

## **Concept-Mapping Software: How effective is the learning tool in an online learning environment?**

Online learning environments address the educational objectives by putting the learner at the center of the educational experience. They do so by addressing many of the problems that traditional learning environments present. For example, students memorizing material and using repetition as a means of retaining that material is often used in the traditional learning environment. This method often presents the same material in different ways, which doesn't mean that it is necessarily effective. In online educational environments, the learner is stimulated to further explore for information and practical examples. As learning becomes more and more self-directed, the students as well as the educator begin to seek tools that will enhance this quest for knowledge.

This paper will attempt to present a case that the concept map is one of the most effective learning tools used in the online educational environment to date.

### **History of Concept-mapping**

According to Joseph Novak, a Cornell University professor who developed the idea in the 1960's, concept maps are tools for organizing and representing knowledge. They include concepts, usually enclosed in circles or boxes, and relationships between concepts, indicated by a connecting line between two concepts. Concepts are represented in a hierarchical fashion with the most comprehensive concepts at the top of the map and the more detailed specific concepts at the deeper level. Using the computer to develop concept maps has many advantages. They are much easier to correct, manipulate and adapt than a paper generated concept map. Concept maps can be converted into multiple formats, and can be sent to the educator or a peer via email for immediate analysis and feedback. With the multi-level functionality of some concept maps, such as SMART Ideas® concept-mapping software, it also provides a more advanced level of understanding in that the learner can add as many deeper levels of understanding as they need to completely comprehend the concepts.

Novak initially based his research on the learning psychology of David Ausubel and in particular his *Meaningful learning theory*. This theory concludes that learning new knowledge is dependent on what is already known. In particular, new knowledge gains meaning when it can be largely related to a framework of existing knowledge rather than being processed and stored in isolation according to more or less random criteria.

According to Novak, new concepts are acquired either by *discovery learning*, which is mainly the way young children acquire their first concepts and language, or by *reception learning*, which is the way school children and adults acquire most of their meanings. Novak elaborates by claiming that the problem with reception learning in schools is that students learn to memorize material rather than obtaining the meanings of the concepts in the material. By using concept maps, the learning process becomes active rather than passive.

There are three other theories in which concept mapping is based: *Dual coding theory*, *Schema theory* and *Cognitive load theory*.

*Dual coding theory* places equal importance on both verbal and non-verbal processing. It assumes there are two cognitive sub-systems; one specialized for the representation and processing of non-verbal objects and the other specialized for dealing with language. It is built on the use of imagery in associative learning. Verbal learning is most effective when accompanied by visual learning. Since there are two cognitive processes, they support each other.

Images and graphics enhance learning in many ways, which is why concept mapping is an effective learning and planning tool. The images promote learning by motivating the learner and facilitating recall and understanding. (1)

*Schema theory* states that comprehension occurs when a reader is able to use prior knowledge and experience to interpret content. This knowledge that is accessed during reading is called a schema.

A concept map is a way that students can use on their own for schema construction and application because they are designed to help the reader clarify ambiguities of a text while at the same time revealing any misconceptions that may result from reading. In order for schema construction to happen, a framework needs to be provided that helps readers to elaborate upon new facts and ideas and to clarify their significance or relevance. (2)

*Cognitive load theory*, as defined by Sweller (1988), states that optimum learning occurs in humans when the load on working memory is kept to a minimum to best facilitate the changes in long-term memory. The working memory is limited to seven chunks of information at the same time. Sweller states that learning requires a connection to the schematic structures of long-term memory and if the connection is not made, the learner will most likely forget the material. Therefore, it is essential that instructional designers or educators designing their own online curriculum, to group information in smaller segments so the working memory is not overloaded and information can be passed to long-term memory more efficiently allowing learning to occur.

### **Concept mapping as a Learning Tool**

Concept mapping is a powerful learning tool in the facilitation of meaningful learning because it serves as a template to aid in the organization and structuring of knowledge even though this knowledge is built up piece by piece. It helps in the utilization of the knowledge in new contexts but also in the retention of knowledge for a long period of time. “Give students time and guidance to make connections to prior learning. This can be done through discussion, mapping and journaling”...”talking, sharing, and discussing are critical; we are biologically wired for language and communicating.” (3)

Because the mind likes patterns and the brain is always trying to create meaning, Patty AcheyCutts explores brain concepts and how to design a brain compatible learning environment by offering suggestions for connecting technology and brain concepts to enhance student learning. One of these explored concepts is meaning. She states that graphic organizers and software, such as SMART Ideas concept mapping software, allows students to create a graphic representation of their learning/thinking. Having students create a graphic representation of their learning opens a window to their understanding. For example, students can use a concept map to summarize a book they have read and both student and teacher can quickly determine how well the student actually comprehends the story.

Taking a constructivist approach will also help in understanding the use of concept maps in the online educational environment. Constructivist learning theory holds that “learners actively construct and reconstruct knowledge out of their experience in the world.” Constructivists believe that individuals learn through their experience and that meaning is rooted in experience. The key to learning is for the learner to find multiple ways to link new information to previous experience.” To facilitate the constructivist learning approach in an online environment, concept maps are often used to link the information together. The process of actually creating a concept map is a significant learning strategy that is graphic and forces the learner to think about the relationships between terms. Students can identify key concepts and show the relationships between them, which aids their understanding more clearly the meaning of material.

There are seven principles of the constructivist learning theory that are important to note in fully understanding its relevance as one of the underlying theories of concept mapping.

1. *Knowledge and beliefs are formed within the learner*

Within the constructivist learning theory, learners create their own knowledge by how they put their worlds together. In other words, Constructivists focus on the connections that the learner is making between ideas. The crucial element is that they learner actively creates a knowledge base through the linkages and experiences.

2. *Learners personally imbue experiences with meaning*

Creating meaning in a constructivist view consists of analyzing and synthesizing experiences so that new understandings are developed.

3. *Learning activities should cause learners to gain access to their experiences, knowledge and beliefs*

Constructivists believe that learning activities should foster an integration of thinking, feeling and acting which assists the learner in the process of developing meaning.

4. *Learning is a social activity that is enhanced by shared inquiry*

One of the goals of constructivist learning is to foster the development of shared meaning between facilitator and learner or between learners as a group. Learner and facilitator probe the connections between new information and previous experience with the idea of developing a mutual understanding.

5. *Reflection and metacognition are essential aspects of constructing knowledge and meaning*

For learners to construct meaning, they need to understand and analyze their own learning processes. Constructivists therefore promote the process of learning how to learn by incorporating reflective and metacognitive strategies into the learning design.

6. *Learners play a critical role in assessing their own learning*

Learners are actively involved in the assessment process and articulate what they have learned and how they have made the connections to their previous experiences.

7. *The outcomes of the learning process are varied and often unpredictable.*

Learners make meaning from new information in light of their personal experiences and thus, unexpected outcomes are common and unique.

Constructivist learning theory can be applied in the online learning environment when there are opportunities for learners to engage in creative and collaborative activities that encourage knowledge construction. If learners are empowered to choose what to create, they are more likely to be personally invested in the activity. Constructivists realize that learners have their own personal learning style and skills therefore a rich learning environment is necessary to allow for multiple learning styles and representations of knowledge learned. (4)

Because concept maps can serve a number of purposes, they are also great productivity tool and time-saver. Therefore, concept maps are not only used as a learning tool but also are quite effective as a planning and assessment tool.

### **Concept Maps as an Assessment Tool**

Concept maps can be used as a way to trace, document and evaluate student learning and knowledge acquisition. Instead of using the various modes of testing that most educators use to assess students' knowledge, such as a multiple choice or fill in the blank test, a more effective practice would be for the student to construct a concept map. The concept map will illustrate their understanding of the important concepts of the material recently

learned. This method would provide the educator with a more effective and easy way to evaluate and also document student progress.

By reviewing a student's concept map from top to bottom, layer upon layer, the educator can gain insight into the way the student perceives a topic, examine the valid understandings and misconceptions that the student may hold, and assess the structural complexity of the relationships the student illustrates.

As stated above, each learner has his or her own unique learning style and skills, and the use of the concept map further enhances this customized approach to learning through self-assessment. This is particularly useful in the online environment where students can share his or her concept map to compare the levels of understanding. If a student hasn't completely grasped the main concepts, it is immediately obvious. When such inconsistencies occur, students can work together to help figure out where the problem lies, going back and manipulating the nodes and connectors that will make sense to that student. (5)

According to Rice, Ryan & Samson (1998), there is an increasing tendency to replace traditional assessment with alternative assessment, such as the concept map, for collecting information about student's ability and acquisition of knowledge. Labeling the concept map as an alternative assessment doesn't mean that it isn't a successful measure of assessing student's knowledge of facts, terms and concepts. Ruiz-Primo and Shavelson (1996) state that the concept map can be used to measure the construction of students' conceptual knowledge structure. They provide three characteristics of a concept map-based assessment:

1. A task that requires students to give evidence of possession of knowledge structure of a domain
2. A format for student's response
3. A scoring system by which concept maps produced by students can be evaluated consistently and accurately.

Without these three measures, the concept map cannot be considered an effective assessment tool.

Concept maps are typically assessed by comparing them to an expert's map, which means that the student's map would be compared to that of the educator. This comparison provides information as to how much is remembered and understood by the student. If there are significant differences between the educator's map and the student's, changes in the way the material is taught may even be re-evaluated to ensure that the students have a better understanding of the major concepts and therefore a closer conceptualization like that of the educator. Freeman and Urbaczewski describe other assessment techniques that could be used to include counting the number of concepts and the number of relationships to determine the degree of complexity. These assessments could be used to measure the student's success but also that of the educator's efficacy. (6)

The use of concept maps to evaluate students' declarative knowledge structure is definitely alluring. A student's map construction directly reflects, to some degree, her or his understanding in a subject area. Nevertheless, before adopting maps for assessment, a common understanding is needed as to what a concept map assessment is and whether it provides a reliable and valid measure of students' knowledge structure.

## Concept Maps as a Planning Tool

So we have learned that making connections is critical in the brain and in the online learning environment, therefore it must be just as important at the beginning stages of learning; the planning of the curriculum to be learned.

Educators and instructional designers can use concept maps in their online curriculum and course design planning. The concept map is an idea generator that can be used individually or in a group, which would make it ideal in the design process. Oftentimes, educators envision what they would like to create but have difficulty putting it all together and making sure that all the major concepts are included. With a concept map, they are able to track any ideas, concepts, key words, processes, or even images related to the subject area they are teaching. These ideas would essentially become the nodes of the concept map and the links that relate nodes to each other grow gradually piecing the concept map together. In no time, they would have their course outlined and ready for the next step in the design process. Concept mapping encourages the participant group to stay on task, and the conceptual framework is expressed in the language of the participants rather than in that of the planner or evaluator. With its pictorial representation and its participant-oriented features, concept mapping can be a powerful method to organize complex problems. (7)

Concept maps are also very effective for structuring and making planning material more accessible. They would help teachers to figure out what it is they actually want students to learn. The emphasis turns from what the educator wants to teach to what the students want to learn. Martin (1994) conducted a study in which he taught education majors to use concept maps to make lesson plans. The teachers in the study found the maps very useful for the development of their lesson plans. “Our students view concept mapping as giving teachers a more comprehensive understanding of what they are preparing to teach, eliminating sequencing errors, and enabling teachers to develop lessons that are truly interdisciplinary.”(8)

Students will usually not remember specific facts from a course. It is more important for the student to learn the main themes of the course and really understanding the relationships between concepts learned. Using a concept map will guide the students to learn relevant concepts rather than insignificant pieces of information.

Another advantage of concept mapping software is the many import and export functions available. These allow you to go from a text file (or many other file formats) to a concept map and back again. So the package can not only draw the map but also plan and create documents and presentations.

For example, you could import a text file of notes, then expand and sort your notes to form the map. You can also add images and color to help create a visual adaptation of your notes. Export the map outline back into a word processor to expand it into a full

document. Or export it to a presentation program such as PowerPoint to create a slide show. You can even create a web site from your map by saving it as an HTML file.

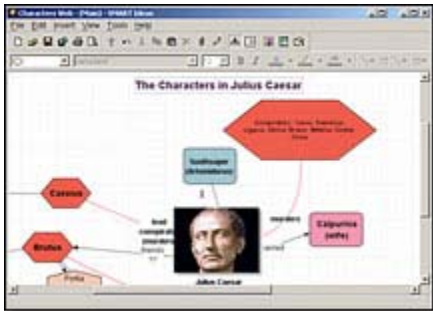
If you are planning a project you can import tasks from Outlook and then develop a project map. In some concept mapping programs there are tools to help do this - you can assign actions, resources and priorities to branches. You can then export your plan to a project management tool, word processor or presentation software, or keep it in graphical form for reference or revision

Concept maps are also very easy to manipulate. This enhanced fluidity allows the educator to change components of their course design with much ease. They can customize the content without much effort if, for example, they wanted to add a course module on a life event that affects the subject area.

## Conclusion

In summary, a concept map is defined as a tool for organizing and representing knowledge. It is an effective cognitive tool in the online learning environment that can be used in many areas of the teaching practice including planning, teaching and assessment. There are many theories that concept mapping is based on including schema theory, constructivist theory, dual coding theory and cognitive load theory. The main theory on which Joseph Novak based his initial work on, however, is Ausubel's meaningful learning theory, which states that learning new knowledge is dependent on what is already known.

## Sample Concept Map



To see more sample concept maps in full format, you can visit *EDCompass* SMART Ideas Activities <http://www.edcompass.smarttech.com/en/learning/activities/ideas.aspx>

You will need to download SMART Ideas concept-mapping software to view these files. <http://www.smarttech.com/support/software/index.asp>

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