level (Novak, 2007).

2) Simplicity: CMs are mainly used for human analysis, giving teachers and students an alternative, structured, and cheaper representation of students' understanding. Novak's definition also indicates that a CM should require no more than 25 concepts to answer its focus question. Since there can be many more ‘concepts’ in a medium length document, CMs (either human made or automatic) can be conceived as a visual summary of the complete document.

3) Subjectivity: As mentioned earlier, CMs represent both the author's knowledge and her writing skills. In an educational context, the terminology used by the student is also important for assessing the outcome, so CMs should be represented using the terms that the author used in her text. If a student uses a certain word to refer to a particular concept, this choice inevitably reflects her vocabulary level, and hence a concept map should retain this information. This means that poorly written essays should be able to produce a CM with meaningful propositions that should also reflect the author’s writing skills limitations (like spelling and grammar errors).

White, Song, and Liu (2006) Institute for Advanced Computer Studies, Department of Computer Science University of Maryland, conducted the study ‘Concept Maps to Support Oral History Search and Use ”The pilot study with six middle and high school teachers. Teacher asked them to produce two stories for their students using the VHF archive: a “simple” story and a “complex” story. The simple story (i.e., Build a story about how wartime affects peoples’ lives) was intentionally general and focused on gathering information about people; the complex story (i.e., Build a story about what happened between people in Warsaw ghettos), was intentionally specific and focused on gathering information about relationships between people. Story construction was felt to be a reasonable approximation of a task teachers would engage in with the archive, and afforded us an opportunity to assess the utility of the concept mapping tool.
The study used a mixed-design: three teachers used the Initial analysis indicates that in constructing complex stories compared with simple stories, participants generally:

a. Built richer concept maps, with more nodes and links;

b. Explored the VHF thesaurus in greater detail, and used some of the thesaurus entries in their search statements, and;

c. Took longer to reach task completion. All participants used the entire 30 minutes for the complex task but used on average 19 minutes for the simple task. Although participants complained about the accuracy of the ASR transcripts in all cases, the search, audio playback, and thesaurus browser used in the study appeared sufficient for both tasks. Participants who used the concept maps for complex tasks built stories containing significantly more sources of evidence ($M = 3.67$) than those without concept maps ($M = 3.33$). The same was not true for the simple tasks. Participants commented that building concept maps enlarged their working memory, supported their highly iterative searching style (for complex stories), and led to the creation of good stories.

Graff (2005) University of Glamorgan, U.K. worked on Differences in Concept Mapping, Hypertext Architecture, and the Analyst–Intuition Dimension of Cognitive Style The aims of this study are threefold: first, to attempt to confirm previous findings on recall performance by users with different cognitive styles in different hypertext architecture conditions; second, to investigate differences in the density and complexity of the concept maps produced by individuals possessing different cognitive styles; and finally to investigate differences in perceived usability of different hypertext architectures. In this study, 55 participants were assigned to one of three hypertext conditions and were required to recall information and produce maps of the hypertext. Cognitive style was assessed using the analyst–intuition dimension of cognitive style. The findings confirmed earlier research that individuals possessing different cognitive styles differed in recall performance when using different hypertexts. Furthermore,
the concept maps produced by participants with different cognitive styles differed between architecture conditions. The findings are explained partly as being due to differences between individuals’ perceived ease of use of hypertext.

Halimi, (2005) ETI, Université de Genève, Suisse researched on, ‘the concept map as a cognitive tool for specialized information recall.’ In her study she discussed some aspects related to the process of text analysis with a concept map aiming at structuring textual knowledge and achieving a better recall of information in the context of teaching technical translation. The concept map is considered not as a system for representing knowledge structures of domains, but as a cognitive means used as a method for text analysis in specialized fields. The study reports data from a research project in which the author carried out an experiment on two groups: the 1st group analyzed the text by extracting its data in the form of a concept map, whereas the 2nd group proceeded using the traditional tool of text analysis. The two groups were later subjected to recall tests; free recall and recall by questionnaire. One very consistent finding shows that the use of the concept map as a tool of text analysis helped not only in retaining the main information units of the text, but also in recalling textual units in defined semantic categories. From a cognitive perspective and to sum up previous observations, we would presume that high level conceptual knowledge facilitates low level text processing when it is organized in an isomorphic way through mapping between domain conceptual systems, as reflected in specialized texts, and the external representation as drawn in a map by the individual. As a result the integration and accumulation of new information in cognitive preexisting structures is facilitated. Confusion noticed in examples of Gr.B results suggests that Gr.A subjects attention was redirected from the beginning (reading process) towards the recognition and definition of conceptual links between notions, which consequently facilitated access to the mental representation.
Karakuyu (2005) Department of Science and Mathematics’ Education, Mustafa Kemal University, Hatay, Turkey worked on, ‘The effect of concept mapping on attitude and achievement in a physics course’ The aim of this study was to investigate the effect of students’ concept mapping on their physics achievement and attitudes toward physics lesson. Participants were 58 ninth-grade students from the two class enrolled to general physics course in a high school in Turkey. One of the classes was randomly chosen as experimental group (28), constructed electricity concept map and the other was control (30) group, did not receive any presentation on concept mapping. Data were collected via the pre- and post-administration of the Physics Achievement Electricity Test (PAET) and Concept Maps Attitude Scale towards Physics (CMASTP). The study conducted in six weeks in a class that met two times a week. The material covered was about electricity. Results showed that while there were no significant differences in the attitude and achievement between the experimental and control groups. However, the experimental group students were observed to have a tendency of more positive attitude than the control group students. Results also showed that drawing concept map instruction was more effective than traditional instruction in improving physics achievement of the participating students.

Lee and Nelson (2005) Department of Educational Psychology and Learning Systems, Florida State University. Worked on Viewing or visualizing—which concept map strategy works best on problem-solving performance? The purpose of this study was to investigate the effects of two types of maps (generative vs. completed) and the amount of prior knowledge (high vs. low) on well-structured and ill-structured problem-solving performance. Forty-four undergraduates who were registered in an introductory instructional technology course participated in the study. Participants were randomly assigned to two treatments that used generative and completed concept maps. Within those treatment groups, participants were differentiated by prior domain knowledge, high or low. Although the high knowledge-generative group outperformed the other three groups on
well-structured problem solving performance, it did not have an effect on ill-structured problem-solving performance.

**Bera & Liu, (2004)** In this study we used students’ log data to examine their tool use patterns while navigating the environment to see which tools were used and at what stages of the problem-solving process. The results showed that the use of different types of tools was associated with different stages of problem-solving, and the students increasingly used multiple tools in the later stages of their problem-solving process. The findings indicated that tools performing different functions enabled students to coordinate multiple cognitive skills and, therefore, facilitated their information processing. Although the log data provided an objective and unobtrusive way to examine students’ actual use of tools, we can only infer about the thinking processes students engaged in while selecting the tools.

**Chularut and DeBacker (2004)** investigated the effectiveness of concept mapping used as a learning strategy with students in English as a Second Language. Seventy-nine ESL students participated in the study. Variables of interest were students’ achievement when learning from English-language text, students’ reported use of self-regulation strategies (self-monitoring and knowledge acquisition strategies), and students’ self-efficacy for learning from English-language text. A randomized pre-test–post-test control group design was employed. The findings showed a statistically significant interaction of time, method of instruction, and level of English proficiency for self-monitoring, self-efficacy, and achievement. For all four outcome variables, the concept mapping group showed significantly greater gains from pre-test to post-test than the individual study group. The findings have implications for both practice and research.

**Fonseca & Extremina (2004)** Faculty of Medicine University of Porto, Portugal worked on ‘Concept Maps as a tool for scientific research in Microbiology and described three projects involving the use of concept maps to clarify, organize and integrate ideas and information in a specific scientific research domain. The research team concluded that concept
mapping provides a useful way to share knowledge and information and to see connections in different works/projects and scientific articles. Concept maps that result from the analysis of a scientific article, the design of a project or from a construction of a protocol are useful tools for communication and share of knowledge between individuals and the research team. These meta-cognitive tools can facilitate knowledge understanding, retrieval, and application promoting therefore the increase in scientific output for all the team members and the optimization of the presentation skills by new research team members.

**Gregory and Durland Indiana University of Pennsylvania (2004)** studied on “Using Concept Maps as a Tool to Assess Student Understanding in General Chemistry Laboratories” The purpose of present study was to determine if students using the WWC lab experiments recognize the connection between chemical concepts and the laboratory procedure. From this study it was evident that students were able to connect the relevant chemical concepts to the laboratory procedure. In each of the series of laboratories studied, the majority of students were able to decipher what the central concept of the series was. They were also able to connect many of the key concepts in the laboratory to the central concept. However, several students failed to mention many of the more important theoretical concepts. Many factors may have contributed to this problem. In this study concept maps served as a valuable tool in the assessment of student knowledge and should be used by both the instructor and the students. By using concept maps, teachers will be able to assess what the students already know, how it is organized, and how they restructure their cognitive framework when a new topic is presented.

**Kharatmal and Nagarjuna (2004)** Homi Bhabha Centre for Science Education, TIFR, Mumbai, India Worked on Refined Concept Maps for Science Education: A Feasibility Study. The study is conducted to test the ease and feasibility of RCM by comparing it with other modes of representation. A homogeneous sample of school students was assigned the
same task from a specific domain. The analysis shows that it was easy and feasible to use RCM by the school students. The fixed set of relation names, does not affect the expression of knowledge and at the same time helps in representing accurate knowledge. The constraints in the RCM served as an anchoring and a facilitator for representing scientific knowledge. From the study, it can be observed that RCM is parsimonious and it does not hinder the representation of critical concepts. Interestingly, a significant change in correct relations in group shows that there appears no loss of knowledge in the RCM thereby indicating there is no inconvenience in retrieving and eliciting the knowledge of the domain. In fact, the constraints served as facilitator which enabled them to represent scientific knowledge. Although there is a constraint applied with the tool, on the one hand it helps in expression of accurate knowledge and on the other it lessens with inaccurate expression.

Liu, M., Bera, S., Corliss, S. B., Svinicki, M. D., & Beth, A. D.(2004) worked on Understanding the Connection Between Cognitive Tool Use and Cognitive Processes as used by Sixth Graders in a Problem-Based Hypermedia Learning Environment Correspondence sent Alien Rescue engages sixth grade students in scientific investigations aimed at finding solutions to complex and meaningful problems. To assist the students, 13 cognitive tools are provided to scaffold their problem-solving. The findings of this study suggest that different cognitive tools are used for different cognitive processes, and students’ degree of engagement in cognitive processing is positively related to the frequency of tool use. These results indicate that there is a connection between 24 cognitive tool use and cognitive processing. In addition, tool use patterns reflected different characteristics of the learners (information processing versus metacognition oriented).

Corderoy, Harper, and Hedberg (2003) examined the effect of the three built-in simulators in Exploring the Nardoo on learning outcomes. In the program, high school students were provided with such tools as a
personal digital assistant, nine genre templates, and three simulators for problem-solving, communicating, and preparing multimedia reports while studying ecology. They believed that cognitive tools in the form of simulations could provide learners with the opportunity to explore and test ideas without risks. They found that although using the simulators resulted in significantly improved acquisition of factual knowledge for both the control and experimental groups, the experimental group that had access to the built-in simulations showed a significantly greater increase in factual knowledge scores than the control group. Results also suggested that the simulations facilitated a deeper understanding of the processes and relationships between causal factors for the students in the experimental group. The authors concluded that these cognitive tools had the potential to provide learners with a greatly enriched learning experience by facilitating the review of their existing knowledge and construction of new knowledge.

Altin (2002) worked on “The Study of Computer Assisted Experimental Method and Concept Mapping Method with Regard to Some Cognitive Processes and Level of Retention” and it was found that

1. Using Computer Assisted Experimental Method while teaching physics has positive and significant effect on students’ achievements.

2. It was found that using Computer Assisted Experimental Method while teaching physics has positive and significant effect on students’ concept learning.

3. Computer Assisted Experimental Method increased the level of the retention of the students.

4. The using of the Concept Mapping Method during the physics courses has positive and significant effect on the achievement of the students.

5. The using of the Concept Mapping Method during the physics courses has positive and effect on concept learning.

6. The using of the Concept Mapping Method during the physics courses
has positive and significant effect on the level of retention of the students.

Some suggestions about the science/physics teaching methods were brought forward in the light of these results. I hope that this research contributes to the studies done in science teaching and gives some useful ideas to the teachers and educators.

**Chang, Sung, & Chen, (2002).** The present study validated the use of concept maps to improve text comprehension and summarization. The study compared a control group to three concept mapping approaches: showing an expert generated CM; scaffold concept mapping (completing a partially-completed expert CM), and constructing CMs from scratch. The results indicated that all approaches to concept mapping improve text comprehension and summarization skills, with the scaffold concept mapping approach leading to the best outcomes. The findings revealed that CMs could also be used to scaffold students reflection.

**Atkinson, Derry. & Wortham (2000)** worked on Learning from examples: Instructional principles from the worked examples research. The investigator found a positive correlation between worked examples and instructional principles.

**Bahr and Dansereau (2000)** used maps in which “split nodes” were compared with atypical list method for teaching German vocabulary. Maps led to significantly better scores on cued recall. The work suggests that the reduction in processing load that seems inherent in map processing can be further enhanced by modifying the presentation of the map. Further work is needed to confirm that “load” is reduced and to examine ways of amplifying those benefits. If maps do indeed reduce cognitive load (at least on certain kinds of tasks), they may be very effective in supporting student learning in multimedia and hypermedia environments. Given the consistent evidence that knowledge maps emphasize macro structural knowledge, they may serve as power tools for providing learners with guidance within instructional hypermedia.
Erdogan and Bayram. (2000) conducted a research on using concept mapping for collaborative learning in higher education. It was found that the strategy is effective in teaching and learning at higher level whereas gender as a variable do not affect the process in terms of achievement.

Guastello, Beasley, and Sinatra (2000) worked on “Concept Mapping Effects on Science Content Comprehension of Low-Achieving Inner-City Seventh Graders. In the study low-achieving seventh-grade students from an urban parochial school were randomly assigned to two equally sized groups. One group was taught by a read-and-discuss, teacher-directed method, and the second group, given the same type of introductory lesson as the first, followed a model of concept mapping that connected major and minor concept ideas. A criterion-referenced test based on the content of a science chapter served as the dependent variable. Prior to any teaching, a pretest was administered. An analysis of covariance with pretest scores as the covariate showed a statistically significant difference in comprehension between the pretest and posttest for the experimental group. Effect size estimates revealed that concept mapping could be expected to improve comprehension scores of low-achieving seventh graders by approximately six standard deviations over a traditional instructional technique. When students lack background information on a topic to aid comprehension, the active participation in constructing semantic or concept maps may help students form a cognitive schema to assimilate and relate the new topic information.

O’Donnell and Dansereau (2000), In the study students studied two texts; one described the autonomic nervous system and the other described probability theory. Students reported significantly more prior knowledge about the autonomic nervous system than about probability theory. Given the influence of prior knowledge on the effectiveness of concept mapping that we have already noted, such differences in material are important to understand. Outcome measures included recall and organization of the recall. The recall scores reflected the quality and quantity of recall and the
organization scores provided a measure of the inclusion of the macrostructure of the material. Treatment effects were found only for organization scores on the probability passage used but were found for recall of the material on the autonomic nervous system. It may be that in the absence of prior knowledge of the content, the initial encounter with the probability material only allowed for the abstraction of organizational information.

Oliver and Hannafin (2000) investigated middle school students’ use of cognitive tools to help them collect, organize, annotate, and evaluate complex information during a scientific inquiry. They proposed that using these tools to manipulate hypermedia resources in a manner consistent with higher-order thinking (e.g., organizing, integrating, evaluating) would help students solve complex, open-ended problems. However, results revealed that the tools mostly supported lower-level information gathering and thinking rather than facilitating higher-order reasoning for which they were designed. The students failed to use the tools to their full potential. Their study suggests that tools may not be effective at providing guidance if the students are not aware of when and how they should use them.

Sigmar-Olaf Tergan (2000) worked on ‘The Use of Digital Concept Maps as Cognitive Tools for Managing.’ The goal of present study was to outline the diverse potential of digital concept maps as a representational medium in supporting spatial semantic display processing for individual knowledge management in complex cognitive processing tasks. The analysis is based on a model of knowledge management processes as described by Probst, Raub, and Romhardt (1999). The processes focused on are cognitive, as well as meta-cognitive processes: knowledge identification, knowledge evaluation, localization of knowledge resources, knowledge generation, knowledge representation/ organization/, knowledge communication, and knowledge application.

Thangarajathi (2000) conducted a research on effectiveness of mind mapping technique in teaching mathematics in relation to sex, parental
Education and Income. He found mind mapping technique more effective than conventional teaching for achievement. Though Boys came out as better mappers in comparison to girls but parental education and income had no effect on technique.

Chmielewski and Dansereau (1998) trained a group of students in the use of knowledge maps by having them complete a series of workbook exercises related to mapping, develop a map of their own, and make judgments about a series of maps. During a second session, all participants, including those who did not receive map training, studied two sets of text materials (no maps were available). They took recall tests 5 days later. Students who received training in knowledge mapping recalled significantly more macro-level ideas than those who did not receive training. This finding of positive transfer from map training to text study was replicated in a second experiment. In summary, the research to date indicates that maps can enhance the acquisition of macrolevel ideas, improve affective responses to studying, and testing, enhance cooperative learning, and lead to positive transfer of text processing skills. A key factor in producing these positive outcomes lies in the training that is provided in the use of maps.

Markow and Lonning (1998) tested the effect of concept map construction on concept understanding in college chemistry laboratories. They found that students had a strong positive attitude towards using concept maps for better understanding of chemistry laboratory concepts, although multiple choice achievement tests did not reveal any difference in students conceptual understanding between the experimental and control groups.

Amer, (1994) conducted a research on the effect of knowledge map and underlining training on the reading comprehension of scientific texts. The investigator found knowledge map more effective than underlining training. Amer compared two methods for increasing comprehension with a control condition. Students were assigned randomly to a knowledge map condition, an underlining condition, or the control condition. Training was
provided to students on how to use knowledge maps or use underlining as a comprehension strategy. Both treatment groups outperformed the control group on an open-ended questioning measure although they did not differ from one another. Those who used knowledge maps, however, outperformed the underlining group and the control group on a measure of summarization quality. Knowledge maps may assist low verbal learners because they draw attention to the macrostructure of the content and encourage top down processing.

Reader and Hammond (1994) designed a study to test the effectiveness of a concept mapping tool in aiding pupil learning from a hypertext system found that use of this tool enhanced the scores on a post-test when compared to standard note taking. They also observed that only one of the eight subjects produced a well structured concept map. ‘Often concepts, some of which had been spatially organised, remained unlinked, concepts that had been linked using organisational links often remained so, with little attempt by subjects to specify them as structural relationships’. This indicates that pupils may need more support in the formation of structural relationships, and encouragement to revise maps.

Anderson & Zeitz (1993) conducted a research on Computer based concept mapping; active studying for active learners. It was found that the technique is effective for high achievers.

Adenwalla and O’Donnell (1992) compared the use of knowledge maps and texts by cooperating dyads and individuals in an undergraduate biology class of deaf students. Deaf students typically experience more difficulties in processing textual materials than their hearing counterparts. The results of this study indicated that knowledge maps were effective with deaf students as evidenced by recall and multiple choice tests, thereby supporting the notion that students with restricted verbal experience can benefit from knowledge maps.

Kommers & Stoyanova (1992), Faculty of Educational Science and Technology, University of Twente, studied 'learning effectiveness of
Concept Mapping in a Computer Supported Collaborative Problem Solving Design.' The present experimental study aimed at investigating the learning effectiveness of concept mapping in a computer supported collaborative problem solving design. The main assumption underlying this research is that shared cognition is a substantial for cognitive construction and reconstruction and that concept mapping is an effective tool for mediating computer supported collaboration. Based on the assumption that the form in which knowledge is shared influence strongly the process of building a shared cognition and hence – the effectiveness of collaborative learning, three scenarios of concept mapping mediated group interaction have been designed – Distributed, Moderated and Shared. These tree scenarios demonstrated differential effect towards different aspects of learning effectiveness both at a group and at an individual level. It is concluded that the mode of sharing and the form of knowledge, which students communicate are more important than the access to the distributed resources itself. The Sharing scenarios showed to be the most appropriate for establishing a supportive learning environment in computer supported collaborative problem solving.

Wiegmann et al. (1992) conducted three experiments that examined the effects of spatial configuration, map format, and link structure. Concept Maps 77 In the first experiment, two maps were constructed that were isomorphic with respect to content. One map was designed according to the gestalt principles of symmetry, proximity, and good continuation that account for how people recognize patterns. Objects that are similar (similarity), are grouped closely together (proximity), or show continuity are more easily recognized. In the web version of the same content, these principles were not used. Students who used the gestalt map outperformed those in the web map group. Three presentation formats were contrasted: text, enhanced map, and unenhanced map. The enhanced map was designed to emphasize the principle of similarity (by using shape and color) and proximity (by using spatial grouping). Labels for links were not used in this particular experiment. Results showed a strong effect for the enhanced map,
thus supporting the results of Wiegmann et al. who recommend that maps be designed according to gestalt principles. In a second experiment, researcher compared students who learned from a single whole map with students who studied the same content presented as a series of stacked maps. In the stacked maps version, the content from the whole map was presented as a series of maps with a map overview of the content. Performance on the content presented in these maps depended on the student’s level of field independence. Field dependent students did better on measures of recall when they studied from the whole map whereas field independent students benefited from the stacked maps. In a third experiment, Wiegmann et al examined the effects of variations in the representation of relationships (plain or embellished links) on the performance of students. In this experiment, participants studied from stacked knowledge maps that were designed using gestalt principles. The maps differed in the representation of the link structure. Links were either embellished or presented with arrowheads, labels, and configurational information (i.e., barbed vs. solid lines) or they were presented as unembellished straight lines. Students with low verbal ability did better when their maps had plain lines whereas those students with high verbal ability performed better when their maps were embellished. Wiegmann et al. interpreted these results as suggesting that the availability of embellished links emphasizes semantic processing, an emphasis that would create problems for those with low verbal ability.

**Dei S.L (1991)** studied the issues of interrelationship among non-verbal measures of cognition and sex difference in performance on these measures. Wechsler’s digit span test, raven’s progressive matrices and non-language task was given to boys and girls of V class boys. The findings revealed no significance difference between boys and girls on the non-verbal cognitive measures. On the other hand the interrelationship between the three measures was found to be positive and significant.

**Gupta, 1991** conducted a study on deprivation in relation to certain cognitive and non-cognitive variable among adolescents. The findings of the
study revealed that the students from non-deprived environment were found
to be introvert The non deprived students were more intelligent, more
creative and more high achieving than deprived students whereas deprived
students were depressive .No significant difference was found between the
two on their cognitive correlates.

Mishra (1991) analyzed the developmental changes in decoding
competence and speech related cognitive processes, using samples of good
and poor readers from class1 and class III children ,decoding serial word
recall naming time speech rate and sequence repetition of good and poor
readers were analysed. The findings revealed significant differences in the
performance of good and poor decoders in naming time speech rate and
sequence repetition, but not in several word recalls. There was also evidence
for performance in decoding as well as speech related processes to improve
as function of the age and grade level of the children.

Raghavan (1991) conducted a research on effectiveness of concept
mapping in Physical Science with respect to scholastic performance,
cognitive ability, attitude towards concept mapping and science interest.
Though he found the strategy effective in terms of performance, and
cognitive ability but no significant relation came out between science
interest and attitude towards concept mapping.

Sahni (1991) conducted a research on Cognitive and non-Cognitive
factors leading to success in computer science students of Delhi. He found
cognitive factors more pronounced in comparison to non-cognitive factors
for achievement.

Shukla (1991) studied development of cognitive style and locus of
control as a function of child rearing practices. The findings revealed that
the relationship among child rearing practices, family structures, SES locale
were found to be positive and highly significant. There was virtually no
relationship between cognitive and locus of control. Students from nuclear
family and with low –SES group scored significantly higher than those from
joint families and the high SES group on the EFT. On the locus of control
measure there was no significant difference between children from nuclear and joint families, whereas differences according to locale and SES appeared to be significant.

Gurley (1982) conducted a research on use of Gowin’s vee and concept mapping strategies to teach responsibility for learning in high school biological sciences. He found it very effective for developing such qualities.

CONCLUSION

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 retention in learning though some studies have been done to check effectiveness of concept mapping as a learning strategy. More over to develop a strategy for teaching concept mapping it is equally important to first explore the processes that contribute to effective mapping. While several studies have already demonstrated the potential of concept mapping strategy as an instructional tool, it is yet to be explored in terms of mapping styles and processes involved in it. Therefore, 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.