CHAPTER I

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1.0.0 INTRODUCTION

Effective teaching strategies are so crucial in learning that the products of teaching such as knowledge, skills acquisition are much dependent on the teaching strategy. The effectiveness of the teacher can be enhanced through the implementation of the appropriate strategy in the learning situation. Since the focus of education has shifted from rote memorization of the facts to the construction of knowledge by the child, the discovery of new teaching strategies and their implementation acquires an unavoidable importance in educational research. Also it has been emphasized that it is more important for the child to develop understanding and scientific temper which requires a lot of efforts from the teacher's side. Hence, for the effective classroom teaching their needs tobe an evolution in the teaching strategies.

1.1.0 Science

Science (from Latin *scientia*) means knowledge as a systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about nature and the universe. This knowledge is determined through the scientific method by experiments and observations, and may take the form of scientific facts, scientific models, or scientific theories. In an older and closely related meaning, "science" also refers to a body of knowledge itself, of the type that can be rationally explained and reliably applied. In modern usage, "science" most often refers to a way of pursuing knowledge, not only the knowledge itself. It is also often restricted to those branches of study that seek to explain the phenomena of the material universe. Science is a systematic effort of acquiring knowledge, through observation and experimentation coupled with logic and reasoning to find out what can be proved or not proved,and the knowledge thus acquired.

Science is a dynamic, expanding body of knowledge covering ever new domains of experience. It is the human act of observing the physical and biological environment carefully, look for any meaningful patterns and relations, make and use new tools to interact with nature, and build conceptual models to understand the world. Scientific method involves several interconnected steps: observation, looking for regularities and patterns, making hypotheses, devising qualitative or mathematical models, deducing their consequences; verification or falsification of theories through observations and controlled experiments, and thus arriving at the principles, theories and laws governing the physical world.

In the 17th and 18th centuries scientists increasingly sought to formulate knowledge in terms of *laws of nature*. Over the course of the 19th century, the word "science" became increasingly associated with the scientific method itself, as a disciplined way to study the natural world, including physics, chemistry, geology and biology. It is in the 19th century also that the term *scientist* began to be applied to those who sought knowledge and understanding of nature

1.1.1 Philosophy of Science

Working scientists usually take for granted a set of basic assumptions that are needed to justify the scientific method: (1) that there is an objective reality shared by all rational observers; (2) that this objective reality is governed by natural laws; (3) that these laws can be discovered by means of systematic observation and experimentation. Philosophy of science seeks a deep understanding of what these underlying assumptions mean and whether they are valid.

There are different schools of thought in philosophy of science. The most popular position is empiricism, which holds that knowledge is created by a process involving observation and that scientific theories are the result of generalizations from such observations. Empiricism generally encompasses inductivism, a position that tries to explain the way general theories can be justified by the finite number of observations humans can make and hence the finite amount of empirical evidence available to confirm scientific theories. This is necessary because the number of predictions those theories make is infinite, which means that they cannot be known from the finite amount of evidence using deductive logic only.

Empiricism has stood in contrast to rationalism, the position originally associated with Descartes, which holds that knowledge is created by the human intellect, not by observation.[Godfrey-Smith 2003]:p20

Critical rationalism is a contrasting 20th-century approach to science, first defined by Austrian-British philosopher Karl Popper. Popper rejected the way that empiricism describes the connection between theory and observation. He claimed that theories are not generated by observation, but that observation is made in the light of theories and that the only way a theory can be affected by observation is when it comes in conflict with it (Godfrey-Smith 2003). Popper proposed replacing verifiability with falsifiability as the landmark of scientific theories, and replacing induction with falsification as the empirical method (Godfrey-Smith 2003). Popper further claimed that there is actually only one universal method, not specific to science: the negative method of criticism, trial and error. Popper called this Conjecture and Refutation(Godfrey-Smith 2003). It covers all products of the human mind, including science, mathematics, philosophy, and art.

Another approach, instrumentalism, emphasizes the utility of theories as instruments for explaining and predicting phenomena. It views scientific theories as black boxes with only their input (initial conditions) and output (predictions) being relevant. Close to instrumentalism is constructive empiricism, according to which the main criterion for the success of a scientific theory is whether what it says about observable entities is true.

Finally, another approach often cited in debates of scientific skepticism against controversial movements like "scientific creationism", is methodological naturalism. Its main point is that a difference between natural and supernatural explanations should be made, and that science should be restricted methodologically to natural explanations.[Godfrey-Smith 2003, p. 151] That the restriction is merely methodological (rather than ontological) means that science should not consider supernatural explanations itself, but should not claim them to be wrong either. Instead, supernatural explanations should be left a matter of personal belief outside the scope of science. Methodological naturalism maintains that proper science requires strict adherence to empirical study and independent verification as a process for properly developing and evaluating explanations for observable phenomena.(Brugger, E. Christian (2004). "Casebeer, William D. Natural Ethical Facts: Evolution, Connectionism, and Moral Cognition". *The Review of Metaphysics* **58**)The absence of these standards, arguments from authority, biased observational studies and other common fallacies are frequently cited by supporters of methodological naturalism as characteristic of the non-science they criticize.

1.1.2 Nature of Science

Science is a dynamic, expanding body of knowledge covering ever new domains of experience. How is this knowledge generated? What is the so-called scientific method? As with many complex things in life, the scientific method is perhaps more easily discerned than defined. But broadly speaking, it involves several interconnected steps: observation, looking for regularities and patterns, making hypotheses, devising qualitative or mathematical models, deducing their consequences; verification or falsification of theories through observations and controlled experiments, and thus arriving at the principles, theories and laws governing the physical world. There is no strict order in these various steps. Sometimes, a theory may suggest a new experiment; at other times an experiment may suggest a new theoretical model. Speculation and conjecture also have a place in science, but ultimately, a scientific theory, to be acceptable, must be verified by relevant observations and/or experiments. The laws of science are never viewed as fixed eternal truths. Even the most established and universal laws of science are always regarded as provisional, subject to modification in the light of new observations, experiments and analysis. The methodology of science and its demarcation from other fields continue to be a matter of philosophical debate. Its professed value neutrality and objectivity have been subject to critical sociological analyses. Moreover, while science is at its best in understanding simple linear systems of nature, its predictive or explanatory power is limited when it comes to dealing with non-linear complex systems of nature. Yet, with all its limitations and failings, science is unquestionably the most reliable and powerful knowledge system about the physical world known to humans. But science is ultimately a social endeavor. Science is knowledge and knowledge is power. With power can come wisdom and liberation. Or, as sometimes happens unfortunately, power can breed arrogance and tyranny. Science has the potential to be beneficial or harmful, emancipative or oppressive. History, particularly of the twentieth century, is full of examples of this dual role of science.

Science is a particular way of understanding the natural world. It extends the intrinsic curiosity with which we are born. It allows us to connect the past with the present, as with the redwoods depicted here. Science is based on the premise that our senses, and extensions of those senses through the use of instruments, can give us accurate information about the Universe. Science follows very specific "rules" and its results are always subject to testing and, if necessary, revision. Even with such constraints science does not exclude, and often benefits from, creativity and imagination (with a good bit of logic thrown in).

1.1.3 Essence of Science

- **Research** – systematic investigation into existing or new knowledge.
- **Scientific discovery**– observation of new phenomena, new actions, or new events and providing new reasoning to explain the knowledge gathered through such observations with previously acquired knowledge from abstract thought and everyday experiences.

- **Experimentation**– facility that provides controlled conditions in which scientific research, experiments, and measurement may be performed.
- **Objectivity** – the idea that scientists, in attempting to uncover truths about the natural world, must aspire to eliminate personal or cognitive biases, a priori commitments, emotional involvement, etc.
- **Inquiry**– any process that has the aim of augmenting knowledge, resolving doubt, or solving a problem.

1.1.4 The scientific method

The scientific method is a body of techniques for investigating phenomena, acquiring new knowledge or correcting and integrating previous knowledge.

The overall process of the scientific method involves making conjectures (hypotheses), deriving predictions from them as logical consequences, and then carrying out experiments based on those predictions (Pierce).An hypothesis is a conjecture, based on knowledge obtained while formulating the question. The hypothesis might be very specific or it might be broad. Scientists then test hypotheses by conducting experiments. Under modern interpretations, a scientific hypothesis must be falsifiable, implying that it is possible to identify a possible outcome of an experiment that conflicts with predictions deduced from the hypothesis; otherwise, the hypothesis cannot be meaningfully tested.

1.1.5 Process

The overall process involves making conjectures (hypotheses), deriving predictions from them as logical consequences, and then carrying out experiments based on those predictions to determine whether the original conjecture was correct.[4] There are difficulties in a formulaic statement of method, however. Though the scientific method is often presented as a fixed sequence of steps, they are better considered as general principles.(Gauch)

Formulation of a question

This stage frequently involves looking up and evaluating evidence from previous experiments, personal scientific observations or assertions, and/or the work of other scientists. If the answer is already known, a different question that builds on the previous evidence can be posed. When applying the scientific method to scientific research, determining a good question can be very difficult and affects the final outcome of the investigation. (Schuster and Powers)

Hypothesis

A hypothesis is a conjecture, based on knowledge obtained while formulating the question that may explain the observed behavior of a part of our universe. The hypothesis might be very specific. A statistical hypothesis is a conjecture about some population. For example, the population might be people with a particular disease. The conjecture might be that a new drug will cure the disease in some of those people. Terms commonly associated with statistical hypotheses are null hypothesis and alternative hypothesis. A null hypothesis is the conjecture that the statistical hypothesis is false. The alternative hypothesis is the desired outcome. A scientific hypothesis must be falsifiable, meaning that one can identify a possible outcome of an experiment that conflicts with predictions deduced from the hypothesis; otherwise, it cannot be meaningfully tested.

Prediction

This step involves determining the logical consequences of the hypothesis. One or more predictions are then selected for further testing. The more unlikely that a prediction would be correct simply by coincidence, then the more convincing it would be if the prediction were fulfilled; evidence is also stronger if the answer to the prediction is not already known.

Testing

This is an investigation of whether the real world behaves as predicted by the hypothesis. Scientists (and other people) test hypotheses by conducting experiments. The purpose of an experiment is to determine whether observations of the real world agree with or conflict with the predictions derived from a hypothesis. If they agree, confidence in the hypothesis increases; otherwise, it decreases.

Analysis

This involves determining what the results of the experiment show and deciding on the next actions to take. The predictions of the hypothesis are compared to those of the null hypothesis, to determine which is better able to explain the data.

1.2.0 Research in Science Education

About 40 years ago science education came to be recognized around the world as an independent field of research. The concerns of this research are distinct from the concerns of science and those of general education. Its methods and techniques were initially borrowed from the sciences but new methods are being developed suited to the research questions. Motivation for the research in science education came from the need to improve the practice of science education.

1. Studies in the 1970s typically compared experimental classrooms with controls. New teaching aids were tried out; lecture methods were compared with activity-based teaching, and so on. These studies gave useful results in particular contexts but it was hard to replicate them. Conditions in classrooms are varied; teacher and student characteristics too vary widely. Teaching and learning are complex, context-dependent processes and one needs to first describe this complexity in order to understand it, before eventually aiming to control it.

2. Research in science education has studied how students' learning follows from doing experiments or watching demonstrations. This research was stimulated as a consequence of evaluations carried out of the "inquiry" or "discovery approach" curricula that were implemented in UK, USA and in many developing countries too in the 1960s and 1970s.

3. Research on the role of language in science learning has led to better understanding of metaphor and analogy, and of how meaning is drawn from science activities.

4. A major finding of research has been that students hold conceptions about natural phenomena, which are different from what they are told in the textbook or what they are taught by the teacher. These are not simply wrong ideas but they follow their own logic and are often based on experience.

5. Since science education is dependent on context, it is important for research to be carried out in our own environment. Studies done in India have found that tribal students' knowledge about the living world is rich and largely reflects their environment and lifestyle. In comparison, urban students' ideas about living things are shaped by knowledge gained through books and stories. Conceptions about health and disease too have been found to be rooted in culture and environment

6. Science education research has drawn from, and also contributed to, the interdisciplinary field of cognitive science. The classical AI approach sees knowledge as stored in the form of propositions which can be represented as networks of nodes and links: i.e. concepts, and the relationships between them. This approach looks to characterize the knowledge frameworks of experts and novices and study the difference between them.

7. In the knowledge representation approach "learning", i.e. the transition from novice to expert performance, is seen as a re-structuring of students' frameworks of concepts and propositions. To test for such learning, new methods of assessment have been developed like, concept maps and semantic networks

Thus in the history of science education research, methods are devised and carried out in different ways to improve the teaching and learning of science. Concept mapping is one of the techniques considered to be useful in this process.

1.3.0. Concept Mapping

Before understanding the meaning and nature of concept mapping,it is necessary to define a concept. All disciplines dealing with different objects of study formulate a specific body of knowledge. This body of knowledge is represented in the form of concepts theories laws and principles. Concepts are the smallest unit of information about an object.

Novak (1984), based on Ausubel's (1968; 2000) and Toulmin's (1972) work, defines "concept" as a perceived regularity or pattern in events or objects, or records of events or objects, designated by a label.

1.3.1 Objects as concepts

Words are one way to describe and name concepts; they are used as labels for concepts. When a concept is named, the word is a label that maps onto our conceptual structure. The regularities in the object determine its category. Flavel, Miller & Miller (2002) roughly define a concept as a mental grouping of different entities into a single category on the basis of some underlying similarity – some way in which all the entities are alike, some common core that makes them all, in some sense, the same thing. The label for most concepts is a single word, although sometimes we use symbols such as + or %, and sometimes more than one word is used.

1.3.2 Events as concepts

The universe consists of objects and events. Both objects and events are needed to represent knowledge about the universe and its contents. We usually think of events as happenings such as a "party" or a "meeting". Happenings, however, include changes in status like occurrences or improvements. For example, "increase in quality of education" is an event-type concept, and so are "adoption of constructivism" and "growth of plants". An examination of a large number of concept maps has shown that the majority deal mainly with objects, not with events (Safayeni et al., 2005). Moreover, experiments and our experience show that using event-type concepts lead to concept maps that are more explanatory in nature, while object-type concepts lead to more descriptive, often classificatory, concept maps. Figure 2 shows a concept map where the concepts "Increase in Quality of Education" and "Move Towards Meaningful Learning" are events.

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. A conceptmap or conceptual diagram is a diagram that depicts suggested relationships between concepts (Peter. J. Hager, Nancy. C. Corbin). A concept map typically represents ideas and information as boxes or circles, which it connects with labeled arrows in a downward-branching hierarchical structure. The relationship between concepts can be articulated in linking phrases such as *causes*, *requires*, or *contributes to*. The relationship between concepts can be articulated in linking phrases such as causes, requires or contributes to.

A concept map is a way of representing relationships between ideas, images, or words in the same way that a sentence diagram represents the grammar of a sentence, a road map represents the locations of highways and towns, and a circuit diagram represents the workings of an electrical appliance. In a concept map, each word or phrase connects to another, and links back to the original idea, word, or phrase. Concept maps are a way to develop logical thinking and study skills by revealing connections and helping students see how individual ideas form a larger whole. An example of the use of concept maps is provided in the context of learning about types of fuel. A concept map is a type of **graphic organizer** used to help students organize and represent knowledge of a subject. Concept maps begin with a main idea (or concept) and then branch out to show how that main idea can be broken down into specific topics.

Used as learning and teaching technique, concept mapping visually illustrates the relationships between concepts and ideas. Often represented in circles or boxes, concepts are linked by words and phrases that explain the connection between the ideas, helping students organize and structure their thoughts to further understand information and discover new relationships. Most concept maps represent a hierarchical structure, with the overall, broad concept first with connected sub-topics, more specific concepts, following.

Concept maps were developed to enhance meaningful learning in the sciences. A well-made concept map grows within a *context frame* defined by an explicit "focus question", while a mind map often has only branches radiating out from a central picture. Some research evidence suggests that the brain stores knowledge as productions (situation-response conditionals) that act on declarative memory content, which is also referred to as chunks or propositions (Anderson, J.R, and Lebrie)

Because concept maps are constructed to reflect organization of the declarative memory system, they facilitate sense-making and meaningful learning on the part of individuals who make concept maps and those who use them.Concept maps make concepts, and propositions composed of concepts, the central elements in the structure of knowledge and construction of meaning. (11.)

A concept map can be a map, a system view, of a real (abstract) system or set of concepts. Concept maps are more free form, as multiple hubs and clusters can be created, unlike mind maps, which fix on a single two centered approach. Ray McAleese, in a series of articles, has suggested that mapping is a process of *off-loading*. McAleese suggests that the process of making knowledge explicit, using *nodes* and *relationships*, allows the individual to become aware of what they know and as a result to be able to modify what they know.

1.3.3 Characteristics of concept maps

Concept maps have specific characteristics that distinguish them from other knowledge representation tools. Not every graph with text in its nodes is a concept map, and the literature (and the Web) is full of diagrams that are wrongly depicted as concept maps. We review some of the key characteristics of concept maps.

1.3.3.1 Propositional structure

Concept maps express explicitly the most relevant relationships between a set of concepts. This relationship is depicted by means of the linking phrases forming propositions. When constructing a concept map, one needs to be careful that every two concepts together with their linking phrases form a unit of meaning, a claim, a short sentence. On occasions, a proposition will span across three or more concepts, but we try to avoid this to the extent possible. Thus a concept map consists of a graphical representation of a set of propositions about a topic.

In a concept map, each concept consists of the minimum number of words needed to express the object or event, and linking words are also as concise as possible and usually include a verb. There is no predefined list of linking words. We consider that a predefined list of words would restrict the users and, even if the list is not enforced, would tempt them to select from the list instead of attempting to find the linking words that best the depict the relationship according their understanding of the domain.

Propositions should not be confused with prepositions, which are a grammatical for such as "to", "by", "above", "of", etc. Unfortunately, in translations to Spanish of concept mapping documents, proposition has been often translated to preposition and there is now a widespread misconception in the Spanish-speaking part of the world that concept maps consist of concepts linked together by prepositions.

1.3.3.2 Hierarchical structure

Within any domain of knowledge, there is hierarchy of concepts, where the most general concepts are at the "top" of the hierarchy and the more specific, less general concepts are arranged hierarchically below. Concept maps tend to be represented in a graphically hierarchical fashion following this conceptual hierarchy. If Figure 1, the most general concepts "Concept Maps", "Focus Question(s)", "Associated Feelings or Affect" are close to the top of the hierarchy as they are more 'general' within the context of concept mapping, while "Infants", "Creativity" and "Experts" are further down the hierarchy. Because of this, concept maps tend to be read from the top, progressing down towards the bottom. Note that this doesn't mean that a concept map needs to have a graphically hierarchical structure: a concept map about the water cycle could be cyclic, while there is a still conceptual hierarchy of precedence or cause and effect in the concept map. Neither does it mean that concept maps need to have only one "root" concept -- there could be more than one. However, we have found that when learning to build concept maps, keeping the concept maps hierarchal with a single root makes it easier for the learner to grasp how concept maps are constructed.

1.3.3.3 Focus question

A good way to delineate the context for a concept map is to define a Focus Question, that is a question that clearly specifies the problem or issue the concept map should help to resolve. Every concept map responds to a focus question, and a good focus question can lead to a much richer concept map (see the companion document Why the Focus Question?). When learning to construct concept maps, learners tend to deviate from the focus question and build a concept map that may be (somewhat) related to the domain, but which does not answer the question. This is fine in the sense that the map built probably answers another focus question, and so the focus question of the map should be changed to reflect this. (CmapTools provides a field for the focus question as part of the information that is stored with a Cmap, and the focus question is displayed in the header of the window when a map is displayed, making the focus question explicit to the viewer). In the case of a school-learning environment, it may be important to have the learner go back and construct a concept map that responds the original focus question.

1.3.3.4 Cross-links

Another important characteristic of concept maps is the inclusion of cross-links. These are relationships or links between concepts in different segments or domains of the concept map. Cross-links help us see how a concept in one domain of knowledge represented on the map is related to a concept in another domain shown on the map. In the creation of new knowledge, cross-links often represent creative leaps on the part of the knowledge producer. There are two features of concept maps that are important in the facilitation of creative thinking: the hierarchical structure that is represented in a good map and the ability to search for and characterize new cross-links. In Figure 1, observe how the concept "Creativity" is linked to both "Infants" and "Interrelationships", each of which are in separate sub domains of the concept map, forming cross-links.

1.4.0 How to Build a Concept Map

Concept maps are typically hierarchical, with the subordinate concepts stemming from the main concept or idea. This type of graphic organizer however, always allows change and new concepts to be added. The Rubber Sheet Analogy states that concept positions on a map can continuously change, while always maintaining the same relationship with the other ideas on the map.

- **Start with a main idea, topic, or issue to focus on.**

A helpful way to determine the context of your concept map is to choose a focus question—something that needs to be solved or a conclusion that needs to be reached. Once a topic or question is decided on, that will help with the hierarchical structure of the concept map.

- **Then determine the key concepts**

  Find the key concepts that connect and relate to your main idea and rank them; most general, inclusive concepts come first, then link to smaller, more specific concepts.

- **Finish by connecting concepts--creating linking phrases and words**

  Once the basic links between the concepts are created, add cross-links, which connect concepts in different areas of the map, to further illustrate the relationships and strengthen student's understanding and knowledge on the topic.

1.5.0 Collaborative Concept Mapping

The concept mapping when done by a group of three to four, by compiling and synthesizing ideas is called as collaborative concept mapping. The task of the teacher is to guide the students so as to work in groups and prepare concept maps with discussion among themselves.

1.6.0 Theoretical Foundations

The technique of concept mapping was developed by J.D. Novak and his research team at Cornell University in the 1970s as a means of representing the emerging science knowledge of students. It has subsequently been used as a tool to increase meaningful learning in sciences and other subjects as well as to represent the expert knowledge of the individuals and teams in education, government and business. Concept maps have their origin in the learning movement called constructivism .In particular; constructivists hold that learners actively construct knowledge.

Novak's work is based on the cognitive theories of David Ausubel (assimilation theory), who stressed the importance of prior knowledge in being able to learn new concepts: "The most important single factor influencing learning is what the learner already knows. Ascertain this and teach accordingly."[8] Novak taught students as young as six years old to make concept maps to represent their response to focus questions such as "What is water?" "What causes the seasons?"

In his book *Learning How to Learn*, Novak states that a "meaningful learning involves the assimilation of new concepts and propositions into existing cognitive structures."

Assimilation theory:

According to Ausubel, "the most important single factor influencing learning is what the learner already knows" (Novak). Relationships between concepts are formed when two concepts overlap on some level. As learning progresses, this network of concepts and relationships becomes increasingly complex. Ausubel compares meaningful learning to rote learning, which refers to when a student simply memorizes information without relating that information to previously learned knowledge. As a result, new information is easily forgotten and not readily applied to problem-solving situations because it was not connected with concepts already learned.

However, meaningful learning requires more effort, as the learner must choose to relate new information to relevant knowledge that already exists in the learner's cognitive structure. This requires more effort initially, however after knowledge frameworks are developed, definitions and the meanings for concepts become easier to acquire. Further, concepts learned meaningfully are retained much longer, sometimes for a lifetime.

Rote learning, common in many schools and universities today, is shown to be of little use for achieving the goals of individuals and society in a time when creative production of new knowledge is in heightened demand. Knowledge creation is viewed as a special form of meaningful learning.

Three basic requirements for meaningful learning include: a learner's relevant prior knowledge, meaningful material (often selected by the teacher) and learner choice (to use meaningful learning instead of rote learning). An important advantage of meaningful learning is that it can be applied in a wide variety of new problems or contexts. This power of transferability is necessary for creative thinking.

Various attempts have been made to conceptualize the process of creating concept maps. Ray McAleese, in a series of articles, has suggested that mapping is a process of *off-loading*. In this 1998 paper, McAleese draws on the work of **Sowa** and a paper by Sweller& Chandler.In essence, McAleese suggests that the process of making knowledge explicit, using *nodes* and *relationships*, allows the individual to become aware of what they know and as a result to be able to modify what they know. Maria Birbili applies that same idea to helping young children learn to think about what they know. The concept of the Knowledge **Arena** is suggestive of a virtual space where learners may explore what they know and what they do not know.

1.7.0 Rationale of the Study

Science has always fascinated us, with the discoveries and inventions. Learning of science requires development of logic. Since science as a discipline strives hard to develop the ability to comprehend and reason it is highly felt by the researcher that there is a requirement to devise a teaching strategy fit for the purpose. Much of the research has occurred in the science education regarding the teaching techniques, assessment and evaluation. Finding the gaps in the previous researches helped me to understand that not much of work has been done in the dimensions of collaborative concept mapping. The intention behind the study is not only to check the effects, but to add to the science education in the form of a teaching strategy. The study will be helpful in addition of a modified teaching learning strategy in science.

1.8.0. Statement of the Problem

The present study intends to study whether the technique of collaborative concept mapping is useful in refining the student's comprehension of content in science. Also the study seeks to answer the question of refinement of student's participation and involvemnt in the class.The problem may be worded as follows:

"THE EFFECT OF COLLABORATIVE CONCEPT MAPPING ON THE COMPREHENSION OF CONTENT IN SCIENCE OF CLASS VIII STUDENTS"

1.9.0. Definition and Explanation of the Terms Used

1. ***Collaborative concept mapping:*** The construction of concept maps which are diagrammatic representations which show meaningful relationships between concepts in the form of prepositions, which are linked together by words, circles and cross links. Concept maps are arranged hierarchically with the super-ordinate at the bottom which are less inclusive than the higher ones. It is a constructivist approach in which the students try to derive meaning out of a concept by analyzing and synthesizing it with the aid of concept map. In this technique the students work in groups and prepare concept map together (collaboratively) with the guidance of the teacher.

2. ***Comprehension of content in science:*** Comprehension means 'logic': the totality of intentions i.e. properties or qualities that an object possesses. Comprehension in science involves the ability to understand a scientific concept by linking its properties and components correctly.

1.10.0. Variables under the Study

Variables are the characteristics or the conditions that a researcher observes, controls and manipulates in order to carry out the study.

The present study has got three types of variables:

1. Collaborative Concept mapping (independent variable): Since the technique of learning will be altered and its effects will be observed on the other variable, concept mapping will be the independent variable of the study.

2. Comprehension of the content (dependent variable): It depends upon the way content is presented and learnt by the students in the form of concept maps. Since the understanding of the concept depends upon various factors out of

which the study focuses on concept mapping. Content comprehension will be the dependent variable of the study.

3. Extraneous variables: Some variables affect the conditions of the experimental concern, along with the independent variables. Such factors are called extraneous variables. The present research has the following extraneous variables: pretest.

1.11.0 OBJECTIVES OF THE STUDY

1. To study the effect of collaborative concept mapping on the comprehension of content in science of the students of class VIII.

2. To study the effect of gender on the comprehension of content in science of the students of class VIII.

3. To study the effect of interaction of gender and the treatment (collaborative concept mapping) on the comprehension of content in science of the students of class VIII.

1.12.0 HYPOTHESES

1. The students taught through collaborative concept mapping will gain significantly higher score as compared to students taught through traditional method.
2. There is no significant effect of gender on the comprehension of content in science of class VIII students.

3. There is no significant effect of interaction of gender and the treatment on the comprehension of content in science of class VIII students

1.13.0 DELIMITATIONS OF THE STUDY

Although the research intends to study the whole population, but due to time constraint the following research will be delimited to a particular area. So that the study can be done exclusively on the selectcd participants and as exact as possible results could be drawn.

1. The study has been delimited to a government school of Bhopal.
2. The study has been delimited to the Demonstration Multipurpose School.
3. The study has been delimited to the students of class 8.