

Flexible LEARNING

Saint Paul University

What is it in a nutshell?

Concept map software facilitates the creation and dissemination of concept maps, which are visual depictions of the relationships among ideas or things.

Background

Concept maps have been around for many centuries: the third century philosopher Porphyry of Tyre advocated their use as a means of visually representing knowledge; Carl Linnaeus used them in the eighteenth century as a basis for his taxonomy of plants and animals; and they came to be formally studied as a learning tool in the 1970s at Cornell University by Joseph Novak, who based his work on the learning theories of David Ausubel. Since then, software programs have come to facilitate the creation and sharing of concept maps; some programs also allow several users to collaborate on the same concept map. Specialists make distinctions among concept mapping, cognitive mapping, mind mapping, and semantic networks, but for the general user they all share one feature: the visual depiction of relationships among ideas or things.

Specific types or brands

- Cmap Tools <http://cmap.ihmc.us/> (Recommended)
- C-Tools <http://ctools.msu.edu/ctools>
- Inspiration <http://www.inspiration.com/productinfo/inspiration/index.cfm>
- Smart Ideas <http://smarttech.com/products/smartideas/index.asp>

Functionality

Comments on functionality will be limited to Cmap Tools, the recommended concept mapping software. Cmap Tools is a free, computer-based application developed by the Institute for Human and Machine Cognition (IHMC). With the software, concept maps are easily created by "dragging" nodes to desired points and connecting them with lines or arrows. Nodes are labelled (and coloured, if desired), and a given node can contain any number of links to web-based resources. The concept map can be saved locally (on your computer) or on an IHMC server (which allows you to work on the concept map from any location, or to collaborate on the concept map with others). The concept map can be viewed using the Cmap Tools software, or can be exported as a web page (which retains the integrated links) or as a PDF or JPG image (which retains the structure of the map, but not the web links). Learning to make a concept map using Cmap Tools takes only a few minutes; however, learning to create a concept map that is an effective learning tool can take a few hours of practice.

Impact on teaching

Concept maps can be effectively used to assess student understanding. For example, at the end of unit, you might ask students to depict the material you just covered using a concept map. When creating a concept map, they will find it more difficult to "gloss over" a gap in their understanding than if they were, say, summarizing in text form their understanding. Concept maps can provide an interesting alternative to traditional assignments.

Impact on learning

Proponents suggest that concept mapping forces students to identify connections, and apprehend them more deeply, than traditional approaches such as reading or writing about a concept. Proponents also suggest that concept mapping makes use of "dual coding"; that is, the students learn the material both from the text labels found on the concept map as well as the visual structure of the map. Proponents also suggest that concept mapping can ease the "cognitive load" on some students, by allowing them to focus on essential relationships, rather than on decoding a written text. Overall, the literature affirms that concept mapping has a positive impact on learning outcomes:

"Horton et al. (1993) conducted a meta-analysis of 18 classroom-based concept map studies. They reported (over 14 studies) that concept mapping by students raised post-test achievement scores by a mean of .42 standard deviations. The mean effect size for 3 studies using teacher-prepared maps was .59." -- Nesbit, John C. And Olusola O. Adesope (2006). Learning with concept and knowledge maps: a meta-analysis. Review of Educational Research, 76(3). Page 415.

There is some evidence that low-ability students, perhaps specifically those with low verbal ability, obtain greater benefit from instructional diagrams than do high-ability learners (Holliday, Brunner, & Donais, 1977; Moyer, Sowder, Threadgill-Sowder, & Moyer, 1984; Stensvold & Wilson, 1990). -- Nesbit, John C. And Olusola O. Adesope (2006). Learning with concept and knowledge maps: a meta-analysis. Review of Educational Research, 76(3). Page 420.

"The meta-analysis found that, in comparison with activities such as reading text passages, attending lectures, and participating in class discussions, concept mapping activities are more effective for attaining knowledge retention and transfer. Concept mapping was found to benefit learners across a broad range of educational levels, subject areas, and settings. Much of this benefit may be due to greater learner engagement occasioned by concept mapping in comparison with reading and listening, rather than the properties of the concept map as an information medium. There is evidence that concept mapping is slightly more effective than other constructive activities such as writing summaries and outlines." -- Nesbit, John C. And Olusola O. Adesope (2006). Learning with concept and knowledge maps: a meta-analysis. Review of Educational Research, 76(3). Page 434.

"Efficacy studies reveal that when Concept Mapping is used in a course of instruction, it is better that it be an integral, on-going feature of the learning process, not just some isolated "add-on" at the beginning or end. In this regard, Concept Mapping appears to be particularly beneficial when it is used in an on-going way to consolidate or crystallize educational experiences in the classroom, for example, a lecture, demonstration, or laboratory experience. In this mode, learners experience an educational event and then use Concept Mapping in

a reflective way to enhance the learning from the event.” -- Canas, Alberto (2003). A summary of literature pertaining to the use of concept mapping techniques and technologies for education and performance support. The Institute for Human and Machine Cognition.

Accessibility issues

Concept mapping can be especially effective for weaker students, or for students whose preferred mode of learning is visual in nature. Students with severe visual disabilities may not be able to use the Cmap software; additionally, text-to-speech software will probably not be able to assist visually-challenged students in creating or "reading" computer-based concept maps.

Best practices

Concept mapping should be fully integrated into a learning experience, not just tacked on. Concept mapping should perhaps be used with weaker students, who seem to especially benefit from it. The more actively engaged a student is in the construction of a concept map, the more he or she will likely learn. Accordingly, while it might be helpful to give students a completed concept map, it is probably better to give them a partially completed concept map, and have them finish it (for example, you might give them the structure of the map, and have them label the nodes and arrows). You might also have them create concept maps from scratch, using Cmap tools. Getting students to work collaboratively on concept maps appears to be effective. If you incorporate concept maps into an assignment, decide in advance what criteria you will use to assess their concept maps, and convey this to your students. You might, for example, assign 1 point to each node in the concept map, 2 points for links between nodes, 3 points for each level in the map's hierarchy, and so on (see <http://groklab.org/visualwiki/2007/06/01/9/>). Alternatively, you might take a more "subjective" approach: rather than counting numbers of nodes and lines, you simply try to gauge the overall quality of the concept map.

Hardware and software requirements

Versions of Cmap Tools are available for Windows, Mac, Linux, Solaris, and OLPC XO. Further requirements are as follows:

- PC with 500 megahertz (MHz) or higher processor clock speed, Intel Pentium/Celeron family, AMD K6/Athlon/Duron family, or compatible processor recommended.
- 256 megabytes (MB) of RAM or higher recommended.
- Disk space requirements: 75 MB of available hard disk space.
- Super VGA (800 X 600) or higher resolution video adapter and monitor.

Impact on support and training

Installing Cmap Tools is no more difficult than installing any software program. If you have administrative rights on your computer, you should be able to [download the program](#) and install it yourself in a matter of minutes. You'll probably have no need to contact ITMS for technical assistance. You may, however, want to consult with your Faculty Liaison, or an Instructional Developer in the Centre for Teaching Excellence, with

regard to using concept maps in ways that are as pedagogically effective as possible. Financial cost Cmap Tools is free.

Current usage at UW

Assignments involving concept maps are used by Dragana Miskovic (Biology 130), Vivian Dayeh (Biology 273), Doug Painter (Kinesiology 105), and others.

Current usage elsewhere

A quick google search reveals that instructors at a wide variety of North American universities (University of Oregon, California Polytechnic State University, Drexel University, and others) have incorporated concept maps in general, and Cmap Tools in particular, into their courses. Here are some descriptions of assignment that involve concept maps:

- <http://users.csc.calpoly.edu/~fkurfess/Courses/581/S01/Assignments/Assignment-2.html>
- http://www.pages.drexel.edu/~mitcheje/Mitchell_Courses/IB/IB-053/A1%20Main.htm
- http://kite.missouri.edu/action_MU2.htm

Current support at UW

Faculty Liaisons and Instructional Developers in the Centre for Teaching Excellence will provide one-on-one support. Departmental workshops can also be arranged.

More information

- [A Concept Map](#) about Concept Map Software:
- [Concept Map Review](#) (SlideShare presentation)
- [Evaluation of Knowledge Management Tools](#)
- [Learning with Concept and Knowledge Maps: A Meta-Analysis](#) (PDF)
- [A Summary of Literature Pertaining to the Use of Concept Mapping Techniques and Technologies for Education and Performance Support](#)
- [Using E-Maps to Organize and Navigate Online Content](#)

The bottom line

Research affirms that concept maps can positively affect learning outcomes. Developing concept maps can be an effective and engaging learning activity for students, especially when they work collaboratively and when the concept maps are integrated deeply into the learning experience. Creating concept maps can be an especially effective activity for weaker students, and for students who have a visual learning preference. The "dual coding" that concept mapping appears to facilitate can result in deeper learning and better retention. Concept map software, such as Cmap Tools, can leverage all the potential benefits of concept maps