CHAPTER 2

REVIEW OF RELATED LITERATURE & RESEARCHES

2.1 Introduction

2.2 Learning

2.2.1 Historical Development in the Study of Learning

2.2.2 Human Learning

2.2.3 Information Processing Model of Human Learning

2.3 Cognitive Theories of Learning

2.3.1 Piaget’s Theory of cognitive Development

2.3.2 Bruner’s Theory of Instruction

2.3.3 Ausubel’s Theory of meaningful Learning

2.3.4 Components of Meaningful Learning

2.3.5 The Continuum of Rote Learning to Meaningful Learning

2.4 Bloom’s taxonomy

2.4.1 Revised Bloom’s taxonomy

2.4.2 Use of Bloom’s taxonomy

2.5 Learning/ Pedagogical strategy

2.5.1 Learning/Pedagogical Strategy & Meaning Construction

2.5.2 Learning/Pedagogical Strategy assisting in Meaning construction

2.6 Graphic Organizers

2.6.1 Use of Graphic Organizers

2.6.2 Types of Graphic Organizers

2.6.2.1 Web Organizer
2.6.2.2   Star Burst
2.6.2.3   Gathering Grid
2.6.2.4   Venn Diagram
2.6.2.5   Sequence Chart
2.6.2.6   Summarizing (5+1 News paper Organizer)
2.6.2.7   Fish Bone Map
2.6.2.8   Spider Map
2.6.2.9   Mind Map
2.6.2.10  Difference between Mind map and Concept Map

2.7 Concept Map: Theory Base
2.7.1   Theoretical Frame Work of Concept Map
2.7.2   Epistemological Foundations of Concept Map
2.7.3   Characteristics of Concept Map
2.7.4   Strategies for introducing Concept Map in Standard Three to Seven.
2.7.5   Steps used in Construction of Concept Map for the Present Study
2.7.6   Uses of Concept Maps

2.8 Review of Researches in Foreign Countries
2.8.1   Concept mapping in Science Subjects
    2.8.1.1 Novak, Gowin & Johansen – 1983
    2.8.1.2 Okebokola & Jegede -1988
    2.8.1.3 Pankratius -1990
    2.8.1.4 Heinz – Fry & Novak -1990
    2.8.1.5 Stensvold & Wilson -1990
2.8.1.6 Willerman & Mac Harg -1991
2.8.1.7 Okebukola -1992
2.8.1.8 Horton & McConney, Gallo, Woods, Senn, Hametin – 1993
2.8.1.9 Roth – 1994
2.8.1.10 Odum & Kelly – 2001
2.8.1.11 Valadares J, Fonseca F & e Soares M.T – 2004
2.8.1.12 Berionni & Baldon -2006
2.8.1.13 Trifone J.D -2006

2.8.2 Concept mapping in Mathematics
2.8.2.1 Afamasaga –Fuata’I – 2006
2.8.2.2 Caldwell et al – 2006

2.8.3 Concept mapping in other Subjects
2.8.3.1 Vakilfard & Armand- 2006

2.9 Review of Researches in India
2.9.1 Concept Mapping in Science Subjects
2.9.1.1 Andal – 1991
2.9.1.2 Rao -2004

2.9.2 Concept Mapping in Other Subjects
2.9.2.1 Gopal -2004

2.10 Implication of the Review of Literature and Researches for the Present Study

2.11 Conclusion
CHAPTER 2

REVIEW OF RELATED LITERATURE & RESEARCH

2.1 Introduction

The problem identified and discussed in chapter one, can only be studied in detail on the foundation of the existing knowledge in the literature. A research becomes strong when it is based upon the previous researches, and established works in that particular area. Number of discussions, experiments and papers are present in the literature regarding the problem selected for the study. A perusal of the literature was done by the researcher for in depth knowledge of the problem.

A scrutiny of the literature would help the researcher to appraise herself to the importance of the problem and how it was studied earlier. It also helps the researcher to examine and decide the scope of the problem and formulate focus questions, objectives and hypotheses. The examination of the literature would bolster the knowledge of the researcher in the fields of methodology used earlier and that would become a guiding beacon for selecting appropriate design and statistical measures.

Concept mapping is a pedagogical tool to enhance meaningful learning; hence in the first half of the chapter, definitions, historical development of learning, Models, theories, and taxonomies related to learning are mentioned from the literature. Then the discussion in the chapter moves to the theoretical and epistemological foundations of concept map, followed by the characteristics of Concept map, activities to introduce Concept maps, and steps to construct a Concept map.
2.2 Learning

The most important aspect of child development is learning. Attempts are made from earlier times to understand and find the various factors affecting learning. Many psychologist tried to define the term Learning.

Mussen, Conger, Kagan (1969) has defined learning as “the process by which behavior, or the potentiality for behavior, is modified as a result of experience. It is the establishment of new relationship - bonds of connection - between units that were not previously associated”.

Eason (1964) defined learning as “those changes in behavior that are determined primarily by the individual’s interaction with his environment.”

Whittaker (1965) defined learning as “the process by which behavior originates or is altered through experience”.

Seifert (1991) says “learning is any relatively permanent change in behavior, thinking, skill, or emotion that results from some relatively specific experience.”

Mohan (2002) says “true learning is not merely acquisition of certain traits or skills; it is a change in behavior brought about by training or experiences.

All the definitions have mentioned that learning is a change in behavior due to the experience received from the environment. The change in behavior and thinking takes place through small steps to reach a complete whole and one minute false step can impair learning.

2.2.1 Historical Development in the Study of Learning.

Whittaker (1965) traces the development in the study of learning from the earlier times, he mentions, it can be divided into three approaches:

A) Associationism – A pre – scientific approach
It was Aristotle who first tried to study the problem of how we learn. He tried to explain the idea of associationism and thus he found the primary laws of association – contiguity, similarity, and contrast.

B) Ebbinghaus – The experimental approach

In the late 19th century the scientific study of how we learn was done by Ebbinghaus. He found the relationship of learning and retention and the effects of various conditions on them. He was the first one to study higher mental processes using scientific method. His conclusions have stood the test of time and are included in the general body of knowledge in the areas of learning.

C) Thorndike – Theoretical interpretation of learning

Thorndike conducted most of his research on animal learning. From his study he has concluded that acts that lead to satisfactory state of affairs are learned while acts leading to unsatisfactory state are eliminated. He also suggests learning always involves trial and error whereby there is gradual elimination of certain responses and gradual acquisition of others. He takes the position of stimulus – response (S-R). Some theorists maintain that these connections are affected by their consequences.

2.2.2 Human Learning

In the every day life the term “learning” refers to how we acquire information about certain subjects. Hence human learning is complicated and number of variables affects this process. According to Kingsley and Garry (cited by Whittaker, 1965) the variables affecting human learning are:
1) The learner – The maturational level, age, sex, previous experience, intelligence, aptitudes, physical state, motivation, and emotional characteristics of the learner needs to be taken into consideration.

2) Nature of the task – The length of the material to be learned, difficulty of the material affects human learning.

3) Method of learning – Amount of practice and its distribution, the degree of learning, knowledge of results, and active versus passive participation of the learner are also factors affecting learning.

Meyer (1987) has arranged the factors in the instruction/learning process slightly different. He has suggested the factors as:-

1) The learner: who comes to the learning situation with existing store house of knowledge, skills, other characteristics

2) The teacher: who comes to the learning situation with teachers knowledge, strategies

3) Curriculum: Subject matter to be acquired by the learner.

Many theories are formed regarding the process of learning. Information Processing view of human learning (Cognitive theorists) says an individual’s behavior is guided by the thought processes and understanding of the prevailing situations. Piaget a leading cognitive theorists suggested people learn by the process of organization and adaptation. At each age an individual develop (general ways of thinking about ideas and objects) schemas. When a person becomes aware of a new stimuli or experience that do not fit into the existing schema, a new schema is created and cognitive growth occurs. The information processing model suggests the output of the human mind depends not only on the input but also on the capacity of the brain
to store, organize and retrieve what it has received and Meta memory (understanding and use of various memory techniques) (Berger1986).

2.2.3 Information Processing Model of Human Learning.

Information Processing Model of human learning is a cognitive theory model and the proponents of the cognitive theories are Piaget, Bruner and Ausubel. According to Dandekar & Makhija (2002), the information Processing model makes three important assumptions about learning. They are -

a. Information is processed in different stages like attending the stimulus, its recognition, its transformation, comparison, making it meaningful and finally the response to it.

b. There are limits to the amount of information processed at every stage.

c. The human information processing system is interactive. The previous stored information and the new learning influence each other.
The important terms of the model are as follows (Seifert 1991, p.166):

- **Sensory register**: the feature of thinking that receives information from the senses and that holds it for a fraction of a second to allow for further processing.
- **Short term memory**: the feature of thinking that provides a temporary working space for information processing; also called working memory.
- **Long term memory**: the feature of thinking that contains the permanent store of ideas and knowledge in a meaningful form.
- **Rehearsal**: repeating ideas or images in short term memory in order to keep them active for possible further proceedings.
- **Elaborative rehearsal**: rehearsal that, in addition to repeating ideas or images, relates them to pre-existing knowledge from long term memory.
- **Chunking**: grouping or linking ideas or information to facilitate memory and retrieval.

The model shows the memory capacity has three levels of storage:

i) Sensory register - where the information is held less than a second

ii) Short term memory – from the sensory register the information is processed into the STM and it remains for a minute

iii) Long term memory - the information stays for months and years and it is learned in the continuum of rote or meaningful method.
Apart from memory capacity of the cognitive model the theorist mentions a second aspect for learning known as Meta memory (Berger, 1986).

B) Meta memory – Involves understanding and use of various memory techniques that can be used to keep things in mind. These are techniques like mnemonics, rehearsal, chunking. Concept mapping and Vee heuristics are also such devices helping in Meta learning. (Novak & Gowin, 1984)

Berger (1986) has mentioned that adult and older children remember better than younger children because of their respective metamemories. By middle childhood, most children are ready to learn almost any concrete skill or concept including learning how to learn through Meta memory techniques. Hence the sample the researcher has selected is standard seven. They should be taught different techniques which will enhance them to remember.

2.3 Cognitive Theories of Learning

Cognitive theories explain learning with an emphasis on relationship between an individual’s actions and his / her thoughts, prior knowledge, and intellectual skills. The proponents of cognitive theory are Piaget, Bruner, Ausubel (Seifert, 1991)

2.3.1 Piaget Theory of Cognitive Development.

Piaget says human beings are born with the tendency of organization, which results in systematic patterns of thinking known as schemas. Human beings also are capable of adaptation. Adaptation is the developmental changes in thinking by which people adjust to their environment. In cognitive development adaptation can occur either by assimilation or accommodation. Assimilation is interpretation or understanding of experiences according to existing schemas. Accommodation is the
modification of schemas to fit new experiences. He says the mechanism of cognitive
development takes place by a combination of four different processes, such as
experience (encounters with environment), social transmission (knowledge conveyed
through members of society), maturation (changes from growth and heredity), and
equilibration (tendency towards stability in thinking).

2.3.2 Bruner’s Theory of Instruction

He views classroom as place were acquisition, transformation of knowledge in
meaningful forms and testing of adequacy of knowledge takes place. He suggests
three ways of learning:

- Enactive learning. - it refers to learning by manipulating objects.
- Iconic learning - it is learning by visualizing objects and events.
- Symbolic learning - it is abstract representation of knowledge usually through
  language. (Seifert ,1991)

2.3.3 Ausubel’s Theory of Meaningful Learning

According to Joyce & Weil (2007) Ausubel’s theory of meaningful learning
addresses three concerns: 1) How knowledge is organized 2) How the mind works 3)
How teachers can apply these ideas in instruction. Ausubel’s theory is known as “A
subsumption Theory of Meaningful Learning and Retention” the theory states that:

“Before we can present new material effectively, we
must increase the stability and clarity of our
student's cognitive structures.”
“The sequence of the curriculum is organized so
that successive learning is carefully related to what
has been learned before.”
“Advance organizers are introductory material
presented ahead of the learning task and at a higher
level of abstraction and inclusiveness than the
learning task itself”. (Open content wiki, 2007).
Ausubel summarized his view in one principle: “the most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly”. (Biehler & Snowman, 1990). Ausubel’s theory of learning has become one of the cornerstones on which Novak built his theory of meaningful learning.

2.3.4 Components of Meaningful Learning.

According to Novak (1998) the three requirements for meaningful learning are:

- Relevant prior knowledge - the learner must have some information that will relate to the new knowledge.
- Meaningful material – the information to be learned must be significant and must contain important concepts and propositions.
- The learner must choose to learn meaningfully.

He takes the position that meanings are derived from our cognitive frameworks, our actions and our emotions. The cognitive frameworks are formed of concepts combined to form propositions related to our experiences. The meanings we hold are a product of our idiosyncratic sequence of experiences and hence vary, at least to some degree, between all people.

Novak represented learning in its three domains and in the concept map he demonstrated the interaction between them to produce meaningful learning. He has demonstrated that learning in the cognitive domain is acquisition of concepts and propositions, learning in affective domain are stored feeling which are translated to stored meanings and learning in psychomotor is skill learning. All the three learning’s are in the cognitive structure developed by meaningful learning.
Figure: 2.2 Learning through the Three Domains (Novak 1998)
2.3.5 The Continuum of Rote Learning to Meaningful learning.

Ausubel has suggested meaningful learning occurs when new learning is related to the existing knowledge of the learner. Novak (1998) mentions that “the neural cells or cell assemblies active in storage during meaningful learning are undergoing further modifications and are probably forming synapses (neural junctions) or some functional associations with new neurons…. with continued learning, nature and extent of neural associations also increase”. He is of the view that, in a school set up children learns often by rote and it may not be assimilated into the existing knowledge framework hence it is lost from the memory very fast. But meaningful learning requires time and effort and such learning exist for life time. In the class room there is more of expository (explanatory) learning though there is guided discovery instruction. In the continuum of expository teaching concept mapping takes a position very close to meaningful learning. (Novak & Gowin 1984, Novak 1998)

Figure 2.3 The Rote - Meaningful Learning Continuum (Novak & Gowin 1984)

ROTE LEARNING MEANINGFUL LEARNING
-------------------------------------------------------------------------------
EXPOSITORY MULTIPLICATION LECTURES CONCEPT MAPPING
TEACHING TABLES TEXT BOOK VEE DIAGRAMING
PRESENTATION

. Meaningful learning is opposed to Rote learning they are the two extremes of a continuum. Rote learning is, which is not related to experiences, it is verbatim, non affective and do not integrate new knowledge with the prior learning. On the other hand meaningful learning is non verbatim and has affective links with the prior learning. According to Novak (1998) meaningful learning requires meaningful
material selected by the “teacher” and it should be based on learner’s relevant prior knowledge stored in the net works of neurons, also the learner should choose to use meaningful learning which will produce constructive changes in the net works of neurons thus producing long term retention of the material.

Learning in any form is linked to cognition or thinking. It was Benjamin Bloom who took the initiative to classify the levels of thinking into instructional objectives. He grouped them into different domains and taxonomies.

2.4 Bloom’s Taxonomy

Discussions of the 1948 convention of the American psychological Association led Benjamin Bloom and his associates to classify the educational goals and objectives. The purpose was to qualitatively express different kinds of thinking behaviors. In 1956 the Bloom’s taxonomy of educational objectives were published. It is a model of classifying thinking according to six cognitive levels of complexity. It is compared to a stairway the lowest three levels are knowledge, comprehension, application and highest three levels are analysis, synthesis and evaluation. As we go to higher levels the lower levels become inclusive in the higher levels (Forehand, 2005).

2.4.1 Revised Bloom’s Taxonomy

In 1990 Lorin Anderson a former student of Benjamin Bloom led a group of experts in various fields for updating the Bloom’s taxonomy to make it more relevant for 21st century. Changes have occurred in terminology, structure, and emphasis (Pohl, 2000; Forehand, 2005)
In the old version the levels mentioned are knowledge, comprehension, application, analysis, synthesis and evaluation. In the new version the levels mentioned are remembering, which is an elaboration of knowledge, understanding, applying, evaluating and creating. Synthesis mentioned in the original taxonomy has become creating and the highest level in the new version.

The original taxonomy is one-dimensional and the revised taxonomy is two dimensional – a) Knowledge dimension (the kind of knowledge to be learned) b) Cognitive Process dimension (the process used to learn).
The terms have changed from nouns to verbs the structure has changed from one-dimensional to two-dimensional. The two dimensional nature was developed by Diana Fisher (cited by Forehand, 2005)

2.4.2 Use of Bloom’s Taxonomy.

Bloom’s taxonomy is a multi tiered model of classifying thinking according to six cognitive levels of complexity. Mohan (2002) has pointed the following purposes for the taxonomy:

a) To establish the accuracy of communication regarding the objectives of education.

b) To establish a common understanding about the hierarchical classification of objectives

c) To help educators to plan and to evaluate learning experiences.

d) To compare existing curriculum goals with a wide range of possible outcomes.

e) To bring uniformity in evaluation.

f) To help in clearly defining and meaningfully evaluating the educational standards of a school.

It is widely accepted that any lesson planning has to be based on the instructional objectives mentioned in the Bloom’s Taxonomy. This will help to set specific instructional goals and objectives to reach during teaching. The taxonomy will help the teacher to specify the teaching task so as to reach a specific instructional goal which in turn gives a desired behavioral change. Behavioral change is learning.
2.5 Learning / Pedagogical Strategy

Strategies are techniques used by the learner to acquire knowledge in the cognitive domains. When a strategy is used by the teacher for teaching a particular subject matter it is often called as pedagogical strategy. The following subsections deals with the learning / pedagogical strategies

2.5.1 Learning/Pedagogical Strategy & Meaning Construction

Meaningful learning requires pertinent prior knowledge “in quantity and quality” (Novak, 1998), which leads to higher levels of cognitive processes such as creativity and problem solving skills. He further elaborates that it becomes difficult and time consuming when the learner has poor prior knowledge or when it is loosely organized. Then the tendency is to switch on to rote learning.

The check posts for meaningful engaged learning were indicated by Valdez, Nowakowski & Rasmussen (1994). They are:

- **Vision of engaged learning** - in this situation the learners are energized and takes charge of their learning and are able to define their own learning goals, and evaluate their own achievement.
- **Tasks of engaged learning** – the tasks needs to be connected to their experience and challenging
- **Assessment of engaged learning** –should be performance based but equitable standards that apply to all students.
- **Instructional models and strategies for engaged learning** – the most powerful models and strategies are interactive and that which engages the learner to construct and produce knowledge in meaningful ways.
- **Learning context for engaged learning** – the classroom should be considered a knowledge building community where they interact and share understandings and have an empathetic environment.

- **Grouping for engaged learning** - classroom should be grouped into twos or more to help them to share and understand and create meaning of the knowledge domain.

- **Teachers role in engaged learning** – the teacher changes role from a informant to a guide, facilitator and guide.

- **Student’s role in engaged learning** – student takes the role of explorer and then reflects and assimilates his findings.

Valdez, Nowakowski & Rasmussen (1994) have mentioned that one of the indicators for meaningful learning is using instructional model and strategies for meaningful engaged learning.

“A learning strategy refers to any activity by a learner that is employed during learning in order to enhance learning” (Meyer1987). According to Kumar (2006) learning strategies are methods or technique individuals use to improve their comprehension, learning, retention and retrieval of information. Husen and Postlthwate (cited by Kumar 2006) have defined learning strategies as mental procedures that assist learning and may also include overt activities. Learning strategy is used by the individual for learning information or mastering a skill. When a learning strategy is used by the teacher it is known as teaching strategy or pedagogical tool. These tools are used by the teachers as vehicles to carry the information or knowledge to the learner in a suitable manner which will help the learner to construct meanings. There are number of learning strategies which are grouped together as pedagogical tools. The age old strategies are lecture method, discussion method,
laboratory method etc. In recent times the numbers of pedagogical tools are increasing and some of the tools enhance the traditional method of teaching such as lecture method.

2.5.2 Learning/ Pedagogical Strategy assisting in Meaning Construction

In a class room situation teaching resulting in meaningful learning produce a climate which is active, alive, exciting and open to fresh original thinking. Then the classroom turns into a discussion oriented critical, learning situation. Meaningful learning can take place in expository teaching (presenting what is to be learned to the learner in a more or less final form) situations as well as in guided discovery or autonomous learning situations. Normally a classroom will have more of expository or reception learning. Lectures and text book presentations are expository in nature.

There are various methods which enhances the lectures. One of the methods suggested to strengthen lectures is Concept mapping (Novak 1984; 1998; Willerman& Mac Harg 1991; Vakilfard & Armand 2006; Borich 2003 cited by Alder & McKelvey 2007). Further Alder and McKelvey suggests that a marginal student, listening to lecture may not be able to retain the information more than the short term, it needs to be linked with the existing schema or as Piaget says it has to be learnt by organization and assimilation for long term retention.

According to Berger (1986) children and adult learn new material when they can link it to some schema or cognitive framework. At each level of the growth, people develop schemas( general ways of thinking about ideas and objects), when a person becomes aware of perceptions or experiences that do not fit an existing schema, a new schema is created, thus cognitive growth takes place. Further Berger cites Resnick (1983), who has pointed “if children are not helped to relate new
information to their existing knowledge, they will create their own, often misleading, relationship between facts.” P.396. To relate existing knowledge base, teachers should begin from prior relevant knowledge. Not only that the teacher should use pedagogical tools which enhance the relationships of the present material with the prior knowledge and also they should be effective in challenging their thinking process. Trowbridge & Wandersee (2003) suggests “to navigate in the cognitive space” everyone requires a map, which can be knowledge gathering as well as knowledge assimilating so as to help oneself position in a vantage point in the realm of knowledge advancement. For this purpose Graphic Organizer performs a great deal of assistance.

In the group of “non linguistic representations” Graphic Organizers stand out as one of the effective achievement producing tools (Bellanca 2007). Concept maps come as one of the graphic organizers which can be used for linking prior knowledge and for finding relationships with new knowledge.

2.6 Graphic Organizers

Graphic organizers are tools which can be used in any learning situations across curriculum to arrange ideas. It can be defined as “visual tools that employ lines, circles and boxes to depict four common ways to organize information: hierarchic, cause/effect, compare/contrast, cyclic or linear sequences” (Ellis & Howard, 2007). It gives visual cues that facilitate understanding, supplies information and develops students’ habits of thinking.
2.6.1 Use of Graphic Organizers

There are many uses for graphic organizers the most prominent are: (IARE 2003, Ellis 2004, Bellanca, 2007).

- Information is gathered from one or more sources including the prior knowledge and is given in a precise understanding manner. It helps in vocabulary scores (literacy development).
- Graphic organizers help information to be structured with hierarchies thus helping in thinking and learning skills (IARE, 2003). According to Ellis (2004) higher thinking operations becomes enhanced and they tend to become “strategic learners”.
- Alvermann & Boothby (1983, 1986); Armbruster et al (1991); Griffin et al (1995); Braselton & Decker (1994) cited by IARE (2003) noted that graphic organizers helps students in classroom work such as comprehension, organizing the data, recall, retentions, and problem solving skills Thus it improves the connections between facts opinions or concepts

Though there are numerous uses, the effectiveness of Graphic organizers depends on teachers’ knowledge of the subject matter and the skills of using Graphic organizers (Ellis, 2004).

2.6.2 Types of Graphic Organizers

The graphic organizers are numerous and still the number is growing. The purpose of graphic organizers vary, some will help in information gathering, some help in making sense of the information gathered, and some helps to come to a conclusion of the problem analyzed. A wide variety of graphic organizers are
available in the World Wide Web. Some of the graphic organizers present in the literature are given below:

### 2.6.2.1 Web Organizer

It is used for gathering knowledge from prior knowledge or from print or any other sources. This is an easy task and helps the students to identify the different parts of the whole unit. It is a descriptive map and the thinking process involved is generating facts. This graphic organizer was developed by Robert Hawley (Bellanca, 2007).

**Fig: 2.6. Web Organizer**

A *web Organizer* can be used to list down facts or information from any sources. It can be also used for reviewing the learned material.

### 2.6.2.2 Star Burst

Star Burst is for gathering information either from print or from prior knowledge or else where. In Star Burst and Web Organizer the key idea is given by
the teacher at the center and students can fill in the sub concepts. This can be done in groups of two or more. Both are very good tool for brain storming session. This was developed by Robin Fogarty (Bellanca 2007).

**Fig: 2.7 Star Burst (Bellanca, 2007)**

2.6.2.3 Gathering Grid

Gathering Grid was developed by Bellanca (2007) which can be used for gathering information based on the criteria teacher / student has already determined. The Grid is placed at the center column and either side the related concepts are placed. It is like a compare contrast table. This graphic organizer will initiate the
learner to analyze and think before coming to a conclusion to the facts to be put in the gathering grid.

**Fig: 2.8 Gathering Grid**

<table>
<thead>
<tr>
<th></th>
<th>Annuals</th>
<th>Biennials</th>
<th>Plants</th>
<th>perennials</th>
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<td>Duration</td>
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<td>Nature - stem</td>
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<tr>
<td>appearance</td>
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<td></td>
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<td>Example</td>
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</tbody>
</table>

**2.6.2.4 Venn Diagram.**

Venn diagram was created by mathematician Thomas venn (Bellanca 2007). It can be used for comparing and contrasting similarities and differences between events, things, or concepts. It helps the learner to analyze, assort and place accordingly thus helping in higher levels of thinking (Bellanca, 2007, Ellis & Howard, 2007).

**Fig: 2.9 Venn Diagram (Bellanca 2007)**
Along with the Gird, the Venn diagram helps in analyzing the similarities and differences. In the Venn diagram the common area for the two circles will carry similarities of the two circles and the non overlapping area carry dissimilarities.

2.6.2.5 Sequence Chart

This graphic organizer is also developed by Bellanca (2007), used for gathering information but in a sequential manner, hence the student understands that the event occurs in an orderly sequence. Sequence Chart can be used in variety of subjects which have events occurring in a sequence. It can be effectively used to explain cell division in biology, chemical reactions in chemistry, events of culminating into a war in history etc. A sequence chart can be used across curriculum wherever events are occurring in a step wise manner. It can be used to generate information from prior knowledge, from print or during classroom discussion. It can also be used to assess the information learned. A fill in sequence chart also can be used according to the situations. An example is as follows.

![Sequence Chart Example](image)
2.6.2.6 Summarizing (5+1 News paper Organizer).

Students get information from varied sources such as television channels like National Geographic, magazines and newspapers. In fact at present many schools have a class period called News paper in Education (NIE) where the students are expected to read and summarize various articles of importance, may be for Environmental Science, or History, Geography, Science etc. This graphic organizer will contain the main topic and the sub titles in the form of various question verbs which will guide the students’ thoughts and focus on the reading of the article or viewing a particular issue. This graphic organizer is challenging and helps the students to carefully analyze the articles. An example is given below. (Bellanaca 2007)

Fig: 2.11  
5+1 News paper organizer (Bellanaca, 2007)

<table>
<thead>
<tr>
<th>Who</th>
<th>What</th>
<th>Where</th>
<th>When</th>
<th>How</th>
<th>Why</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgeons, Urologists, Cardiologists</td>
<td>myomectomies, cervical cancers, hysterectomies, pyeloplasties, kidney procedures, spleen removal, mitral valve repairs</td>
<td>major hospitals</td>
<td>in near future</td>
<td>using robots</td>
<td>very delicate touch, tight spaces, hard-to-reach places</td>
</tr>
</tbody>
</table>

Summary:
In the near future, medical specialists will use robots to help with operations that need a very delicate touch or are in hard-to-reach places of the patient’s body. Cervical cancers, spleen removals, kidney procedures, and mitral valve repairs show the range of operations that could use the robots. Right now, they are too expensive. (Based on article “New Surgical Breakthroughs Using Robots,” U.S News and World Report. July 31, 2006.)
2.6.2.7 Fish Bone Map.

Fish bone map was developed by Kaoru Ishikawa in 1940 for use in total quality management (Bellanca 2007)

Fig: 2.12 Fishbone map (Hall & Strangman 2002 Bellanca 2007, NCREL, 1988)

The fish bone map is a graphic organizer which can be used to analyze the cause effect relationship. This map helps the student to make sense of the problem and find the relationship between the causes and the outcomes (Hall & Strangman 2002). It is a challenging task. It can be used to generate a lot of discussion and articulating the various causes for an event. Habits of thinking can be enhanced to higher order thinking when judiciously used in the class.

2.6.2.8 Spider Map

The spider map helps to find the relationship between different concepts. The concepts can be split in sub concepts. Thus various types of cell reproduction can be depicted in the spider map. Many other topics which have relationship can be effectively constructed using the spider map. When the concepts do not show any hierarchy spider map can be used.
2.6.2.9 Mind map

Tony Buzan developed mind mapping in the 1970’s. The free Encyclopedia – Wikipedia has defined mind map as “a diagram used to represent words, ideas, tasks, or other items linked to and arranged radially around a central key word or idea. It is used to generate, visualize, structure, and classify ideas, and as an aid in study, organization, problem solving, decision making, and writing.” Buzan 1989 (cited by Weidmann and Kritzinger 2003) suggests mind maps have a central concept from which a “main word” is selected, from which 5 to 10 main ideas (child’s words) are selected and placed around the main word and again 5 to 10 child words can be arranged around each word, thus creating a network of concepts around the main word.
The guide lines suggested by Tony Buzan in his book *Mind Map Book* (1991) are as follows: (Wikipedia, 2008)

1. Start in the center with an image of the topic, using at least 3 colors.
2. *Use images, symbols, codes, and dimensions throughout your Mind Map.*
3. Select key words and print using upper or lower case letters.
4. Each word/image must be alone and sitting on its own line.
5. *The lines must be connected, starting from the central image.* The central lines are thicker, organic and flowing, becoming thinner as they radiate out from the centre.
6. Make the lines the same length as the word/image.
8. Develop your own personal style of Mind Mapping.
9. *Use emphasis and show associations in your Mind Map.*
2.6.2.10 Difference between Mind Map and Concept Map

Concept maps define the relationship between the concepts. It represents “meaningful relationships between concepts in the form of propositions” (Novak & Gowin 1984) Novak explains “propositions as two or more concept labels linked by words in a semantic unit” In concept maps the concepts are seen in boxes or bubbles and there is a link line with connecting verb. The concept maps shows hierarchy with the most inclusive concept at the top and the subtopic come down the line which can have cross links. Whereas mind maps, have only one central idea at the center and with the key words all around the central concept. It has a “tree structure” (Wikipedia 2008) There are no linking words and concepts are not in bubbles or boxes.

2.7 Concept Map: Theory Base

The cognitive theories such as Piaget, Ausubel have undoubtedly affected in the formulation of Concept Map. The theoretical framework and epistemological foundations are discussed in the following subtitles.

2.7.1 Theoretical Framework of Concept Map

Cognitive, affective and psychomotor are the distinct domains of learning which do not occur in isolation but work together to make one whole The cognitive domain includes those aspects of thinking, knowing and problem solving. (Mohan 2002) In constructivist view, these tasks occur as a “process of personal cognitive construction, or invention, undertaken by the individual who is trying, for whatever purpose, to make sense of her social or natural environment” (Taylor 1993, cited by Duit 2007)
According to Novak & Canas 2006 “concepts are the building blocks of knowledge in all fields” and this can trigger in individuals either for “static thinking (surface or rote thinking) or dynamic thinking (deep or meaningful thinking)”. Novak (1998) says by the age of 30 months a child recognizes the concept labels by concept formation and meaning building is concept assimilation that is never finished in a life time.

A science educator should remember transferring knowledge does not lead to understanding unless the knowledge is tied, or embedded into the missing spaces of the existing schemas thus leading to “self organization and reorganization” (Yager 1991). He reminds the science educator “knowledge is not transferred by means of words without first an agreement of meaning and some experiential base.

In the classroom setting when the teacher and the student negotiates and constructs meaning for a body of knowledge, knowledge acquisition do not occur as the transfer of “ nuggets of truth” (Kelly 1955 as cited by Duit 2007) but the learner becomes an active participant in the construction of knowledge, thus meaningful learning occurs.

Graphic organizers are visually powerful learning tools (strategy) to construct meaning and thus help in meaningful learning. Concept maps are graphic organizers constructed by J.D. Novak of Cornell University (USA) in 1972 while trying to make sense of the children’s domain of knowledge before and after instruction. The method has turned out to be effective for teachers for organizing the knowledge before and during instruction and for the students to find meaning with the concepts learned in any knowledge domain.

Novak (2006) defines “Concept maps are graphical tools for organizing and representing knowledge. They include concepts, usually enclosed in circles or boxes
of some type, and relationships between concepts indicated by a connecting line linking two concepts. Words on the line referred to as linking words or linking phrases, specify the relationship between the two concepts.” Concept maps are “visual road maps” to show pathways in a specific knowledge domain. Some of the terms connected with concept maps are explained by Novak, they are as follows:

- **Concept:** are perceived regularity in events or objects, or records or events or objects designated by a label. The label for most concept is a word or more than one word sometimes symbols such as + or % are used.

- **Propositions:** are statements about some object or event in the universe, either naturally occurring or constructed. Propositions contain two or more concepts connected using linking words or phrases to form a meaningful statement. Sometimes these are called semantic units, or units of meaning.

### 2.7.2 Epistemological Foundations of Concept Map

Concept map is founded on Ausubel’s learning theory which keeps focuses on the influence of student’s prior knowledge on subsequent meaningful learning. In 1968 Ausubel pronounced the famous dictum “The most important single factor influencing learning is what the learner already knows. Ascertain this and teach him accordingly” (Duit 2007 Novak 1984 , 1997) Curriculum guide (N.D) echoes Ausubel’s thoughts as , “Meaningful learning results when a person consciously and explicitly ties new knowledge to relevant concepts they already possess”. Meaningful learning is the central idea of Ausubel’s learning theory Ausubel suggests that when meaningful learning occurs, it produces a series of changes within our entire cognitive
structure, modifying existing concepts and forming new linkages between concepts. This is why meaningful learning is lasting and powerful whereas rote learning is easily forgotten and not easily applied in new learning or problem solving situations which the present science curricula so advocate (Curriculum guide, CDC N.D). Canas and Novak (2006) briefly summarized the epistemological ideas considered in the construction of concept maps as follows:

- The universe consists of objects and events and energy exchanges during events.
- Concepts are constructed by humans and are perceived regularities or patterns in events of objects or records of events or objects, designated by a label usually a word.
- Two or more concepts can be linked with appropriate words to form a meaningful statement or proposition.
- Concepts and propositions are the building blocks of knowledge in all fields.
- The key learning principles that were considered, based on Ausubel’s (1963; 1968) cognitive psychology were:
  - Meaningful learning (as contrasted with rote learning) is necessary for development of conceptual understanding. Meaningful learning is sometimes characterized as deep or dynamic learning, (in contrast with surface or static learning).
  - New learning must build on relevant prior concepts and propositions held by the learner.
  - The learner must be encouraged to choose to learn meaningfully.
  - Appropriate concrete props are needed to learn abstract concepts, together with appropriate didactic instruction.
• Learning is highly idiosyncratic and progresses over time.

• High quality meaningful learning leads to construction of well integrated concept and propositional structures (i.e. cognitive structures) that better facilitate new learning and creative problem solving.

Given these foundational ideas, Novak’s groups sought to represent knowledge as a hierarchical structure of concepts and propositions, a form they called a concept map. (p.2)

2.7. 3 Characteristics of Concept Maps.

The characteristics of Concept maps are indicated as follows by Novak (2006)-

• They include concepts, usually enclosed in circles or boxes of some type, and relationships between concepts or propositions, indicated by a connecting line between two concepts. Words on the line specify the relationship between the two concepts.

• The concepts are represented in a hierarchical fashion with the most inclusive, most general concepts at the top of the map and the more specific, less general concepts arranged hierarchically below.

• The concept maps contain the “cross-links.” These are relationships (propositions) between concepts in different domains of the concept map. Cross-links help us to see how some domains of knowledge represented on the map are related to each other.

• The concept maps have specific examples of events or objects that help to clarify the meaning of a given concept. (p 1-2)
2.7. 4 Strategies for Introducing Concept Mapping in Standard Three to Seven.

In the classroom situation, many activities can be used to introduce concept mapping. Novak (1984) in his book *Learning how to Learn* has suggested a number of activities helping in concept mapping. Some of the activities are listed verbatim below:

**A. Activities to prepare for concept mapping (Novak & Gowin, 1984, p.29-30)**

1. Make two lists of words on the blackboards or overhead projector using a list of familiar words for objects and another list for events. For example, object words can be car, dog, chair, tree, cloud, book; and event words could be raining, playing, washing, thinking, thunder, birthday party. Ask children if they can describe how the two lists differ.

2. Ask the children to describe what they think of when they hear the word car, dog, etc. Help them recognize that even though we use the same words, each of us may think of something a little different. These mental images we have for words are our concepts; introduce the word concept.

3. Repeat the activities in step 2, using event words. Again, point out the differences in our mental images, or concepts, of events; You may want to suggest at this point that one reason we have trouble understanding each other sometimes is that our concepts are never quite identical even though we know the same words. Words are label for concepts, but each of us must acquire our own meaning for words.

4. Now list words such as are, where, the, is, then, with. Ask children what comes to their minds when they hear each of these words. These are not
concept words; we call them linking words and we use them in speaking and writing. Linking words are used together with concept words to construct sentences that have meaning.

5. Proper nouns are not concept words but rather names of specific people, events, places, or objects. Use some examples and help children to see the distinction between labels for regularities in events or objects and those for specific events or objects (or proper nouns).

6. Using two concept words and linking word(s), construct a few short sentences on the board to illustrate how concept words plus linking words are used by humans to convey meanings. Examples would be: The dog is running, or there are clouds and thunder.

7. Have the students construct a few short sentences of their own, identify the concept words and tell whether each is an object or event, and also identify the linking words.

8. If you have bilingual children in the class, have them present some foreign words that label the same events or objects. Help the children recognize that language does not make the concept but only serves as the label we use for the concept. If we learn words but fail to learn what kind of regularity in objects or events the words represent, we have not learned new concepts.

9. Introduce some short but unfamiliar words to the class such as dire, terse or canis. These are words that stand for concepts they already know, but have somewhat special meaning. Help children see that meanings of concepts are not rigid and fixed but can grow and change as we learn more.

10. Choose a section of a text book (one page is sufficient) and duplicate copies for the children. Choose a passage that conveys a definite message. As a class,
ask them to read the passage and identify key concepts. (Usually 10 to 20 relevant concepts can be found in a single page of text material) Also have the children note some linking words and concept words that are less important to the story line.

b. Concept Mapping Activities

1. Have the children rank order the concepts they have found in a text page from most general, most inclusive to least general, least inclusive. Their list may vary, but they should recognize that some concepts are more salient to the story line than others. Now help them to construct a concept map using the concepts from their lists. This might be done on the black board.

2. For home work or seat work, choose several other text passages and have students construct a map (using steps 9 and 10). There is value in having two or more children map the same text selection and later compare maps. We have also found it is helpful to have students work in twos or threes to construct a map; much good discussion among students can occur. Individual or group maps can be put on the board or overhead projector then it can be explained to the class.

3. A good way to help students recognize that good maps capture the essential meanings in a text is to have them read their map as a story one or two days after it was completed. Students who construct good maps will show remarkable fidelity in reproducing the meaning of the text, even though they have not memorized the text.

4. Make up two or more lists of concept words from some topic recently discussed in class. The words should be related, that is they should have
relevance to a common theme. Let students choose the topic of the word list and then have them repeat step 1 above.

5. After each student has constructed a few maps, it would be useful to introduce them to scoring procedures. Take one of the group constructed maps and show them how it would be scored. Have students score one of their own concept maps and showing the map on the board or overhead projector, ask a few students to explain their scoring values.

6. Have a “progress discussion” with the class.

Many of the above activities were followed during the experiment by the researcher and were found to be very useful.

**2.7.5 Steps used in the Construction of Concept Maps for the Present Study.**

Novak (1998) has outlined the steps to follow in the construction of the maps. These steps were read in the class before the introduction of concept mapping strategy. Also they were typed, duplicated and pasted on each student’s class work note book so that they can follow the steps in the construction of the maps.

A. Identify the focus questions or knowledge domain (area) you wish to map. Identify 10 or more concepts that are connected to the question or knowledge domain.

B. Rank order the concepts by placing the broadest and most inclusive idea at the top of the map

C. Work down the list and add more concepts as needed.

D. Begin to build up your map by placing the most inclusive at the top.

Usually one or two or more will be at the top.
E. Next select two or three sub concepts to place under each general concept. Avoid placing more than three under any other concept.

F. Connect the concepts by lines. Label the lines with one or two linking words. So that it reads as a valid statement. The connection creates meaning. When you hierarchically link together a large number of related ideas, you can see the complete answer to the question or the structure of meaning to the given knowledge area.

G. Rework the structure of the map, which you may include by adding or subtracting sub concepts. (p.227)

Novak (2006) has given an example of a good concept map, for the focus question, “what is a plant?” In the introductory period prior to the treatment a good map and a bad map was shown to the students. The good map and the bad map used in the experiment are given below: the source of both the map is http://cmap.coginstruwf.edu/info/plant.gf
Fig: 2.15 A string map showing poor understanding

Concepts:
- paper
- wood
- trees
- logs
- cut
- grow
- mill
- water
- soft
- wasp nest
- chew
- pulp
- fibers
- writing
- books

Fig: 2.16 A map with cross links shows deeper understanding.
The introductory class the researcher explained the term concepts with examples, presented the good and the poorly made concept maps for the focus question “what is a plant?” Once they were familiar with the idea concept and concept map, they were given practice to make concept maps using a portion of the lesson which they have learned. In the earlier stages students were often reminded to read the steps pasted on their work note books to make them familiar with the steps to follow in constructing the concept maps.

### 2.7.6 Uses of Concept Maps

The figure 2.16 shows that concept map is similar to a spider chart or a flow chart with interconnections. Another characteristic of concept map is hierarchical nature of the concept map, with more general concepts at the top and more inclusive specific concepts below. Thus a concept map depicts hierarchy and relationships among concepts, which bring clarity of meaning and integration of crucial details. It also makes one think in multiple directions and different levels of abstraction, resulting usually in acquiring deeper understanding of the topic and clarifying misconceptions. Hence concept mapping is an easy way to achieve very high levels of cognitive performance, when the process is done well (Novak 2006).

Many students find science (Biology) as blur of numerous disconnected facts which need to be memorized. Bascones & Novak, 1985; Novak, 1991; Novak, 1998 (cited by Novak 2006). has pointed out if concept maps are used in planning instruction and students are required to construct concept maps as they are learning, previously unsuccessful students can become successful in making sense out of science and acquiring a feeling of control over the subject matter (p10-11). From the
above discussion and the volume of research reports it is seen that concept mapping is used for teaching – learning situations. A variety of uses can be briefly identified: (Canas et al., N.D.).

- as a scaffold for understanding,
- for consolidation of educational experiences,
- to improve affective conditions for learning,
- as an aid or alternative to traditional writing,
- to teach critical thinking, and
- as a mediating representation

2.8 Review of Researches in Foreign Countries

Concept mapping originated when J.D Novak professor of Cornell University United States of America, and associates tried to assess students’ learning in a 12 year long study. The byproduct of the study is the pedagogical tool – concept map. From then on many researchers have been studying on the pedagogical tool and its various applications in different fields. At present, every two years, International Conference on Concept Mapping – Theory, Methodology, and Technology is met. The first conference was in Pamplona, Spain and the second conference was in San Jose, Costa Rica. The third conference was in 2008 September 22-25 in Tallinn, Estonia, Finland. The main directors are Joseph Novak and A.J Canas. The contact of their home site is http://cmc.ihmc.us/

Researches in foreign countries are further divided into three sections they are, 2.8.1 deals with concept mapping in Science, 2.8.2 deals with concept mapping in Mathematics and 2.8.3 deals with concept mapping in other subjects.
2.8.1 Concept mapping in Science subjects.

A number of studies are conducted using concept mapping as a pedagogical tool in Science subjects. 13 researches are reviewed in this section spanning from 1983 to 2006. The objective, methods and conclusion of the study are summarized and given below.

2.8.1.1 Novak, J.D., Gowin,B., & Johansen, G.T. (1983). *The use of concept mapping and knowledge Vee mapping with junior high school science students*

**Objective:** The main questions in the study were (i) can seventh and eight grade students use concept mapping and Vee mapping strategies concurrent with regular program. (ii) Will students’ acquirement of science knowledge and problem – solving performance change as a result of instruction in the strategies.

**Method:** The study involved all of the seventh grade science classes at school A and some seventh grade and eight grade classes at school B, near Ithaca, New York. No exact number of the sample was given. The study was an experimental study. Standardized test scores were available in the school to indicate their general ability. The students were first instructed on concept mapping.

**Conclusion:** The study showed both the grades were able to construct “hierarchical maps but were weak in showing cross links” All the students grouped into the four ability groups based on the SCAT scores could do successfully concept mapping and factors like motivation were found to be more important. The “orthogonal relationship between performance on concept mapping tasks and standard measures of ability” suggests the constraints of the latter measure as a pointer of students’ cognitive abilities.
The second question was studied using a “Wine bottle test” which was based on transfer of learning to a new situation. The results showed that there is a significant superiority in problem solving performance on novel problems after less than six months of instruction with these strategies. The correlation between achievement / performance measures and standardized test scores suggest that concept mapping and Vee mapping tap abilities that are not well measured by standardized achievement test or conventional course performance measures.


Objective: The study proposes that the cognitive preference orientation of individual involved in the concept mapping exercise influences performance on concept mapping tasks and subsequent meaningful learning.

Four Cognitive preference modes have been described. These are: Recall (R) Acceptance of information for its own sake without consideration of its implications or applications. A preference for Recall indicates an interest in learning a name, a number, a definition, a formula an observation, or a fact.

Principles (P) Representation or explanation of fundamental principles or relationships. A preference for P indicates an interest in identifying a relationship between variables, or a rule that can be applied to a class or objects, phenomena or an interest in explaining phenomena.

Questioning (Q) Critical questioning of information for completeness, general validity, or limitations. A preference for Q indicates an interest in critically analyzing
and commenting on the validity of information and / or in generating suggestions and hypothesis for further research.

Application (A) Application of information in solving problems in real- life situations. A preference for A indicates an interest in using scientific information to solve problems in commerce, industry, farming, or in daily life. The hypothesis generated for this study are (i) Individuals with preference for P will achieve best in a concept mapping exercise and attain meaningful learning when compared with individuals with A, Q, and R cognitive preferences. (ii) To find out the learning mode (cooperative or individualistic) under which students using the concept – mapping strategy will achieve meaningful learning better.

Method: 145 students enrolled in the pre- degree science program of Lagos State University were the subjects
Cognitive preference data were collected using the Biology Cognitive Preference Inventory. Meaningful learning was measured using a 40 item achievement test whose items are at the comprehension and higher levels of Bloom’s taxonomy. Initially there were 68 items three members checked the content validity and three members checked the item constructions and classified the items into knowledge, comprehension, application, analysis, synthesis, and evaluation types. There was good spread of the test items and the reliability was 0.79 A pre test- posttest experiment with non random assignment of subjects to experimental and control group was employed and then 4 x 2 factorial design was used. 84 students were assigned to the experimental condition and 106 to control condition. Students were oriented on the procedures they used plain sheets of paper and by trial and error they constructed the concept maps Each student copied out the final version of his concept map on a clean sheet of paper. The maps were scored by giving one point for each correct linkage or
relationship five points for each level of hierarchy and five points for each cross link showing correct relationships. By first three weeks they attained fluency and beginning of the second phase they were given pre test. The subjects were classified into different ability levels based on their records of performance in biology. Three weeks was the treatment period then they(experimental & control) were given an overview of the topic (photosynthesis)after this experimental subjects were asked to individually construct the concept map of photosynthesis based on the class discussion during the review exercise. All were given achievement tests.

**Results:** There was no significant difference between the mean pretest scores on achievement of experimental and control group thus showing group equivalency. The posttest scores show the experimental group achieved 25.12 mean score showing they achieved meaningful learning. t-test comparison of the mean scores for each of the four cognitive preference areas for the two learning modes revealed significant t-values in cases except Application. Within learning modes, subjects with P, Q, A and R cognitive preferences were also found to be significantly different in achievement on the post test as revealed by the ANOVA for the cooperative and individualistic conditions. The second analysis procedure was a 4 x 2 ANOVA on the post test scores. It was found to be (F9=(3,56) = 19.63,p<0.01) Evidence was there fore produced to support the earlier conjecture that cognitive preference significantly influences meaningful learning through concept mapping. The effect of the learning mode (F(1,56)=14.21,p<0.01) shows the superiority of cooperative learning over the individualistic mode. The interaction between learning mode and cognitive preference was also found to be significant.(p<0.001)To find the cognitive preference that best facilitates concept mapping the mean and standard deviations of the scores of the experimental subjects at the end of the experiment was computed. The results show
that subjects with preference for P had the highest mean score followed by those with preference for A and Q Students with preference for R had the least mean score. Analysis was carried out to show how students in the two learning modes and four cognitive preference areas perform in concept mapping. It shows that students with P, Q, A Cognitive preference within cooperative learning mode scored significantly higher on the concept mapping exercises when compared with those who worked individually . No significant difference was found in the concept mapping performance of students with Recall cognitive preference in the two learning modes.


**Objective:** In this study the main question under study was (i) Are there any difference in achievement between groups that receive instruction in concept mapping and groups that receive standard instruction? Secondary question also arose and it as follows: (ii) Are there any difference in achievement between groups that maps prior to, during, and subsequent to instruction and groups that map concept map subsequent to instruction only? These questions produced the following hypothesis. H (i)-1: There is no statistically significant difference in achievement between groups that receive instruction in concept mapping and groups that receive standard instruction. H(i)-2: There is no statistically significant difference in achievement between groups that map concepts prior to, during, and subsequent to instruction and groups that map concepts subsequent to instruction only. H (ii)-1 Groups that receive concept mapping
instruction score significantly higher on an achievement test than groups that receive standard instruction. H(ii)-2 Groups that map concepts prior to, during, and subsequent to instruction score significantly higher on an achievement test than groups that map concepts subsequent to instruction only.

**Method:** A sample of 87 was taken and the instruments used were 30 items of Ontario Assessment Instrument Pool: Physics- Senior Division (OAIPPSD ,1981) The items were classified as to content and behavior. The items selected for this study were matched by behavioral objectives to the objectives of the unit under study. Content validity was assumed based on the selection process of the items. The unit under study was titled’ Conservation of Energy and Momentum” The students were used to an informal classroom environment in which they worked at their own pace. Most students formed partnerships and worked in small groups. The teacher supplied an introductory motivational lecture, mini lectures to small groups or the whole class and a review at the end of the unit.

Four of the classes had six weeks of instruction in concept mapping The instruction included the submission of concept maps on reading passages on scientific laws and theories and on the general content of physics. The four classes also submitted concept maps of the previous units.

Three of the classes took a pretest identical to the posttest on the first day of the unit. Classes were assigned at random and the teacher was same .Control group followed the normal instruction with no concept mapping instruction Since they had no concept maps they were required to complete an additional experiment in lieu with the units.

The post instructional mapping group were two and they required to submit concept maps at the end of the unit. The teacher responded to individual questions
concerning the structure of students’ concept maps but there were was no attempt made at large- scale classroom instruction on the concept maps for the unit.

The pre / post Instructional Mapping group were two and they required to submit a concept map of the key concepts of the unit under study prior to instruction, the first or second day of the unit. These two classes were encouraged to revise their concept maps as the unit progressed. Again the teacher responded to individual questions, but no attempt was made at large scale classroom instruction on the concept maps for the unit. The research design followed in this study was based on the Solomon four group designs.

**Results:** A two way factorial analysis (ANOVA) was performed to determine if a pretest- posttest effect was present. One factor was the level of treatment and the other was pre test condition – either yes or no. There was no significant interaction effect. The statistical test for first hypothesis was analysis of covariance of the post test means. The math sub score of he Scholastic Achievement Test (SATM) was the covariant. The sample sizes were equal for this analysis. The $F=4.21$ was significant leading to the rejection of the hypothesis. For Hypothesis H(ii) -1 a single –df comparison of the adjusted treatment means was taken and it was significant resulting in the acceptance of the H(ii) hypothesis. A single df comparison between two experimental groups was significant resulting in the rejection of the hypothesis H(i) and the acceptance of the hypothesis H(ii) hence it can be concluded that sample groups that received instruction on concept mapping scored significantly higher than groups that received standard instruction . The level of treatment was related to the gain achievement . Groups that mapped concepts prior to, during, and subsequent to instruction recorded higher posttest scores.
Objective: The focus question for this study was the use of concept mapping as a tool to enhance meaningful learning in college auto tutorial biology students over a three instructional unit exposure. Further, this study investigates student attitudes towards concept mapping.

Method: For the auto tutorial Biology course Mastery Learning was used, the course was self paced. Concept mapping was introduced to a group of twenty students who volunteered to try out a new learning strategy. Students received hand outs, including introduction to concept mapping as a learning strategy, characteristics of concept maps examples of a good and bad maps, and direction on how to begin mapping. They made individual maps and received feedback on their maps for three instructional units. This program ran about one month. In the first two weeks they got familiarized themselves with concept mapping procedures. Comparisons between mappers and nonmappers were made only on the third unit to be mapped which took one to two weeks on the third unit to be mapped. A Control group, of 20 students agreed to use their usual learning strategies and be tested on one unit. They were matched as closely as possible for SAT score and beginning knowledge of the third instructional units. There were no statistically significant differences in SAT scores or initial knowledge between the mapping and control groups. However the control group showed an edge over the mapping group in initial knowledge.

Student knowledge of the unit was evaluated immediately after the study of the third unit and five months later. Multiple choice questions and clinical interview were used. Open ended questions were used for the clinical interview. They were asked to write on blank sheet of paper as well as describe orally and it was tape recorded. Interviews
were evaluated using concept mapping template method described in Novak & Gowin(1984). Concepts found in the interview were listed and put in a hierarchical system and checked with the template. Thus the final interview score was found out.

learning efficiency was found out, long term objective measure including final exam, final grade and overall GPA were also compared. In-depth analyses of how Mapping affected Learning was also measured using the counting the number of cross links in the initial and final interview. Student attitude were analyzed using a Thinking-Feeling-Acting Questionnaire which consisted of 25 statements.

Results: Learning and Retention: Mappers vs. Controls. 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 mean scores for the mapping group. Differences in means were greater in the five month measures than the immediate results.

Concept mapping and SAT score: Since there were no statistical difference between the control and experimental group it was hypothesized that perhaps a subgroup of the mappers were actually benefiting most from the mapping process. Correlation results between independent and dependant variables indicated that SAT score generally showed stronger correlations with dependant variables for mappers than for controls. Split plot ANOVA results indicated a significant interaction (p=0.04) of mapping with SAT measures in relationship to interview scores and a tendency toward interaction (p=0.12) in relationship to learning efficiency. A closer examination of the data indicated that while there were only small differences between the low- SAT mappers and controls, the high SAT control tended to out score high SAT mappers on the initial interviews, and the reverse was true on the five month post interview. When the amount of time spent studying was taken into account, the learning efficiency results
showed that the initial learning efficiency showed little difference between the two high-SAT subgroups, but that the high SAT mappers had a tendency toward higher long-term learning efficiency over the high-SAT controls. Furthermore, high SAT students generally rated the Thinking-Feeling–Acting Questionnaire more highly than low-SAT students. Although test outcomes did not appear to improve for low-SAT students after a three-unit exposure (one month) to mapping, a few low-SAT students came back after their participation in the program to describe later successes. One student applied his efforts in a chemistry course and went from 11 points below the mean on a chemistry prelim to 12 points above the mean. Another student, who never completed a successful map in first semester biology, mapped every unit in the second semester. She went from a B- to an A in the course. There were no statistically significant results in other long-term measures of academic performance between the two groups, although again it appeared that high SAT mappers tended to compete better than low SAT mappers.

**In-Depth Analyses of Templates and Maps:** Results of the more detailed analyses of template and maps gave some insight into how mapping might actually improve student performance. Error analyses indicated that mapping helped to clarify learning by reducing errors. An analysis of mappers’ interviews and maps showed that only 10% of the errors made on initial interviews and 34% of the errors made on post interviews were made on concepts that had been included on student maps. A comparison of mappers and control on three knowledge application questions indicated that controls made significantly more errors on both initial and post interviews than mappers (Initial errors: Mappers = 1.4, Control=2.6; post errors: Mappers=0.93, Control=2.0; p<0.05). Theoretically, cross links should enhance integration of concepts. Examination of cross links in template transcriptions of
interviews indicated that controls, but not mappers, showed a significant drop in number of cross links from initial to post interview. Improved integration of learning should enhance retention of concepts. An analysis of mapper interviews and maps showed that only 35% of concepts dropped from initial to post interviews were found on concept maps that students had made.

**Subjective student evaluation** gave further strengthening evidence about the effects of mapping on learning. First of all, students claimed in open ended final evaluations that mapping affected their learning style by increasing integration 52%, better organization 18%, not just memorizing 18%, better understanding 12% and better retention 12%. One student claimed mapping confused him more than clarified knowledge for him. Some students on the final evaluation indicated they had to study less on the units they mapped for the final exam. Similarly to the open – ended final evaluation, students on the Thinking – Feeling –Acting Questionnaire responded that mapping helped more in the long run than in the short run.(Mean = 4.1 on scale of 1 – 5) and that they were more an active than a passive learner when using concept maps.(Mean =4.3 on a scale of 1 -5) Further, questionnaire totals correlated negatively with initial test results (interview = -0.21; multiple choice = -0.25) and positively with posttests results(=0.18multiple choice =0.23) In the semester following the mapping experience , 42% of the students reported continued use of mapping . All of these claims indicate mapping facilitated a movement toward more meaningful learning particularly in the long run.

Correlation results indicated that the students treated mapping as an integrated educational experience. All the student claims about how mapping affected their thinking were positive and indicated enhancement of meaningful learning. Most important to the students was the increased integrating of knowledge. Mapping helped
them to make sense out of the material. To a lesser degree, mapping helped students learn how they learned, clarified connections between concepts by putting them on paper, and cut down on time spent memorizing. Students indicated an overall positive feeling toward their experience with mapping. Two slightly negative student feelings referred to the amount of time that mapping took when they had other commitments and frustration when new concepts did not fit into old structure. Students indicated a variety of uses of mapping. Generally, students used mapping to tie together concepts that were introduced in the reading. Sometimes students used mapping to take notes from the book. Rarely, students used mapping to take notes in lecture, to explain concepts to other people, and to help them in other courses. The thinking, feeling and acting subsections of the questionnaire all correlated positively with each other.

2.8.1.5 Stensvold, M., & Wilson, J.T. (1990). The Interaction of Verbal Ability with Concept Mapping in Learning from a Chemistry Laboratory Activity

Objective: The study was an attempt to attain further data relationship between concept mapping and improved comprehension. In addition, this study was designed to investigate the use of concept mapping in conjunction with science instructional laboratories.

Method: The study used quasi – experimental design Treatment groups were asked to construct concept maps before and after the completion of series of laboratory activities. The control group completed the same laboratory activities but did not construct the concept maps. After the completion of the laboratory activities, all students were administered a comprehension test which was constructed by the authors to measure knowledge and comprehension of the laboratory related chemical concepts. Seven intact science classes containing a total of 104 ninth grade students
were selected. The intact classes were randomly assigned to control and treatment groups. Three ninth grade science teachers were involved in the study. Teacher 1 taught one treatment group, teacher 2 taught two treatments and one control groups and teacher 3 taught one treatment and two control groups. Equivalence of the control and treatment groups were confirmed using a Scheffe’ procedure to compare student ITED scores. One week before the laboratory activities, one of the researchers and each classroom teacher conducted two days of instruction on concept mapping with each treatment group. During this instruction, students constructed concept maps on the properties and characteristics of metallic elements. Students then practiced concept mapping for the remainder of a week. During this time, control group students worked on library research unrelated to the chemistry activities. Concept maps were scored by counting the number of concept words and the number of appropriate links (as determined by the researcher) between words on each student map. A map score was determined by dividing the number of appropriate links by the number of concept words. The student concept maps in this study displayed very little cross linking between groups of concepts. This may be due to the students’ brief exposure to the concept maps.. After the completing the laboratory activities, all students were given a 33 item comprehension test. This test included 10 questions to measure comprehension of concepts from the laboratory activities, and eight questions assessing applications and analysis of concepts related to chemical bonding. Content validity of this test was confirmed by three science educators. The reliability KR 21 showed for the test as 0.65.

Results: The study was focused on the group differences in performance on the comprehension test of concepts related to the laboratory activity. The means show a difference of 1.55 points on the comprehension test between the control and treatment
groups. However the Cochran – Cox t- test indicated the difference was not significant (t= 1.78 p=0.08) A secondary effect examined relationship between comprehension and ability measures and complexity of the concept maps made by students. Correlation between map words, map links per word and the ability measures were not significant at the 0.05 level. None of the skills and aptitudes measured appeared significantly related to concept mapping performance. The relationship of concept mapping to comprehension was further evaluated using regression analysis. Map words, map links, and links per word were used as predictor variables in regression equations to predict student score on the comprehension test. Significant regression equations (p<0.05) were found between both map links ($r^2 = 0.15$) and the comprehension test. While the number of words a student wrote on a map was not related to performance on the comprehension test, the number of valid links made on a map predicted comprehension test performance. This finding has implications for the use of student concept maps in instruction. Concept map instruction should focus on relationships between concepts and not be limited to acquiring lists of terms.

Ability measures were expected to interact with concept mapping instruction to differentially predict performance on the comprehension test. These aptitudes x treatment interactions were evaluated by comparing regression slope obtained for each aptitude predicting comprehension. Slopes for treatment and control groups were compared using an analysis of covariance. Significant differences in the slopes of regression lines between control and treatment groups were indicated for the ITED vocabulary subtest by analysis of covariance (F=2.11,p=0.04) . Concept mapping students who scored below approximately 14 on ITED vocabulary subtest achieved higher scores than control group students. In this study, 24 out of a total of 104
students scored 14 points or less on the vocabulary sub test. According to ITED testing materials, 57% of student scores are normally expected to lie below 14. High ability students performing concept mapping achieved lower scores on the comprehension test than similarly able students who did not construct concept maps. High verbal ability students may prefer to use a rote style of learning very different from that required to construct an articulated concept map. In this study, it is possible that students with higher verbal skills made concept maps which limited their perceptions in the laboratory. They may have selected and attended to too little information. It is possible that these students performed the laboratory activity with a fixed structure of information which did not change during the activity, a disadvantage when the activity presented information which challenged their concept structures. High verbal ability students may find concept mapping more useful if an effort is made to reduce possible interference with these students’ learning patterns. One specific way to do this is to encourage these students to revise their concept maps periodically during the laboratory activity.


**Objective:** The focus of the study was to determine if a concept map used as an advance organizer can improve the science achievement of eighth-grade students.

**Method:** Eighty-two eighth-grade students in four science classes participated in this study. The instrument used to measure academic achievement was a teacher-made test. The KR-21 reliability was 0.64. The test consisted of 50 objective questions. The questions were at all levels of Bloom’s taxonomy, except synthesis and evaluation. Two science teachers were assigned an experimental and control group. The classes
were given a two week unit dealing with the physical and chemical properties of elements and compounds. Each class participated in lecture-note taking sessions, lab sessions, and teacher demonstrations. On the first day the control group was given an introductory lesson that included objectives of the unit and some interesting questions designed to instill motivation. On the same day the experimental group received a blank concept map with spaces assigned for the concepts in hierarchical fashion. Arrows showing the linkage between the concepts were included. The students completed their concept maps by copying the teacher’s example, which was on the overhead projector. The concept map was explained in the context of an advance organizer. Each map was checked and they were also instructed that they can modify their concept maps at any time.

**Results:** indicate that use of concept mapping as an advance organizer produces a significant increment in academic gain for the students in eighth grade physical science classes. The effect size of 0.40 in this study is well within the range of the other studies. It is more likely that a concept map developed by the teacher provided the students with greater direction for learning the concepts and facts that overlapped with the teacher’s test than did the technique of using only discussion of the objectives in the unit.


**Objective:** The research was conducted to find out whether concept mapping alone is better for enhancing learning than concept mapping in cooperative learning groups.

**Method:** For the study 147 students of senior secondary class II Biology students
(11 graders) in two schools were selected as the subjects. Both followed identical teaching plans. 98 students enrolled in biology received training in how to make concept maps. Training spanned six 80 minute periods. In each period, the first 65 minutes were spent on lecture / discussion/demonstration activities during which each student listed in a notebook the keywords, concepts, phrases, examples and main ideas that were used. The remaining 15 minutes were spent arranging the concept in a hierarchy from the most general, most inclusive, to the sub ordinate. Lines and arrows were then used to connect the concepts. Labels were put on the lines and arrows in a propositional form. Where applicable, examples were inserted at the end of a branch. Using the modified preference scale, preference for cooperative and individualistic work was found out and the group was divided into three. Group A included 37 students who preferred cooperative work. Group B included 30 students who preferred individualistic work but forced for cooperative work. Group C included 31 students who preferred individualistic work Group D 49 students in another school formed the comparison group. All the 147 students took a pre test of multiple choice test on five topic to covered during the treatment phase of the study. The mean pretest scores ANOVA shows no significant difference between the four groups (F (3,143)=1.06 p>.05) The treatment lasted for 10 weeks during which Group A and B worked together in making concept maps. As lesson progressed each student took notes on the concepts, main ideas, phrases and examples used. 20 minutes of 80 minute lesson period was used in group discussion and construction of the concept maps then the whole class discussed one group’s map at the end of the lesson as a review. Group C worked individually with 15 minutes left in the lesson and then the whole class discussed one student’s map. Group D were involved in lecture/Discussion./ demonstration throughout the 80 minute lesson. A biology teacher who
got in service training in concept mapping for 15 weeks taught the four groups in the
two schools. At the end of the study same achievement test was given to all the
subjects’ Results: pretest scores showed there is no statistical difference between the
groups. Analysis showed that students who expressed preference for cooperative
group work showed the highest mean score on post test. Group B ranked the second
then Group C who preferred to work individually and finally Group D, the control
group.

Instructional Tool

Objective: The research questions which guided the study were: (i) What is the
effectiveness of concept mapping as an instructional tool for improving students’
achievement? (ii) What is the effectiveness of concept mapping as a strategy for
improving students’ attitudes? (iii) Is there a difference in the effectiveness of teacher-
prepared versus student prepared concept maps in improving student achievement and
/ or attitudes? (iv) Is there a gender effect when concept mapping is used as an
instructional tool?

Method: The purpose of the study was to integrate the outcomes of the available
research on the effects on students of using concept mapping as an instructional tool.
Meta analysis developed by Gene Glass 1981 was used. In its simplest form, effect
size (ES) is determined by subtracting the mean score on the dependant variable of the
control group from the mean score of the experimental group and dividing this
difference by the standard deviation of the control group. For the meta analysis, data
sources were the computerized data bases of (a) the Educational Resources
Information Center (ERIC); (b) Dissertation Abstracts International; and (c) Psychological Abstracts. A search of these data was conducted using the key words: “Concept mapping”, “semantic mapping”, and “concept maps”; in searching Dissertation Abstracts International the key word “education” was also included. A research report was determined acceptable if it satisfied the three criteria. They were (i) study had to occur in actual classroom, (ii) study should use concept mapping technique as the instructional tool, (iii) the report had to provide sufficient data for the calculation of an effect size. Two authors independently read each report thus collected and in the final analysis only 18 of the research reports were selected. Eleven variables were used to describe the sample characteristics of each study. Out of the 18 concept mapping two were conducted in grade 5 two were in grade 8 and five were conducted in grade 9 two at grade 10 one each at grade 11 and 12. Finally five of the 18 studies took place in college settings. The studies took place in U.S, Canada, Nigeria and Taiwan.

**Result:** Meta analysis results showed that concept mapping has generally positive effects on both student achievement and attitudes in the studies examined. Concept mapping raised individual student achievement in the average study by 0.46 standard deviations, or from the 50th to the 68th percentile. Concept mapping also strongly improved student attitudes. However, the examination of these effects using cross-tabulations reveal some differences which may warrant closer inspection, or raise new questions for future research. In nine studies with biology as the content focus, students exposed to concept mapping achieved on average at the 72nd percentile, while experimental students of the typical study examining chemical or physical science achieved at only the 56th percentile. The interest was a considerable difference in the average size of both achievement and attitude effects depending on the location.
of the study. In US and Canada the average achievement raised by 0.29 (50th to 61st percentile) standard deviation. While in the three achievement studies conducted in Nigeria and one in Taiwan raised the average achievement by 1.00(50th to 84th percentile). For attitude also same contrast was seen. Two U.S studies the average students’ attitude improved by 0.19 standard deviation(50th to 57th percentile) whereas in the two Nigerian studies students’ attitudes increased by 2.95 standard deviation (50th to 99th percentile) .These difference may be due to novelty and Hawthorne effects. The North American students are accustomed to experiencing instructional and technological innovations which are not the case of the developing nations. There was also a difference in achievement effects when comparing those studies which employed a conventional control groups with those which employed a placebo treatment for the control group. When compared to normally instructed students, average concept mapping students achieved at the 72nd percentile. On the other hand, when compared to student receiving an alternative treatment, concept mapping students achieve at only 47th percentile. This may be a somewhat artificial difference. The meta analysis also showed that there was little difference in the effectiveness of teacher-prepared versus student prepared concept maps in improving students’ achievement. In four studies which used teacher prepared concept maps students’ achievement improved from 50th to the 71st percentile and in student prepared concept maps students’ achievement improved from 50th to 66th percentile. It was therefore surprising that when students did prepare their own concept maps, they showed much stronger achievement gains if they themselves were required to supply the key terms necessary to construct the maps.( mean ES= 0.87) For the five studies in which teachers supplied the key terms for students who then constructed maps, minimal average gain in achievement was evident (means ES = 0.08) A comparison
between the effectiveness of teacher-prepared and student-prepared concept maps in improving student attitudes was not made since only one of the four studies employed teacher-prepared maps. Since only one study had a gender variable, the fourth research question remained unanswered. This meta-analysis shows that concept mapping had generally medium positive effects on students’ achievement and a large positive effect on students’ attitude. Gender effect could not be studied as there were only one study and there were no evidence to show student-prepared maps were more effective than teacher-prepared maps.


**Objectives:** The study was guided by the following questions:
(i) What understanding do students have of concept maps?
(ii) From the students’ point of view, how does collaborative concept mapping help in learning?
(iii) From the students’ point of view, what are the benefits of reflecting on the experience of collaborative concept mapping?

**Methods:** The study followed a qualitative design. Written reflections on concept mapping experiences, an essay on concept mapping, selected interviews, a questionnaire, videotaped concept mapping sessions, and their transcripts constituted the data sources for this study. The participants were forty-six students from three sections of an introductory physics course for high school juniors and the study was conducted during the full length of the year 1991-92 school years in a private high school in Canada.

**Results:** The analysis of the data sources showed, first students demonstrated a good understanding of concept maps and emphasized their usefulness as a learning tool.
Second, a large number of students identified in concept mapping a tool that provides opportunities for engaging in collaborative construction of knowledge and negotiation of meaning. Thus, students emphasized implicitly the socio cultural aspects of the learning tool that helped them establish a discourse community. Students elaborated how justifications, explanations, and elaborations of their own views helped maintain the dynamics of their interactions. They also provided elaborate explanations of the interactional dynamics in their peer groups. Third, students expressed mixed views on writing reflections. Finally the negative case analysis gave views regarding dislike for collaborative concept mapping as a classroom activity. This analysis also provided some evidence why this activity may not be beneficial to all students.


**Objective:** The study was to explore the effectiveness of concept mapping, the learning cycle, expository instruction, and a combination of concept mapping/learning cycle in promoting conceptual understanding of diffusion and osmosis.

**Methods:** Four high school biology classes (108 secondary students of grades 10 - 11 enrolled in four sections were the sample of the study) were taught diffusion and osmosis concepts with the aforementioned treatments. Conceptual understanding was assessed immediately and seven weeks after instruction with the Diffusion and Osmosis Diagnostic Test (DODT).

**Results:** Indicated the concept mapping/ learning cycle and concept mapping treatment groups significantly out performed the expository treatment group in
conceptual understanding of diffusion and osmosis. The two treatments (CM and CM/LC) were not significantly different from the LC treatment.


**Objectives:** The authors focus on the long term use of concept maps in classes and the reflection upon its use.

**Methods:** The authors have been using concept maps, especially one of the researchers, for about twenty years, mainly in the teaching of Physics. They could realize that they satisfy many useful targets in the teaching of that subject. In the present paper the authors have given a case study of two concept maps. The first one is a map constructed by an 11th grade pupil in a subject called Physics Laboratorial Techniques. He was invited to construct this map after having performed an experimental activity in which he accurately determined the mechanical equivalent of heat, and after having elaborated a report on that experiment for which he was given a B mark. The map shows pupil’s misconception, particularly between heat and temperature.

The second map was constructed by one of the author’s in order to structure the planning of an 8th grade curricular unit entitled ‘Light and Vision’. This map was constructed according to the thematic sequence indicated in the National Curriculum for the Instruction of Physics and Chemistry.

**Results:** According to Valadares, Fonseca & eSoares, what an individual knows, in the broadest sense of the word – her/his complex cognitive structure – influences extraordinarily the way she/he will learns other knowledge. When powerful and relevant anchoring ideas, whether they are images, symbols, concepts, or relation
between concepts, are incorporated in her/his cognitive structure, which Ausubel calls as “subsumers” she/he has an affective commitment to relate new knowledge to prior learning, she/he transforms the logical meaning of new knowledge into psychological meaning, learning meaningfully. Along with Moreira 1998 the authors confirms that there is a non-arbitrary, non-verbatim, substantive incorporation of new knowledge into cognitive structure; what is incorporated in the cognitive structure is the substance of the new knowledge, of the new ideas, and not simply the words used to express them. The new knowledge is thus interiorized, becoming part of the cognitive structure and also changing the concepts to which they are related.

They have said the concept maps are meta cognitive tools that allow the representation of knowledge structures in thematic fields and the disclosure of “secrets” in the cognitive structures of students of all ages. As a learning strategy, concept mapping stimulate learners’ commitment and involvement in negotiation of ideas, which is very important to learn meaningfully. It is also a teaching support, helping to establish networks of concepts that progressively differentiate a central concept in a coherent, structured and integrated manner guiding the sequence of teaching. The authors experience points that concept mapping help students organize their knowledge and allowed to operate at the knowledge reorganization level in opposing to the curricular linear structures. Strategies based on concept maps supported a pro – active formative assessment and strengthen its didactic role. Using this instrument means giving a new meaning to education, as well as a new meaning to concepts of teaching, learning, and assessment of learning.

**Objective:** To study the systematic use of concept mapping for personal knowledge building.

**Method:** A project titled “The words of Science” was conducted by the authors and primary teachers for students of the age 6 -11 years based on the systematic use of concept maps and laboratory teaching. Maps and laboratory teaching give 6 -12 year students the opportunity to operate in a particularly stimulating learning environment that creates the necessary conditions for personal knowledge building. Students were the players and protagonists during the teaching activities through a continuous process of discovery, investigation, research and synthesis. Students attempt to give answers to multiple questions arising from the observation of scientific phenomena or from the solution of problematic issue. In this context, the building of concept maps allows students to become aware of their knowledge building processes whilst also representing the knowledge synthesis operated by students. **Conclusion:** The teaching experience described by the authors have proved effective since they are guided by an educational and training model that privileges laboratory discovery and problem-solving processes and procedures in a cooperative group. In this context concept maps support and substantiate the different steps faced by students to build meanings and knowledge. They become a method and strategy to promote significant learning, combining the leading role of the single student (individual map) with the group cooperative mediation (group map). The authors have also found the maps play a relevant role in acquisition of meta cognitive competencies, because they induce
reflection and thought. Thinking, reflecting, representing a knowledge “space” through maps, means to test a personal knowledge experience, which is mediated and enriched through dialogue and interpersonal – social communication.


**Objective:** This paper intents to study the efficacy of concept mapping in motivating students to become more self regulated learners by adopting a more meaningful approach to learning biology.

**Methods:** The study was a quasi – experimental pre – post design and mixed methodology that included quantitative and qualitative analysis. 82 level one (top level) tenth year biology students were the subjects. They were taught the use of concept map software. Once they demonstrated an understanding of the technique they were asked to individually construct concept map that serve as the foundation of a course unit (ecology). Through out each teaching unit teachers collected and provided constructive feedback to students with reference to propositional validity and structured complexity of students’ maps. The feedback did not involve correcting students’ mistakes, misconceptions nor filling in missing contents. The feedback took the form of providing questions designed to encourage a more meaningful approach to the construction of their concept maps. Subsequent to this students were asked to modify and expand their maps. This process continued till the day of the test. Maps were scored using Novakian procedure. To generate sufficient data four separate classes were selected with two different teachers. Teacher effect was reduced because both had constructive philosophy and agreed to follow the same curricula with same laboratory activities and design similar tests to assess for meaningful understanding.
All the concept mappers were given similar level of feedback remarks. The tools used were (i) motivated strategies for learning questionnaire (MSLQ) by Pintick, Smith, Garcia & Mckeachie (1991) (ii) The achievement Goal Orientation Questionnaire (AGOQ) by Somuncuglu and Yildirim (1999)(iii) A concept mapping questionnaire designed by the author.

**Results:** Concept mapping was found to encourage meaningful approach to learning. Adaptive changes were in direct relation to the level of mapping proficiency. The results support the principles of expectancy value theory. The study has shown that concept mapping is an effective learning strategy.

2.8.2 Concept Mapping in Mathematics

Concept mapping has been tested as a pedagogical tool in the instruction of Mathematics. Some researches related to this area are mentioned below.

2.8.2.1 Afamasaga-Fuata’i, (2006). *Innovatively Developing a Teaching sequence using Concept maps*

**Objective:** The study explored ways in which mathematical thinking and reasoning can be deeper and conceptual based using concept mapping and Vee diagrams. The research questions which guided the study were (i) to critically analyze selected content of the 7 -12 mathematics syllabus (ii) to illustrate their conceptual understanding of syllabus outcomes and indicators, activities and problems; and (iii) to develop requisite skills in the design of conceptually rich activities to promote working and communicating mathematically.

**Method:** The main study is design experiment in which the student teachers critically analyzed syllabus out comes, problems and activities for underlying concepts and
principles before illustrating the results on maps followed by an examination of (a) the kinds of discourse that emerged during critiques of presented maps and student reflections on how their constructing experiences impacted on the way they planned, thought and viewed the teaching of mathematics topics; (b) the types of participation norms established for the development and critique of maps during weekly workshops; and (c) the types of practical means by which the researcher “orchestrated relations among these elements” The sample included 10 students of the two secondary mathematics education units. The present paper is a part of the major study hence it is a case study of one student teacher’s work on using concept maps to plan a teaching sequence on the topic “Derivatives”

**Results:** The student teacher was empowered to use these tools innovatively (i) to critically analyze syllabus outcomes and (ii) to design a suitable teaching sequence by hierarchically and visually clarifying prior knowledge and future knowledge and using appropriate mathematical language to effectively communicate staged – appropriate mathematics content. Since completed, practice and final maps encapsulated both the conceptual and epistemological frame works of a topic, through their construction, the student teacher routinely searched for connections between key and subsidiary concepts, and whilst doing so, he made insightful observations about the qualitative distinction between the nature of maps that are more abstract as in topic concept maps or those that are more concrete as in problem concept maps. He also distinguished between dimensions of a concept map when used as a meta cognitive tool to collect his thoughts and ideas about the focus of the map (verb- type) and a final concept map described as his ‘best – description maps (noun type). A significant advantage of being proficient in concept mapping is the acquisition of critical skills that can be usefully applied to many situations such as demonstrated
through his additional effort to situate the assigned topic within the macro picture of the two – year mathematics curriculum. Thus, a student teacher’s work with concept maps illustrates the conceptual structure underpinning a teaching sequence in order to communicate efficiently his perceptions of what it means to developmentally and conceptually teach a selected topic in contrast to simply compiling a sequential list of sub topics.

2.8.2.2 Caldwell, et. al. (2006) Developing a Concept Mapping Approach to Mathematics Achievement in Middle School.

Objective: The authors have focused on the usage of concept mapping in Math achievement. Method: A project to bring the use of concept mapping into middle grade math began at the University of North Florida (UNF) in the spring of 2005, and has produced a design for a two week, summer middle grades math camp for delivery in the summer of 2006.

The summer camp had three primary objectives: (i) to increase the interest of the participating students in learning about mathematics and its applications; (ii) to improve the readiness of the students for entering and succeeding in Algebra I; and (iii) to introduce concept mapping through Cmap Tools, as a mathematics teaching, assessment, and learning strategy. Four full day workshop were designed to have the teachers learn to use Cmap Tools and also to have the teachers develop well – organized mathematics and applied mathematics activities that were designed to (i) increase student interest in learning mathematics (ii) focus on well- defined math objectives that were related to Algebra I and (iii) introduce concept mapping as a component of the teaching and learning strategy.
Preceding the camp there were teacher professional development workshops for the middle school teachers of the camp. The workshop focused on the use of concept maps in planning, classroom delivery, and assessment; on the use of Cmap Tools software and on the development of activities appropriate to Algebra I topics.

The primary purpose of the project was to have impact on the students’ performance in math and to encourage them to apply themselves more to their math courses. The teachers were instructed to implement concept mapping into their regular classrooms and the resource personnel from the university planned to visit the classes and give guidance over the course of the year. By the end of the year 2006 they planned to have number of workshops through out Florida to achieve the purposes outlined in the project.

**Result:** The study formulates plan to implement concept mapping as a strategy for teaching math so that it will produce an impact on the performance of math courses. It is a development of an approach plan for the implementation of concept mapping as a strategy.

### 2.8.3 Concept Mapping in Other School Subjects.

A few researchers were reported where in concept maps are used in other subjects. Some of the studies are reported by researcher

#### 2.8.3.1 Vakilifard, A., & Armand, F. (2006). The Effects of ‘Concept Mapping’ on Second language learners’ Comprehension of Informative Text

**Objective:** The author in the present study aims at observing the effects of an instructional sequence, based on the most effective approached test in first language, on informative text comprehension in French as a second language. The adult French
second language learners of an advanced level from the language school of the ‘Université du Québec à Montréal’ were subject to a weekly intervention over a 4 week period, while a control group equivalent followed the traditional approach (explanation of new words and expressions, discussion of the key concepts).

Method: Before reading an informative text, participants in the experimental group were invited to collaboratively replace the labels in a Fill-in Concept Map. Then, after reading the text, the participants were asked to correct it individually. Over the course of the 4 weeks, the author and associates used the instructional strategy of the progressive devolution concept map, which is an approach to scaffold fading.

Results: obtained with comprehension questionnaires on the reading text specific to each meeting indicated that the experimental group obtained a better performance than the group that had used the traditional approach.

2.9 Review of Researches in India

In India, researches related to Concept Mapping are meager. A few researches are seen in the literature. Some studies on concept mapping are done in India most of them are conducted in science subjects as in western countries. A few studies based on other subjects are also seen in the literature. 2.9.1 deals with researches connected with Science, 2.9.2 deals with other subjects.

2.9.1 Concept Mapping in Science Subjects

Though a number of studies are conducted in America and else where, the number of studies in India is not much. Educationists are aware of the studies based on concept mapping yet it needs to take root in India.

Objective: The study focused on concept mapping as teaching-learning strategy in physical science. The objectives were i) to find out the influence of concept mapping on scholastic performance in physical science among standard IX students. ii) to find out the relationship between relevant psychological variable in terms of cognitive ability, attitude towards concept mapping, science interest and performance in concept mapping. iii) to study the significance of difference in scholastic performance between those students who learnt physical science through teaching with concept mapping and those who learnt physical science through teaching without concept mapping and iv) to find out the difference in concept mapping performance and scholastic performance among boys and girls and in a coeducational setting.

Method: A sample of 286 students of standard IX covering boys, girls, and coeducational students were taken from the state and central board schools. They were distributed in three experimental and control groups. The age of the subjects ranged between 13–14 years. The tools used in the study included concept maps, scholastic performance test in physical science, Attitude scale, cognitive ability test and science Interest Inventory. The collected data were treated with correlation path analysis and path coefficient analysis of covariance and critical ratios.

Result: The findings were i) it was found from the path analysis that the relevant psychological variables such as cognitive ability, attitude towards concept mapping and science Interest had both a significant direct influence on scholastic performance and an indirect influence through concept mapping. Similarly, concept mapping as a
teaching – learning strategy had a significant positive influence over scholastic performance. The path direction had been the same with boys, girls and coeducation students. ii) On comparing the co-efficient of determination, the highest extent of determination had been found between cognitive ability and concept mapping for all the three groups. For coeducation students 51% cognitive ability accounted for concept mapping performance, for boys it had been 49% and for girls 44%. The contribution of cognitive ability to scholastic performance had been lower in all the three groups. 19 % in case of boys, 37% in case of girls and 38% in the case of coeducation students .iii) The experimental and control group of boys, girls and coeducation students were found to have no difference in the post test scholastic performance scores in physical science. iv) girls were found to have performed better than boys in post test scholastic performance scores in physical science. v) Coeducation students were found to have performed better than girls and boys in post test scholastic performance in physical science vi) coeducation students were found to have performed better than girls and boys in concept mapping. (Buch vol: Sharma 1992)


Objective: The objective of the study was to develop and implement concept mapping as a strategy in the selected few units of science for VIII standard students and study its effect on the achievement, concept attainment, and the process skills of students belonging to different intelligence groups. The second objective was to study the attitude of students towards concept mapping in science. The gender difference in
science achievement, process skills, and attitude towards concept mapping was also measured.

**Method:** the design was quasi experimental pre post, non randomized group was taken into consideration. Raven progressive Matrix was used to group the students according to their intelligence. Achievement test, process skills test, concept attainment test were developed along with the attitude scale. The lessons were taught using concept mapping technique and concept maps evolved as the lesson developed during the review stage also concept map was developed on the black board with the help of the students.. Test were administered at the end of the units and the data were statistically analyzed.

**Results:** The analysis of the data revealed that the experimental group students had performed better when compared to the control group on achievement test, process skills and concept attainment test on the post test occasion. The analysis of the attitude shows that 90% of the students had a positive attitude towards concept mapping strategy. The strategy had a differential effect on the different levels of intelligence groups. The F value shows for concept attainment test was found significant implying that there is a difference within and between the students of different intelligence in their concept attainment ability. But there was no difference found either between or within the different grades of students in their performance of process skills. There was no difference observed between girls and boys in their achievement, process skills, concept attainment and in their attitude towards concept mapping.
2.9.2 Concept Mapping in Other Subjects.

One study was found outside science which used concept mapping as a pedagogical tool. This study was presented in the first Episteme International Conference for Science and Mathematics hosted by HSBC in 2004 in Goa. The researcher could talk in person to Ms Gopal who conducted the study. The study is given below.

2.9.2.1 Gopal, P. (2004). *Concept Mapping – A pedagogical Tool for Grammar Lessons*

**Objective:** The objective is to study the effects of the use of concept maps on the teaching and learning of English grammar.

**Method:** The subjects were 94 students of the IX standard students of the Army Public School Delhi. One section was selected as the experimental and the other became the control group. The units selected for the study were some topics from grammar and English prose. The experimental group was given instruction with concept maps and in the control group the lecture method was used. In the experimental group the grammar lesson proceeded from the prior knowledge and the prose lesson concept map developed as the lesson progressed. After 30 lessons test was conducted on the topic covered.

**Results:** The mean, standard deviation, and spread of the scores around the mean shows that two groups were comparable on the test taken before the study began. The post test shows that the mean the standard deviation are higher than the control group and the t test shows that it is significant at 0.01 level. This signals that concept map instructions signals a better performance in grammar lessons.
2.10 Implication of the Review of Literature and Researches for the Present Study

New researches are build on old researches. They form the foundations on which further study is done. Hence the review of literature has given the researcher the insight into the various aspects of learning and the place of graphic organizer in the process of learning. It also gave guidelines to introduce concept map in standard seven. The researches earlier done were guiding the present study in selecting the measuring instruments and statistical techniques. The review of various study helped to foresee some of the problems, which can arise, and the solutions that may be used. The scope and design of the study along with limitations and delimitations were planned with the informations gleaned from the review of the literature and researches done earlier.

2.11 Conclusion

How learning takes place has been intriguing human mind from time immemorial. Educationist understood learning can take place by rote or can be acquired meaningfully. Rote learning is lost very fast. In the school, learning is usually verbatim and children forget very fast the learned information. Lecture method is a time-tested strategy and this method can be enhanced using various meta memory techniques such as concept mapping. Concept mapping has been used in various subjects of science. Many researches were done in west and elsewhere using concept map as a pedagogical tool. In India the research in this area is meager.

Reviewing the literature and the researches done on learning and concept mapping has given direction for the present research. It has enhanced researcher’s
knowledge on how children learn and the position of graphic organizers in the realm of learning. Review of researches gave the direction to delimit the study and the possible statistical measures that can be used for the study. The conceptual framework of the study became clear due to the extensive reading.