**What is a Concept Map?**

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**Introduction**

Concept maps are graphical tools for organizing and representing knowledge. They include concepts, usually enclosed in circles or boxes of some type, and relationships between concepts indicated by a connecting line linking two concepts. Words on the line, referred to as*linking words* or *linking phrases*, specify the relationship between the two concepts. We define *concept* as a *perceived regularity or pattern in events or objects, or records of events or objects, designated by a label* . The label for most concepts is a word, although sometimes we use symbols such as + or %, and sometimes more than one word is used. Propositions are statements about some object or event in the universe, either naturally occurring or constructed. Propositions contain two or more concepts connected using linking words or phrases to form a meaningful statement. Sometimes these are called semantic units, or units of meaning. (The companion documents,[What is a Concept? ... from a Concept Mapping Perspective](http://cmap.ihmc.us/docs/Concept.html), [What are Linking Words? ... from a Concept Mapping Perspective](http://cmap.ihmc.us/docs/LinkingWords.html), and [What are Propositions? ... from a Concept Mapping Perspective](http://cmap.ihmc.us/docs/Proposition.html) provide brief introductions to concepts, linking phrases and propositions).

Figure 1 shows an example of a concept map that describes the structure of concept maps and illustrates the above characteristics. In the Figure, "Concept Maps", "Organized Knowledge", and "Focus Question(s)" are concepts, "represent", "needed to answer" are linking words, and together they form the two propositions: "Concept Maps represent Organized Knowledge", and "Organized Knowledge <is> needed to answer Focus Question(s)".

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| Cmap on Concept Maps Figure 1. A concept map showing the key features of concept maps. Concept maps tend to be read progressing from the top downward.(click on the image for a larger view) |

Concept maps were developed in 1972 in the course of Novak's research program at Cornell University where he sought to follow and understand changes in children's knowledge of science (Novak & Musonda, 1991). During the course of the research effort, it became clear that concept maps were useful not only to represent the change in children's understanding of a topic, but they were also an excellent tool for the participating graduate students to express their understanding of their courses. The popularity of concept mapping soon spread and now its used all over the world as a means to represent a person's knowledge about a domain of knowledge, by users of all ages and in all domains of knowledge.

**Characteristics of Concept Maps**

Concept maps have specific characteristics that distinguish them from other knowledge representation tools. Not every graph with text in its nodes is a concept map, and the literature (and the Web) are full of diagrams that are wrongly depicted as concept maps. We review some of the key characteristics of concept maps.

***Propositional Structure***

Concept maps express explicitly the most relevant relationships between a set of concepts. This relationship is depicted by means of the linking phrases forming propositions. E.g., in Figure 1, the relationship between concepts "Organized Knowledge" and "Concepts" is expressed through the linking words "is comprised of", forming the proposition "Organized Knowledge is comprised of Concepts". The same linking words are part of the proposition "Organized Knowledge is comprised of Propositions". When constructing a concept map, one needs to be careful that every two concepts together with their linking phrases form a unit of meaning, a claim, a short sentence. On occasions, a proposition will span across three or more concepts, but we try to avoid this to the extent possible. Thus a concept map consists of a graphical representation of a set of propositions about a topic.

In a concept map, each concept consists of the minimum number of words needed to express the object or event, and linking words are also as concise as possible and usually include a verb. There is no predefined list of linking words. We consider that a predefined list of words would restrict the users and, even if the list is not enforced, would tempt them to select from the list instead of attempting to find the linking words that best the depict the relationship according their understanding of the domain.

Propositions should not be confused with prepositions, which are a grammatical for such as "to", "by", "above", "of", etc. Unfortunately, in translations to Spanish of concept mapping documents, proposition has been often translated to preposition and there is now a widespread misconception in the Spanish-speaking part of the world that concept maps consist of concepts linked together by prepositions.

***Hierarchical Structure***

Within any domain of knowledge, there is hierarchy of concepts, where the most general concepts are at the "top" of the hierarchy and the more specific, less general concepts are arranged hierarchically below. Concept maps tend to be represented in a graphically hierarchical fashion following this conceptual hierarchy. If Figure 1, the most general concepts "Concept Maps", "Focus Question(s)", "Associated Feelings or Affect" are close to the top of the hierarchy as they are more 'general' within the context of concept mapping, while "Infants", "Creativity" and "Experts" are further down the hierarchy. Because of this, concept maps tend to be read from the top, progressing down towards the bottom. Note that this doesn't mean that a concept map needs to have a graphically hierarchical structure: a concept map about the water cycle could be cyclic, while there is a still conceptual hierarchy of precedence or cause and effect in the concept map. Neither does it mean that concept maps need to have only one "root" concept -- their could be more than one. However, we have found that when learning to build concept maps, keeping the concept maps hierarchal with a single root makes it easier for the learner to grasp how concept maps are constructed.

***Focus Question***

A good way to delineate the context for a concept map is to define a Focus Question, that is a question that clearly specifies the problem or issue the concept map should help to resolve. Every concept map responds to a focus question, and a good focus question can lead to a much richer concept map (see the companion document [Why the Focus Question?](http://cmap.ihmc.us/docs/FocusQuestion.html)). When learning to construct concept maps, learners tend to deviate from the focus question and build a concept map that may be (somewhat) related to the domain, but which does not answer the question. This is fine in the sense that the map built probably answers another focus question, and so the focus question of the map should be changed to reflect this. (CmapTools provides a field for the focus question as part of the information that is stored with a Cmap, and the focus question is displayed in the header of the window when a map is displayed, making the focus question explicit to the viewer). In the case of a school-learning environment, it may be important to have the learner go back and construct a concept map that responds the original focus question.

***Cross-Links***

Another important characteristic of concept maps is the inclusion of cross-links. These are relationships or links between concepts in different segments or domains of the concept map. Cross-links help us see how a concept in one domain of knowledge represented on the map is related to a concept in another domain shown on the map. In the creation of new knowledge, cross-links often represent creative leaps on the part of the knowledge producer. There are two features of concept maps that are important in the facilitation of creative thinking: the hierarchical structure that is represented in a good map and the ability to search for and characterize new cross-links. In Figure 1, observe how the concept "Creativity" is linked to both "Infants" and "Interrelationships", each of which are in separate subdomains of the concept map, forming cross-links.

***Theoretical Foundation***

Concept maps have a strong psychological and epistemological foundations, based on Ausubel's Assimilatioin Theory (Ausubel, 1968, 2000) and Novak's Theory of Learning, which explain that people learn new things by using their current knowledge and, to a greater or lesser degree, seeking ways to integrate new knowledge and related knowledge already known. When learning meaningfully, the integration of new concepts into our cognitive knowledge structure takes place through linking this new knowledge to concepts we already understand. Thus a concept map is a graphical representation of these relationships between concepts in our cognitive structure. See the companion document [How People Learn](http://cmap.ihmc.us/docs/HowPeopleLearn.html) for a brief explanation, while the document [Psychological Foundations of Human Learning](http://cmap.ihmc.us/docs/PsychologicalFoundations.html) goes into more detail on the theoretical foundations of concept mapping.

***Mediating Representation between Humans***

Concept maps are meant to be used by users of all ages, from pre-school children to scientists, and are not meant to be interpreted by computers --they are a form of communication between humans. As such, there are no predefined vocabularies of concepts and linking words, and therefore the resulting propositions are for the most part not "formal" or "precise" enough for computers to interpret and reason upon. A concept map where propositions are limited to formal (and rigid) representations that can be interpreted by computers becomes a semantic net, or an RDF or similar representation.

**References**

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