

USING CONCEPT MAPS TO ORGANIZE INFORMATION FOR LARGE SCALE LITERATURE REVIEWS AND TECHNICAL REPORTS: TWO CASE STUDIES

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Abstract. Concept maps were used as a way to organize concepts and ideas for two large scale projects. One project was a dissertation encompassing several sub-areas in cognition and visual perception, and the other was a joint project on uses of concept maps. Concept map and associated resources can provide a powerful way for researchers to organize and make sense of large domains of research, either on a personal level or as part of a team effort.

1 Introduction

The primary goal of this project was to explore the use of concept maps in assisting an individual and a team in developing integrated literature reviews on a large scale. Two comprehensive literature reviews encompassing large domains of research were addressed. The first was part of a doctoral dissertation in the area of Cognitive/Experimental Psychology, and the second was a team project on concept map theory, applications and software. In their broadest forms, each project had very extensive domains to address, with reference databases (e.g., Endnote libraries) containing several hundred associated journal articles, scientific or educational books, and other associated information.

Concept mapping in general, and sophisticated concept mapping software in particular, has many benefits to writing and knowledge organization on a large scale. Researchers have demonstrated the utility of concept maps at several points in the review process, from developing terms to search in electronic databases, to writing individual papers (Czuchry and Dansereau, 1996; Giombini, 2004). Concept maps also provide a way to externalize knowledge and thinking processes (McAleese, 1998), with implications for communication between individuals and teams, as well as applications in knowledge preservation in large complex domains.

Concept mapping software, such as CmapTools, also allows the construction of knowledge models, defined as “sets of concept maps and associated resources about a particular domain of knowledge”. (Cañas, Hill and Lott, 2003). These knowledge models can be developed by experts, as in the Mars projects (Briggs, Shamma, Cañas, Scargle and Novak, 2004). Knowledge models can be shared via Places in CmapTools and the WWW. Examples of knowledge models developed at IHMC are in the Place IHMC Knowledge Models.

In addition, Novak has suggested that representing concepts in concept maps will allow individuals to potentially view interconnections between areas that had not been previously seen. Experts are considered to have richer knowledge structures, both in terms of the amount of relevant declarative knowledge stored, and in terms of the interconnections between knowledge.

2 Procedure

Concept mapping software (IHMC CmapTools) was used to assist knowledge organization and development in two large scale projects. Each of the projects involved a complex domain, with many subdomains and interconnections among areas. Concept maps were used in several ways during this process. In both cases, initial collection and analysis of materials occurred before concept maps were developed, and concept maps were used as a way of structuring large collections of information. Initially materials for both projects were collected in Endnote, a reference and bibliography manager (<http://www.endnote.com/eninfo.as>). As this databases became large (with several hundred references in each file), and categorizing and identifying key concepts and more detailed analyses of articles becomes somewhat problematic.

2.1 Project 1: Dissertation Literature Review and Study Guide

The first project to be described was a dissertation in the area of cognitive-experimental psychology exploring the relative importance of components versus structural information across a range of visual perception tasks. The literature base relevant to the dissertation encompassed several general tasks and areas in visual perception, including similarity and related topics in perceptual matching, global versus local processing, configural versus structural views of object perception, perceptual grouping and texture segmentation, visual search and target detection tasks. Each of these research areas has a large database of associated resources, and a smaller key set of resources related to components or features and structures or forms based on those component features.

In developing concept maps for these topics, a folder for each subtopic was initially developed. Under these folders several types of concept maps were developed. The concept maps were used to explore ideas and relevant concepts in individual research articles, especially comprehensive literature reviews. Concept maps were also used to describe key concepts and task in the subdomain, and to describe relevant theory and identify key researchers.

In addition to folders of concept maps for subdomains, there were several types of “overall” concept maps, addressing general organization of the topics and their interrelationships. The main goals in these maps were to integrate the topics using the main themes of the dissertation, to identify major issues and categories of research, and to look for “cross-cutting” topics and issues that were relevant across domains. There were several partial overall concept maps developed, which were primarily conceptual in nature (see Figure 1).

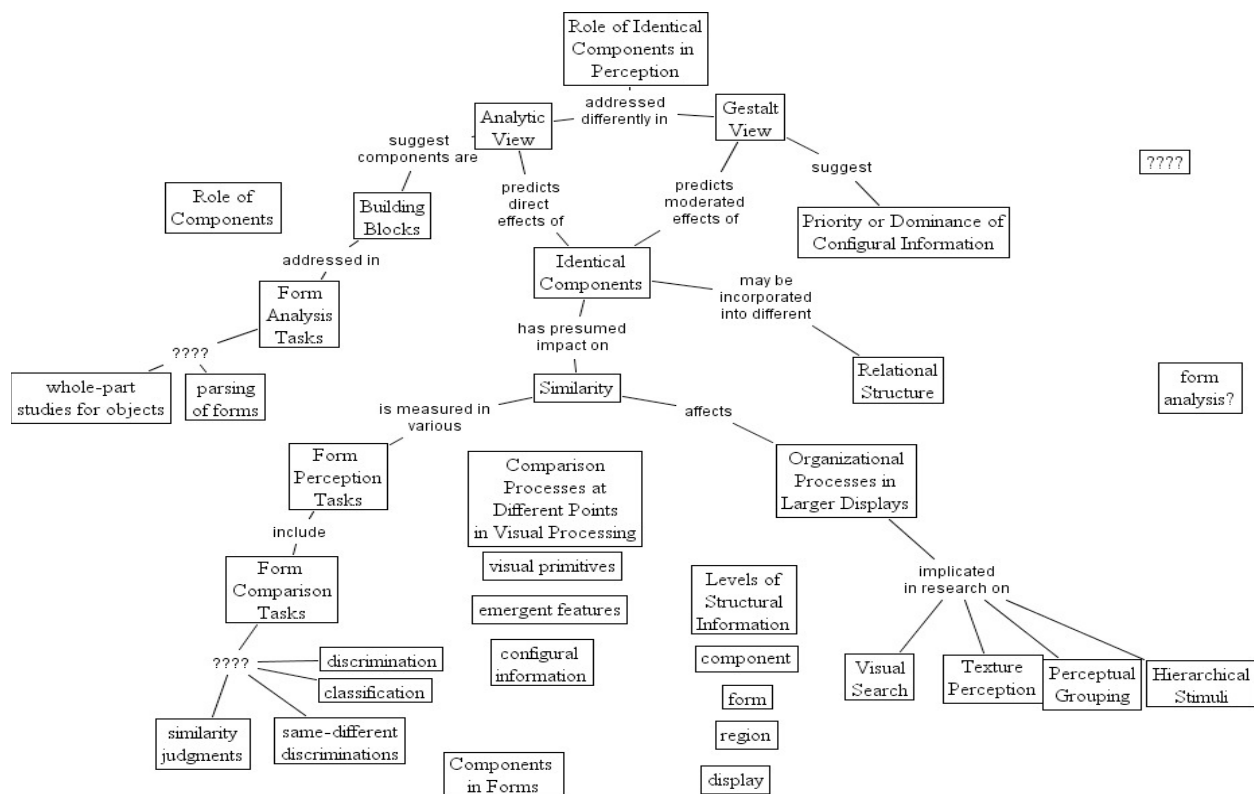


Figure 1. One of several drafts of an overall map, indicating potential areas to address in literature review.

The concept maps were not always fully developed or put into ideal concept map form, which made them more useful as an individual tool than for sharing with others. The examples shown here are more integrated than many that were used. In some cases, more attention was paid to location of concepts on the screen than linking, and in other cases, maps became large and complex to the point that they could not be easily read by a naïve viewer.

However, they were eventually used to develop higher level maps related to the introduction of the dissertation. These maps were never fully integrated into a knowledge model. Some versions of these maps appear at IHMC Public Cmaps, cmap papers 2006, under OSU Folder and osu papers.

The link between the concept maps and the writing process is a critical one, as information will often need to be shared with others who are not concept map users. In some cases, concept map construction operated at a much lower level of detail than the writing process required, and the need to develop overview or top level maps is a critical one. Particularly in terms of addressing individual papers included in the library, it would have been time-consuming to map each paper, but the mapping process of a few critical papers allowed important theories and concepts to be identified.

2.2 *Project 2: Team Literature Review*

The second project was developed as part of the procedure in writing a literature review as part of a team (Coffey, Carnot, Feltovich, P. Feltovich, J., Hoffman, Cañas and Novak, 2003) One person had primary responsibility for collecting and cataloging resources, both in an Endnote library, and physically as required. Initial collection of resources was broad in nature, but eventually was narrowed more specifically to a list of approximately 300 resources. Concept maps organizing and categorizing some of the resources were begun before formal discussion as a team. The team developed relatively general categories which were used to guide the writing of the literature review, and to add key words into the Endnote database. The concept maps were developed as part of an individual effort to externalize more specific subcategories and topics. Concept maps were developed to represent key subareas in the domain, which matched many of the overall categories for the team literature review. In addition, the primary topics addressed in the concept maps often were on a more specific level than the categories used in the overall literature review. Concept maps were also used to identify key articles and researchers in specific subareas, as well as key concepts and applications. In addition, when web resources associated with particular articles and domains were available, these were sometimes linked into the concept maps as resources. The concept maps were intended to be potentially useful to the team of individuals working on the literature review, and to provide an alternative method of identifying articles of interest. The concept maps also operated at a lower level of detail than the primary categories chosen in the literature review, attempting to develop lists of potential resources for approximately 20 areas of research. The team developing the literature review developed five main categories, which included eight more specific subdomains, and integrated resources from the more specific submaps as appropriate.

An additional way in which CmapTools software was used in this process was as a way to collect and sort WWW resources in terms of categories related to the literature review. Not all of these categories and resources were included in the final version of the literature review. In addition, copyrighted material or material not available on the WWW could not be integrated in this way. However, in a personal set of resources, concept maps could serve as a way to organize and access collections of resources.

It should be noted again that some of the maps for the specific subareas were not always fully developed concept maps, but served as a useful way of integrating and organizing information. Because they were not completed fully, they were probably more useful for the map constructor than for others. Potentially these smaller unfinished maps could have operated as resources rather than maps in themselves, but reminding users of potential subareas of research was deemed important. Some versions of the maps and resources are available at Some versions of these maps appear at IHMC Public Cmaps, cmap papers 2006, under CMap Uses and CNET master files. In some cases, original maps were replaced by team-generated ones. In addition, there were some problems in copying maps and resources, so some of the original structure has been lost.

3 **Summary**

This article reports on case studies involving use of concept mapping software to organize and integrate information in two large domains. On a personal level, the concept mapping software provided a useful way to externalize knowledge and see connections in complex areas of research. Concept maps also provided a way to develop re-

usable sets of resources, and the potential to link to and to organize online and other resources. The externalization of thinking processes allowed thinking processes to be shared, as well as for an individual to re-enter projects more effectively by providing external records of what had been done. In addition, the concept maps provided a way to represent both detailed information, and overarching themes across areas. Weaknesses in sharing maps that were not fully developed must be recognized, although potentially these undeveloped maps could serve as a basis for collaborative effort at a more detailed level. Some potential pitfalls or areas to be addressed include addressing the relationship between concept mapping and the writing process. When communicating with people who are not concept map users information from the concept maps needs to be put in another format. In addition, concept mapping at lower levels may distract learners and users from thinking at higher levels. Higher level or more abstract maps should often be developed early in the process, and revised as information at lower levels indicates a need. Potential types and uses of top maps have been addressed by Hoffman (2006).

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