

# Concept Mapping as an Effective Teaching Practice in Science in Education

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**Paper no:** 57 **Received:** 9 Feb 2013 **Revised and Accepted:** 20 May 2013

## Abstract

To impart instructions in science keeping in view the dynamic nature of learner, subject and environment there is imperative need to work out some constructivist approach which must focus on meaningful learning also-Concept Mapping is such response in this regard which, being a two dimensional technique for hierarchical arrangement of concepts, sub concepts and their relationship(s), represents the cognitive structure of learner with respect to the concerned concept(s) in context. Over the years, the effectiveness of concept mapping as instructional -, diagnosing-, evaluative -and nurturing tool has been positively proved.

**Keywords:** Concept mapping, Concept, Propositions

## Introduction

Science is an accumulated and systematized learning in general usage restricted to the natural phenomenon. Science is a cumulative and endless series of empirical observations, which result in the formation of concepts and theories, with both concepts and theories being subject to modification in the light of further empirical observations. Science is both a body of knowledge and the process of acquiring it. The first aspect indicates science as a product while second aspect indicates science as a process. In other words, science is both a product as well as process of knowledge acquisition. In its process form it suggests the ways and means of exploring the truth and in its product form it presents a systematic and organized body of useful knowledge. The process form of science is more important than its product form as the way of exploring the truth and acquiring knowledge is always given more preference in sciences than the mere memorization or gaining knowledge of the accumulated facts. The science constantly remains in the search for truth and what it gets on account of this search can never be taken as absolutely and permanently true. These results can be challenged and modified or altered in view of further explanations and findings. Therefore science by its nature is always dynamic, not static.

Science education is an integrated concept arrived by linking science and educational psychology. Science education, in developing countries like India, should keep into consideration the following aspects:-

- There must be active involvement of students in seeking information for use.
- To enable the students to identify problems with local interest/impact.

- Teaching must go beyond a given series of class sessions.
- Science being experience that students are encouraged to have.
- There should be an environment which should foster learning with a focus on the future.
- Learning should take place because of activity.
- Students should readily see the relationship of science processes to their own actions

So, it requires on the part of the teachers to impart science instruction keeping in view the dynamic nature of science because teaching is not merely transmitting information; it is mutually beneficial interaction between teacher and students that catalyzes knowledge construction and meaning making. In this regard, helping students in making conceptual connections so that his/her prior knowledge is taken into account and he/she actively constructs knowledge-concepts mapping, as an effective teaching practice can be relied upon. Concept mapping developed by Professor Joseph D. Novak of Cornell University (1983), is a two dimensional technique for visually representing the hierarchical arrangement of concepts as well as their relationships also. Concepts are defined as a perceived regularity in events or objects or records of events or objects, designated by a label. The label for most concepts is a word. Though hierarchical arrangement of concepts in a concept map, generated by concept mapping, means that the concepts are arranged with the most inclusive, general and concrete concepts at the top of the concept map and the more specific, less general, abstract concepts arranged hierarchically below. The hierarchical structure for a particular domain of knowledge also depends on the context in which that knowledge is being applied or considered. Therefore, it is best to construct concept maps with reference to some particular question to which answer is sought or some situation or event that the learner is trying to understand through the organization of knowledge in the form of a concept map. Concept maps are an offshoot of Ausubel's theory of meaningful learning and help in developing the Meta cognitive skills of learners. Another important feature of concept maps is the relationships between the concepts and this relationship is indicated by word(s) or phrases. These word(s) or phrase are called propositions. These are relationships (propositions) between concepts in different domains of the concept map that reflect another important characteristic of concept map which is the inclusion of "cross links" which help to see how some domains of knowledge represented on the concept map are related to each other. In the creation of new knowledge, these cross links often represent creative leaps on the part of knowledge producer. Thus, these two features of concept maps namely the hierarchical structure of concepts and relationships between the concepts are helpful in the facilitation of creative thinking.

#### • Steps in the construction of a concept map

Following are the steps involved in the construction of a concept map:

- In learning to construct a concept map, it is important to begin with a domain of knowledge that is very familiar to the learner, constructing the map. Since concept map structures are dependent on the context in which they will be used, it is best to identify a segment of a text, a laboratory activity, or a particular domain or a question that one is trying to understand. This creates a context that will help to determine the hierarchical structure of the concept map. It is also helpful to select a limited domain of knowledge for the concept maps.
- Once a domain has been selected, the next step is to identify the key concepts that apply to this domain. These concepts should be listed.

- From the listed concepts a rank order is established from the most general, inclusive concept to the most specific, least general concept. Although, this rank order may be only approximate, it helps to begin the process of map construction.
- After the hierarchical arrangement of concepts, cross links are sort/searched. These links between different domains are related to one another, hence the concepts.
- After this, the suitable word(s), phrases etc. should be placed between the linked concepts which serve as propositions.
- Finally, the map should be revised and thus a “final” map is prepared.

Now as an example consider the concept map for the topic “Structure of Atom” of IX standard.

### Uses of concept maps

Concept mapping has a variety of applications within a broad range of domains. It can be used to:

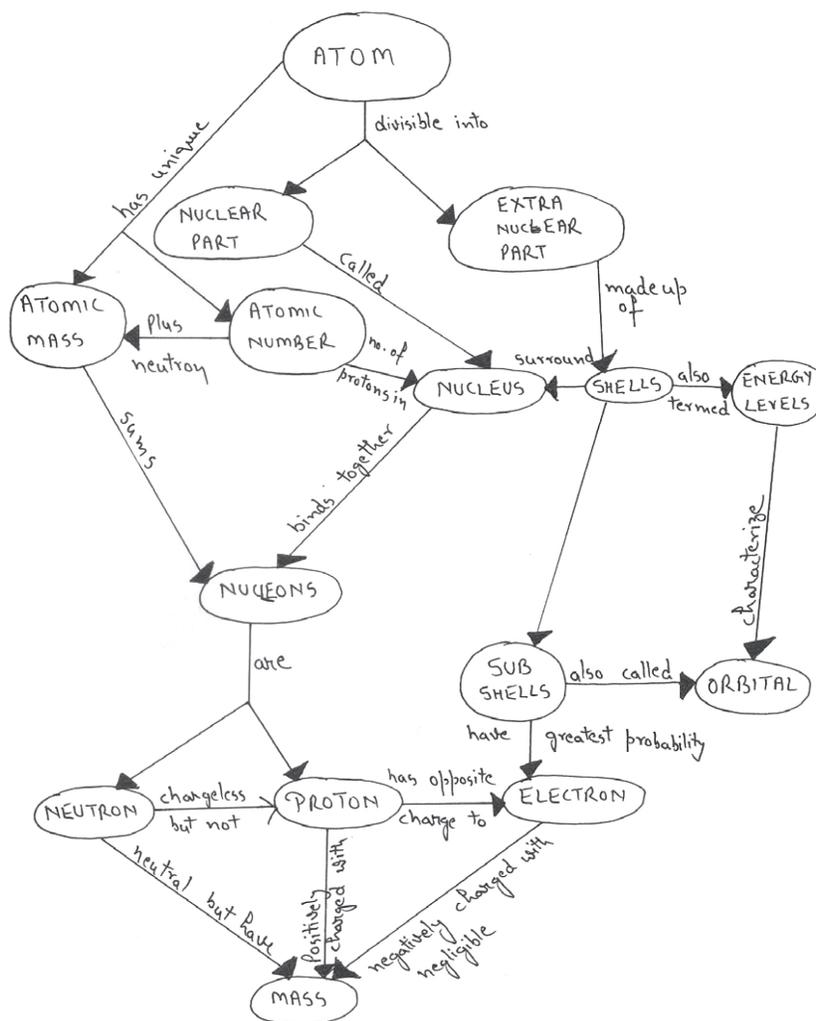
- Generate ideas (brain storming) etc.
- Design a complex structure (long texts, hypermedia, large website etc.)
- Communicate complex ideas
- Aid learning by explicitly integrating new and old knowledge
- Assess understanding or diagnose misunderstanding.
- Enhance the problem-solving phases of generating alternative solutions and options.
- Facilitate knowledge elicitation and management.
- Encourage positive self concept (Plotnick, 1997, Gaines and Shaw, 1995, Seaman, 1990, Williams, 1997)
- The use of concept maps is becoming more widespread in sciences. Researchers have found that the concept mapping should be recommended” as means of producing meaningful learning in the analysis of scientific articles as well as enhancing the integration of theory and practice” (Peled, Barenholz *et al.*, 1993) and is also an effective means of bridging the gap between conceptual and procedural knowledge (Khan, 1993)

### Concept mapping in class-rooms

Concept mapping as an effective teaching practice can be used in class-rooms with respect to the following aspects:

### Concept mapping as an instructional tool

Concept mapping as an instructional tool has been widely used across different academic levels that are from primary to university. Concept mapping is effective in comparison to the conventional method of instruction in generating a significant difference on the academic gain or achievement, self-monitoring, knowledge acquisition, self-efficacy (Chulart, 2003). Some studies have taken into account extreme groups of the students with respect to achievement (Merill, 1987), aptitude (Draheim, 1986) and proficiency (Chulart, 2003). Some other studies revealed that students had positive perceptions, attitude towards concept mapping (Taylor, 1985; Wood, 1992; Wholeben, 1994). Concept mapping facilitates the students to increase



the integration of knowledge, make sense of the learning material, clarify connections among concepts (Heinze-Fry,1987).Concept mapping helps in drawing representations and facilitates the students in organizing knowledge base like an expert (Michael,1994).It is helpful in developing students' reasoning skills. Concept mapping as an instructional tool proves effective for the individuals of different cognitive levels (Shopper,1993).Concept mapping is quite effective in , in problem solving , in facilitating the students to outperform their counterparts on using novel problem-solving (Novak,1984) and also as an alternative learning method for low achieving students(Huang,1991).

### Conclusion

The instructional effects of concept mapping in comparison to conventional method are quite apparent as it takes into account students' cognitive structure and the cognitive structure is the most important variable affecting the meaningful learning (Ausubel,1963).

- Concept mapping as an instructional tool leads to the development of structural or conceptual hierarchy.
- Concept mapping enables a student to process the information because the teacher acts as the presenter of the information. Also concept mapping aims at the teaching and learning of concepts at “understanding level” in a meaningful way.

### **Concept mapping as a diagnosing tool**

Concept mapping as a diagnosing tool is effective in providing a clear picture of students’ understanding/ misunderstanding and a complete, unified understanding of the subject (Feldsine, 1987). The term diagnosing tool means the ability of concept mapping to find out, detect, search or diagnose the wrong concepts among the students. Such kind of diagnosis facilitates to find out obstructions in the cognitive structure with respect to the learning material. Incorrect propositions reflect that such students are clear about the relationship of the two concerned concepts but what kind of relationship should be there between those concerned concepts may not be clear to them. Correct propositions but with wrong direction of linkage between two relevant concepts shows that these students are not clear about the hierarchy of the concepts.

Concept mapping, as a diagnosing tool, is effective in identifying both valid and invalid ideas held by the students.

### **Concept mapping as an Evaluative tool**

Studies have explored the effectiveness of concept mapping as an evaluative tool with positive results (Feldsine, 1987; Wallace, 1989; Lavie, 1990). Other studies (like Bar-.Lavie, 1987; Beyerbach, 1988; Schreiber, 1990; Coleman, 1994; Michael, 1994; Wholeben, 1994) have proved that concept maps may be used as an index of cognitive structure and can be a valuable evaluative tool also. Concept mapping can be used as a technique for conceptual change.

Concept mapping can detect the extent of understanding of concepts and structure of knowledge. Concept maps as evaluative measures are able to reflect differences in the concept and propositional knowledge of students.

### **Concept mapping as a Nurturing tool**

Concept mapping as a nurturing tool facilitates the nurturing of creativity among the students in problem-solving situations that is, in generating the creative solutions of the problems (Ahuja, 2007).

Concept mapping as a nurturing tool facilitates to inculcate creativity by enabling the students to use novel concepts for drawing a concept map, incorporate relevant propositions and link one example with more than one relevant concept. The last aspect measures the diversification of the thinking as the greater the number of examples linked with more than one relevant concept greater is the divergent thinking employed by the student.

Thus, concept mapping can be used to assess or describe a variety of constructs and outcomes as well as in instruction. Concept mapping helps in the organization and representation of knowledge which ultimately raises the quality of learning and leads to meaningful learning. So, concept mapping can be practiced as a versatile and promising tool in the area of science education.

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