CHAPTER 10

EDUCATIONAL KNOWLEDGE DOMAIN VISUALIZATIONS: TOOLS TO NAVIGATE, UNDERSTAND, AND INTERNALIZE THE STRUCTURE OF SCHOLARLY KNOWLEDGE AND EXPERTISE

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> [M]ost cognitive scientists believe, learning best begins with a big picture, a schema, a holistic cognitive structure, which should be included in the lesson material—often in the text. If a big picture resides in the text, the designers' task becomes one of emphasizing it. If this big picture does not exist, the designers' task is to develop a big picture and emphasize it[.] (West, Farmer and Wolff, 1991, p. 58).

1. INTRODUCTION

Today, we attempt to access all humanity's knowledge and expertise using search engines such as Google. This works well for fact retrieval. However, search engines do not enlighten the user as to the inherent structure of the information being searched or give the user feedback as to its completeness. There is no 'up' button. The user is not able to see what dataset was queried, how the entries in a search result set relate to each other or how the retrieved entities relate to the entities that were not retrieved. Effective approaches to information access and management need to take into account the human user's perceptual and cognitive capabilities. Humanity is in true need of better tools to filter, navigate, understand, and utilize (scholarly) knowledge.

This chapter discusses domain maps as an alternative means to organize, navigate, and internalize scholarly knowledge. We first discuss the educational uses of maps and the benefits of information visualization and spatialization for education. Subsequently, we introduce thematic maps, cognitive and concept maps, knowledge domain visualizations, and information spaces employing the metro map metaphor. All four are visual representations of geographic or abstract semantic spaces. Given that our interest is in the access, management, and internalization of scholarly knowledge, knowledge domain visualizations are discussed at greater length. To this end, we discuss how the educational use of knowledge domain visualizations is supported by the semantic network theory of learning. We also discuss some of the elements of good knowledge domain map design. These are drawn from visual perception principles and the study of human memory, and cognition. The final section projects a potential future of educational knowledge domain visualizations.

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2. EDUCATIONAL USAGE OF MAPS

This section discusses the utilization of spatial learning strategies, big picture views, and conceptual maps in educational settings. There has been a long history of spatial learning strategies in the field of education (Holley and Dansereau, 1984). With the development of the semantic network theory of learning, many educational theorists began creating and implementing spatial learning techniques. These spatial representations of knowledge are used as: (1) learning tools, (2) evaluation tools, (3) curriculum and instruction planning tools (via both macro and micro maps) and (4) tools to facilitate cooperative learning (Milam, Santo, and Heaton, 2000) and cooperative scientific research or collaboratories (MacEachren, Gahegan, and Pike, 2004).

In education, visual representations of the big picture view are applied for diverse reasons. First, they provide a structure or scaffolding that students may use to organize the details of a particular subject. In this fashion, information is better assimilated with the student's existing knowledge and the visualization enhances recall. Second, big picture displays make explicit the connections between conceptual subparts and how they are related to the whole. Third, big picture representations help to signal to the student which concepts are most important for them to learn (West, Farmer, and Wolff, 1991).

One commonly used instantiation of big picture views are concept maps. (See Figure 1 and also the subsequent section on Cognitive and Concept Maps.) A concept map is made up of four core elements: (1) shapes or nodes—representing core elements of a concept, (2) connectors or links between the shapes or nodes, (3) connecting

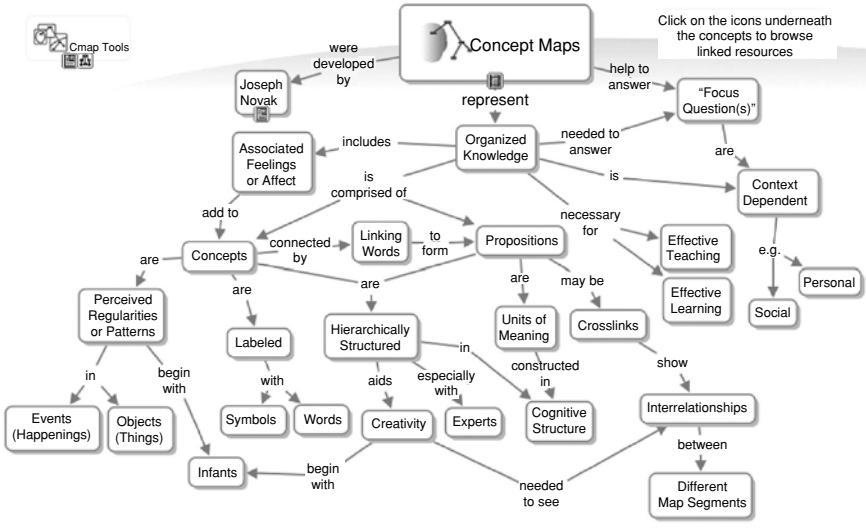

Figure 1: Exemplary concept map showing information about concept maps. Created by Joseph Novak and rendered with CMapTools. Copyright: Institute for human and machine cognition (IHMC). Used with permission.