Concept Mapping

In the 1960s, Joseph D. Novak (1991) at Cornell University began to study the concept mapping technique. His work was based on the theories of David Ausubel (1968), who stressed the importance of prior knowledge in being able to learn about new concepts - "the most important single factor influencing learning is what the learner already knows. Novak concluded that, "Meaningful learning involves the assimilation of new concepts and propositions into existing cognitive structures." Thus, meaningful learning results when a person consciously and explicitly relates new knowledge to relevant concepts they already possess. 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.

The concept map is a device for representing the conceptual structure of a subject discipline in a pictorial form, analogous to a road map. A concept map is a graphical representation where nodes (points or nodes) represent concepts, and links (arcs or lines) represent the relationships between concepts. The most useful form of a concept map for teaching and learning is one arranged in a hierarchical organisation which the more general and more inclusive concepts are at the top of the map and the more concrete and specific ones at the bottom.

The concepts and links are labelled on the map to form propositions. Propositions are two or more concept labels linked by words which provide information about the nature of the relationship or connection between concepts. The links between the concepts can be one-way, two-way, or non-directional. The concepts and the links may be categorised, and the concept map may show time based or causal relationships between concepts.

Concept maps and learning

Most learning materials rely heavily on printed text to provide information. Whilst this may be the primary means of conveying information it doesn't allow for different styles of learning. Not everyone learns well through reading. Some people learn more effectively in other ways. Concept mapping can assist with the following learning styles:

- **Visual learners.** Concept mapping is an excellent tool for visual learners because it uses diagrams, graphs, sketches and other visual representations to create and understand ideas
- **Physical and logical learners.** They learn well by physically drawing maps, links, diagrams, and similar types of visual images.
- **Social learners.** They learn well by drawing together as a group (e.g., on a whiteboard, flipchart or paper).
- **Non-visual learners**. Concept mapping helps these individuals confirm what they've read.

Visual representation has several advantages:

- graphical symbols are quickly and easily recognised;
- minimum use of text makes it easy to scan for a word, phrase, or the general idea; and
- it allows for development of a holistic understanding that words alone cannot convey.

An example of a concept map

The best way to explain concept mapping is to explore an example.
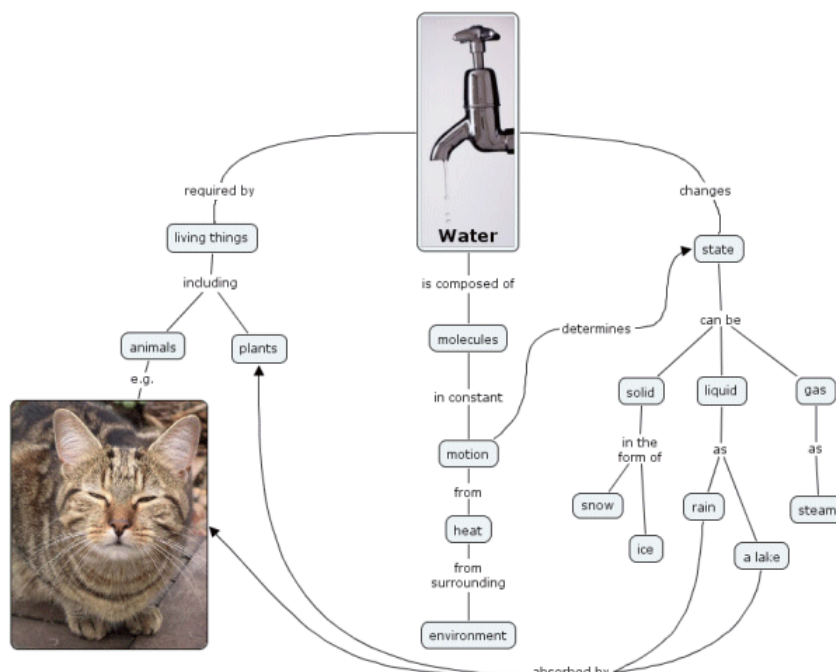
In this map, the key concept is water, and the lesser concepts are: 1) its importance to living things; 2) its composition; and 3) its various states and the effects of those states. Because it's a visual image, it's much easier and quicker for many learners to grasp the idea of water and all the related concepts than it would be for them to read a description. There are many variations on concept maps, but the basic structure consists of the following items:

- **Nodes or cells.** Nodes contain a concept, item, or question. In the above example, the nodes are the ovals containing the main concept of "water" and then the explanatory information beneath that concept.
- **Links.** Links are the lines explain the relationship between the nodes. In this case, the links are labelled with such words as "required by" and "is composed of". These words explain the relationship between the nodes. The arrows, of course, show direction and lead your eye from one node to the next.

The example demonstrates that concept mapping is a method of showing relations between ideas, images or words. Concept maps help you develop logical thinking as well as study skills because they reveal connections and help you see how individual ideas make up a larger whole. Concept maps are also very flexible and can be used to understand ideas of virtually any kind. You can make the maps as simple or complex as you like: linear, branched, radiating or cross-linked.

There are other potential benefits of performing concept mapping. First, it's a creative process similar to brain storming and can help "reveal" all kinds of new ideas. Second, concept mapping allows you to collaborate with one or more people, enhancing team and group work. Third, concept mapping results in a concrete visual image, a repurposable media artefact and learning resource. This means that you, as a learner or educator, are better able to uncover any missing links that might not have been apparent in a printed text. Fourth, concept maps aid memorisation and revision. Finally, and possibly the most important, these kinds of maps take advantage of the human capacity

to recognise patterns in images. Concepts maps are a better representation of how we model knowledge in the brain. This, in turn, improves learning and recall.

A useful advantage of representing the concepts being studied in a tangible form is that they can be readily revised when needed. Since concept mapping is always an active rather than passive learning experience, the process of creation helps to consolidate existing knowledge and serves to make more concrete and precise understanding of the meanings and inter-relations between concepts. When presenting concept maps to students, educators should never expect students to memorise them. This could merely promote rote learning and so defeat the purpose of encouraging active meaningful learning on that part of the learner. Often it will be more beneficial to provide incomplete maps that function as prompts or advance organisers to new topics. Students should be encouraged to critique, restructure and add to a map to produce their own version.

Educational uses of concept mapping

In the teaching and learning of Medicine (or any subject), concepts do not exist in isolation. Each concept depends on its relationships to many others for its meaning. A concept map depicts hierarchy and relationships among concepts. It promotes clarity of meaning and the identification and integration of crucial details. The concept map building process requires one to think from multiple viewpoints and to consider back and forth between different levels of complexity and abstraction. In attempting to identify the key and associated concepts of a particular topic or sub-topic, one will usually acquire a deeper understanding of the topic and clarification of any prior misconceptions.

Creativity tool: Producing a concept map can be similar to participating in a brainstorming session. As ideas are expressed and written down without criticism they become clearer and the mind becomes free to receive new ideas. These new ideas may be linked to ideas already represented, and they may also trigger new associations.

Teaching a topic: In constructing concept maps, difficult concepts can be clarified and can be arranged in a systematic order. Using concept maps in teaching helps teachers to be more aware of the key concepts and relationship among them. This helps teachers to convey a clear general picture of the topics and their relationships to learners. In this way, they are less likely to miss and misinterpret any important concepts.

Learning Tool: Concept mapping tools are one of the few educational technologies specifically designed to improve the learning process. The technique encourages constructivist approach to learning, which asserts that new knowledge should be integrated into existing structures in order to be remembered and become meaningful. Concept mapping stimulates this process by making understandings explicit and requiring the learner to pay attention to the nature of the relationship between things. Learners tend to engage in more deep forms of thinking when they trying to represent ideas graphically.

Concept mapping is also being used to assist with problem solving in education. It can be used to enhance the problem solving phases concerned with generating alternative solutions and options. The communication enhancing aspects of concept mapping can also help collaborative working. Concept mapping can be used to reinforcing understanding and learning through the visualisation of key concepts and summarising relationships.

Assessment and Evaluation Tool: Concept mapping can also be used to assess pre- and post knowledge. They work well to illustrate the "misconceptions" learners may have developed as explanations of a subject. Student conceptions are often incomplete and inaccurate leading to

misunderstandings. Learner's concept maps make explicit their conceptions (and misconceptions) and can help tutors identify and diagnose inaccurate and missing concepts.

Summary

Concept mapping is a technique for representing the structure of information visually. There are several uses for concept mapping:

- to generate ideas and gather new knowledge and information;
- to design complex structures or processes such as long documents, presentations, websites;
- to communicate complex ideas; share knowledge and information generated;
- to develop critical thinking skills; develop an understanding of a body of knowledge;
- to access prior knowledge; aid learning by explicitly integrating new and old knowledge; and
- to assess understanding or diagnose misunderstanding.

A wide range of computer software for mind and concept mapping is now available. Two applications are available via the University network: MindGenius (see: http://www.mindgenius.com/) and CmapTools (see: http://cmap.ihmc.us/) which is also downloadable as a free application for most common operating systems.

Further reading

Ausubel, D. (1968). "Educational psychology: A cognitive view." New York: Holt, Rinehart, and Winston.

Buzan, T. (1995). The MindMap book. (2 ed.). London, UK: BBC Books

Gaines, B.R. and Shaw, M.L.G. (1995) Collaboration through Concept Maps. see: http://ksi.cpsc.ucalgary.ca/articles/CSCL95CM/

Jonassen, D. H. (1996). "Computers in the classroom: Mindtools for critical thinking." Eaglewoods, NJ: Merill/Prentice Hall.

Novak, J.D. (1991). Clarify with concept maps: A tool for students and teachers alike. *The Science Teacher, 58*(7), 45-49.

Trowbridge, J. E. & Wandersee, J. H. (1998). Theory driven graphic organizers in J. J. Mintzes, J. H. Wandersee, & J. D. Novak (Eds.), Teaching science for understanding: A human constructivist view. (pp. 95-131). New York: Academic Press.

See also: Concept Mapping bibliography - http://users.edte.utwente.nl/lanzing/cm_bibli.htm

http://bit.ly/1b4lgMM
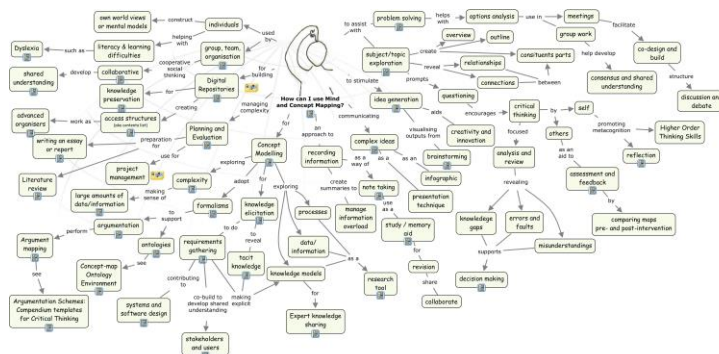
Steps in the construction of concept maps

n.b. There is no single "correct" concept map. Each map is different because everyone has a unique understanding of the world.

1. **Start with a question:** Ask yourself open rather than closed questions: Who, What, Where, When, Why, Which and How? Try to adopt alternate perspectives and consider the pro's and con's around the issue.

2. **Generate and select concepts:** Identify concepts to be mapped by reflecting on a theme and thinking of important key words or phrases, e.g., through brainstorming

3. **Rank concepts:** Decide what concept is the main idea. Order the concepts (key words) from the most abstract and inclusive to the most concrete and specific.

4. **Cluster the concepts:** Group concepts that function at similar level of abstraction and those that interrelate closely. Look for ways to classify concepts.

5. **Arrange into a two-dimensional array:** Layout the concepts in a diagrammatic representation. Select one of the concept map formats (see examples below). Try each format and explore how they might be used for different kinds of information, e.g., if you want to depict an organisational structure a hierarchy map is best.

   Select the most important and inclusive topic and write it at the top of the page or on a post-it. Find the next most important as it relates to the first word.

6. **Link concepts and add propositions:** Connect concepts with linking lines and label each line with a proposition. Draw a line between two concepts (nodes) and write a brief label for it – selecting words that identify relationships between them - n.b. linking words should not be concepts themselves.

   Select the next concept and write it on the map (or post-it). Start building up the map by branching one or two general concepts from the main concept. Add other more specific concepts to the general ones as the map progresses.

   Put the rest of the words on the map.

   Look for opportunities to draw cross-linkages to connect concepts from different branches of the map.

7. **Revise and refine map:** Review and reflect on the organisation of the map. Ask yourself is it clear? logical? attractive? Good maps are like good writing; they are usually result from several drafts. Show a map to your colleagues and friends to get feedback. Once satisfied with the arrangement of the concepts on the map, construct a final map.

n.b. focus on the critical questions:

- What is the central word, concept, research question or problem around which to build the concept map?
- What are the concepts, items, descriptive words or telling questions that you can associate with the concept, topic, question or problem?

Suggestions:

- Use a top down approach, working from general to specific or use a free association approach by brainstorming concepts and then develop links and relationships
- Consider possible formats for visual structuring, experiment with a variety of visual layout formats
- Use different colours and shapes for nodes and links to identify different types of information
- Use different coloured nodes to identify prior and new information, arrows or words for emphasis, e.g., use a cloud node to identify a question.
- Focus upon a visual language approach to communication; explore using visual materials such as photos, sketches, graphs, etc
- Relax, close your eyes and allow your mind to "free associate" and draw informal, thumbnail sketches of your visual impressions
- Imagine a bird's eye overview of the subject matter to be presented; look with fresh eyes, is the visual presentation attractive?
- Ask yourself, are these visuals compelling? Do they help convince the viewer that the subject matter is important and inviting?
- Use maps as preparation for an assignment, essay or before and after a tutorial or group discussion, make a map to represent the information presented in the tutorial.
- Keep a record of the maps you do

**See: Constructing your first Concept Map -
http://cmap.ihmc.us/docs/ConstructingAConceptMap.html**

**Concept Mapping as a Tool for Group Problem Solving -
http://www.youtube.com/watch?v=A625Yh6v6uQ**