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Effectiveness of Concept Mapping and Mind Mapping in Science Teaching

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Abstract

In recent years, constructivist theory has received considerable attention in education scholarship, practitioner preparation, and policy formation. The constructivist epistemology assumes that students construct their own knowledge on the basis of interaction with their world and communication with their teachers. Significant amongst such teaching strategies are the use of: concept and mind mapping techniques. There is empirical support for the use of mapping in enhancing, retaining and improving knowledge. Evidence from the cognitive sciences shows that visual displays do enhance the learning. Concept mapping is often confused with mind mapping. So, this paper attempts to compare the two strategies and also throws light upon the researches conducted to study their effectiveness in science teaching.

Keywords: **Mind Mapping, Science Teaching, learning**

Introduction

Teaching science in middle school is both rewarding and demanding. Creating an exciting learning environment with a rich science curriculum that engages all students is challenging enough. Monitoring the progress of the individual students and knowing that they understand the science concepts which are being taught can be overwhelming. In recent years, constructivist theory has received considerable attention in education scholarship, practitioner preparation, and policy formation (MacKinnon & Scarff Seatter, 1997; Richardson, 1997). The constructivist epistemology assumes that students construct their own knowledge on the basis of interaction with their world and communication with their teachers. Over the last two decades the constructivist perspective and its associated teaching strategies have emerged as prominent approaches to the teaching of sciences at both high school and university levels. Significant amongst such teaching strategies are the use of: concept and mind mapping techniques. Within a constructivist framework, learning takes place as learners progressively differentiate concepts into more complex understandings and also reconcile abstract understanding with concepts acquired from experience. There is empirical support for the use of mapping in enhancing, retaining and improving knowledge. Evidences from the cognitive sciences shows that visual displays do enhance learning (Vekiri 2002; Winn 1991). Maps allow the separate encoding of information in memory in visual and well as propositional form, a phenomenon called ''conjoint retention'' or ''dual coding'' (Kulhavy et al. 1985; Paivio 1971, 1983; Schwartz 1988).

When a constructivist approach is adopted, mind mapping and concept mapping prove to be effective tools in facilitating meaningful learning (Akinoglu & Yasar, 2007, Buzan, 1996, Erdogan, 2008, Riley & Ahlberg,

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2004). Constructing concept and mind maps help students understand the linkages between concepts and ideas and their relationship with other interdisciplinary knowledge bases. It promotes the development of abilities of students to integrate a range of scientific knowledge, facts and theories which may be drawn from a range of different but inter-related disciplines. Mind mapping allows students to imagine and explore associations between concepts; concept mapping allows students to understand the relationships between concepts and hence understand those concepts themselves and the domain to which they belong.

Mind maps

Mind mapping (or ''idea'' mapping) has been defined as 'visual, non-linear representations of ideas and their relationships' (Biktimirov and Nilson 2006). Mind maps comprise a network of connected and related concepts. However, in mind mapping, any idea can be connected to any other. Free-form, spontaneous thinking is required when creating a mind map, and the aim of mind mapping is to find creative associations between ideas. Thus, mind maps are principally association maps. Usually contain general concepts at the top of the map, with more specific concepts arrayed hierarchically below. Connector lines usually contains keywords or phrases that summarize the relationship between the topics they connect. Topics may be cross-linked with each other to depict more complex relationships between topics. Topics in mind maps may only have one parent; in a concept map, a topic may have multiple connector lines, each one representing a different relationship.

Mind Mapping for teaching and learning Science

The mind map is a tool that helps students think and assimilate new knowledge and develop new and more complex conceptual schemas. It consists of a central idea to which related concepts are linked. Mind maps are commonly used to organize and represent tacit knowledge.

Researches on effectiveness of mind mapping technique in teaching and learning reveal the following benefits: Evreklia, E, Balim, A. G., and Inela D. (2009) Study showed that mind maps provide an effective study technique in improving the long-term memory of factual information in science subject by 10%.The

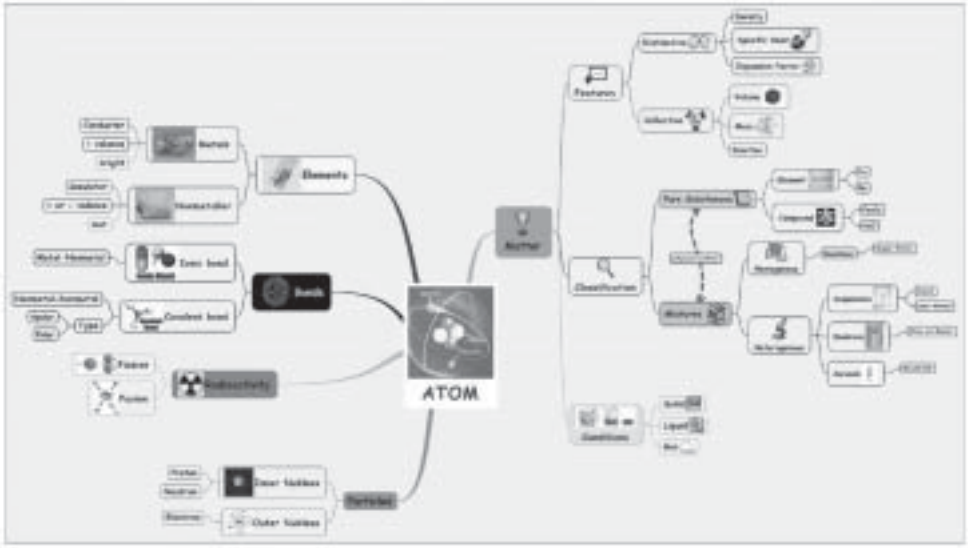

Fig. 1: An example of a Mind Map

effectiveness of mind mapping in teaching and learning science is demonstrated by Goodnough, K. and Long, R. (2006) study which found that the teacher enjoyed using mind napping and the technique fostered student motivation in learning science.

Concept Maps

Concept mapping is a process of meaning construction. The concept maps (CMs) that result from this process are diagrams – usually bi-dimensional – that illustrate relationships between two or more concepts. Concepts can be defined as regularities perceived in objects, events, situations, or properties (Novak & Gowin, 1984).

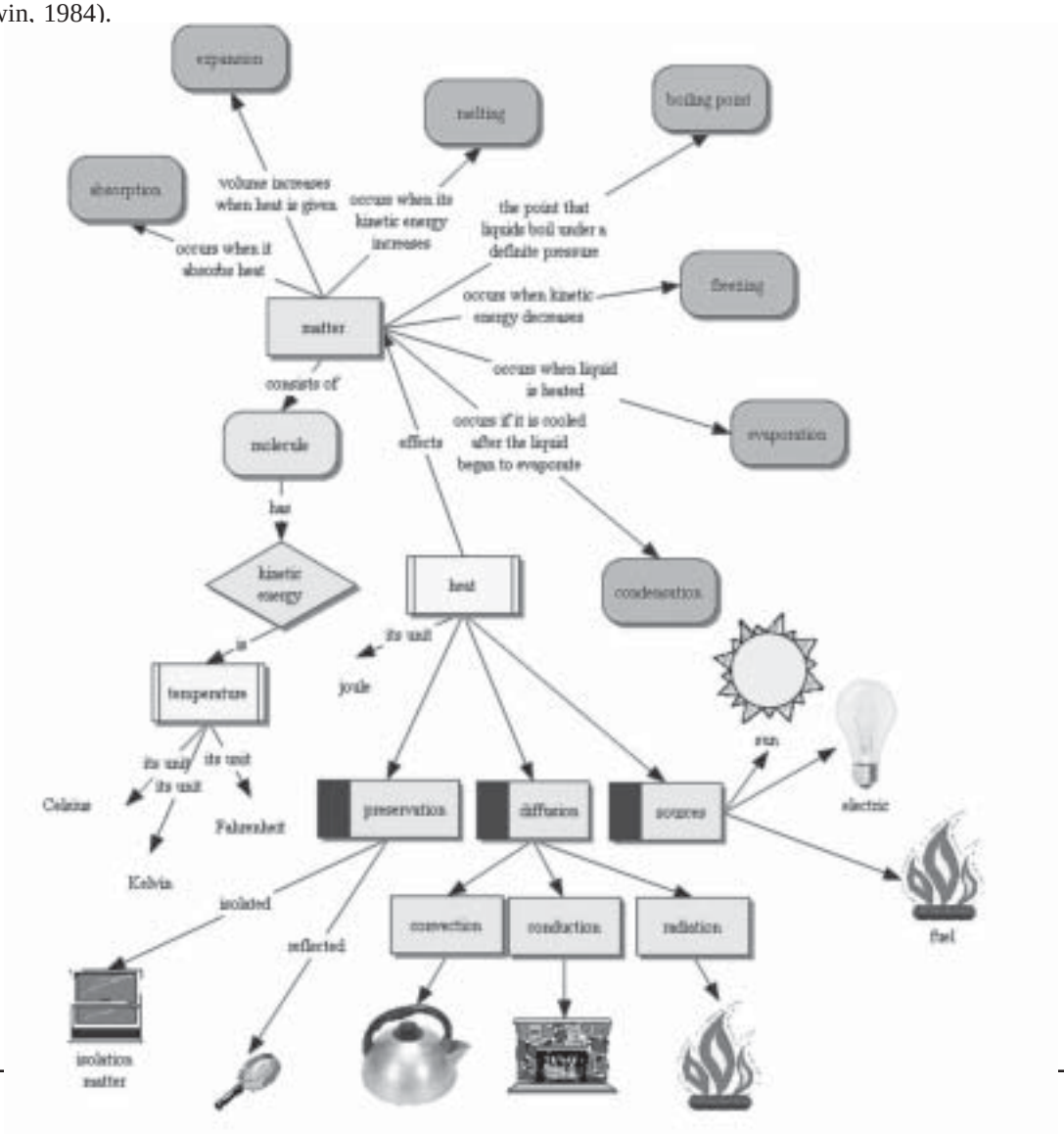

Fig. 2: An example of a concept map

Concept mapping is often confused with mind mapping (Ahlberg 1993, 2004; Slotte and Lonka 1999). However, unlike mind mapping, concept mapping is more structured, and less pictorial in nature. The aim of concept mapping is not to generate spontaneous associative elements but to outline relationships between ideas. Thus, concept mapping is a relational device. A concept map has a hierarchical ''tree'' structure with super-ordinate and subordinate parts (primary, secondary and tertiary ideas). The map normally begins with a word or concept or phrase which represents a focus question that requires an answer (Novak and Can˜as 2006). Cross-links using connective terms (usually prepositional phrases) such as ''leads to'', ''results from'', ''is part of'', etc., are used to show relationships between concepts represented.

Concept Mapping for Teaching and Learning Science

The concept map is a technique for representing knowledge in graphs; it is a very useful and effective tool for students to learn science subjects. Concept maps provide a unique graphical view of how students organize, connect, and synthesize information. As a result, concept mapping offers benefits to both students and teachers. Concept maps give students an opportunity to: (1) think about the connections between the science terms being learned, (2) organize their thoughts and visualize the re-lationships between key concepts in a systematic way, and (3) reflect on their understanding. In sum, concept maps allow students to think deeply about science by helping them to better understand and organize what they learn.

Table 1: A Comparison of Concept Maps and Mind Maps

Parameter	Concept map(J.D Novak)	Mind map (T. Buzan)
Definition	A concept map is atop-down diagram showing the relationshipsbetween concepts,including crossconnections amongconcepts, and theirmanifestations	A mind map is a multicolouredand image centred,radial diagramthat represents semanticor other connectionsbetween portionsof learned materialhierarchically
Main function orbenefit	Shows systematicrelationships among sub-concepts relatingto one main concept	Show sub-topics of adomain in a creativeand seamless manner
Typical applicationcontext	Classroom teaching,self study and revision	Personal note takingand reviewing
Reading direction	Top-down	Center-out
Core design rules or Guidelines	Start with mainconcept (at the top), and end with examples(bottom, withoutcircles); boxes/bubblesdesignate concepts,arrows representrelationships; includecross-links amongelements	Start with main topic(center) and branchout to sub-topics,employ pictograms andcolors to add additionalmeaning. Writetext above the branches
Macro structure Adaptability	Flexible, but alwaysbranching out	Somewhat flexible, but alwaysRadial
Advantages	1. Rapid information Provision 2. Systematic, proven approach to provide overview 3. Emphasizes relationships and connections among concepts 4. Ability to assess quality of concept map through evaluation rules	1. Easy to learn and Apply 2. Encourages creativity and self-expression 3. Provides a concise hierarchicOverview 4. Easy to extend and add furtherContent
Disadvantages	1. Not easy to apply bynovices; requires extensivetraining 2. Concept maps tend to be idiosyncratic 3. Time consuming evaluationthrough tutors 4. The overall patterndoes not neces sarilyassist memorability	1. Idiosyncratic, hard toread for others 2. Represents mostlyhierarchic relationships 3. Can be inconsistent 4. Can become overlycomplex (loss of bigpicture

Conclusion

While the overriding objectives of the two mapping tools are similar, there are differences in their application. Mind maps are intended to help develop strategies, as a technique for brainstorming. Concept maps are intended to have a pedagogical function, and to serve as a method for presenting information and for assessing students' understanding of information in the science subjects. The difference between mind mapping and concept mapping is also at the level of precision and formality. Mind maps are less formal and structured. Concept maps are formal and generally more tightly structured. Mind maps emphasise diagrams and pictures to aid recall of associations; concept maps generally use hierarchical structure and relational phrases to aid understanding of relationships. The use of these techniques in science teaching is a development which will enrich and provide new directions in education in the future.

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