Presentation of Complex Medical Information: Interaction Between Concept Maps and Spatial Ability on Deep Learning

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ABSTRACT

The purpose was to test the effect of placement of concept maps on learning complex medical information presented online. Blocked by a median split of scores on the Paper Folding Test (Ekstrom, French, & Harman, 1979), college students were randomly assigned to one of three experimental conditions (map before text, map after text, and no map). For purposes of analyses, learners were categorized into low and high ability groups using the lower and upper 25% of scores. A 3 X 2 MANOVA was performed on two correlated dependent variables, recall and application, revealing a statistically significant interaction effect on application learning. For this dependent variable, low spatial ability learners in the no map condition (control group) scored statistically significantly lower than high spatial ability learners.

Keywords: Cognitive Load, Complex Learning, Concept Maps, Pretraining, Prior Knowledge, Spatial Ability

INTRODUCTION

Challenges for Learning Complex Material Online

Innovations in technologies that permit individuals and entities to share information present new challenges for the design of effective learning environments. Learning opportunities are increasingly global, access to information occurs with ever-increasing speed, and individuals have little control over the difficulty of the information they encountered. Individuals may be challenged to build understanding while processing information that is both novel and complex. Researchers have explored the role of long term memory (e.g., schema, prior knowledge) as well as inherent features of the material to be learned (e.g., complexity, interactivity) on the ability of working memory to process

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information (e.g., Paas, Renkl, & Sweller, 2003; Sweller & Chandler, 1994). Robust findings reveal the lower the cognitive load; the easier it is for an individual to process information for understanding and problem-solving. Cognitive load is greater when the content is more complex and the material involves multiple interactive elements (Sweller & Chandler, 1991, 1994; van Merrienboer & Sweller, 2005; Zheng & Cook, 2011; Zheng, Miller, Snelbecker, & Cohen, 2006). In comparison, simple, factual based learning appears to be cognitively less demanding (Frye, Zelazo, & Palfai, 1995; Johnson, Boyd, & Magnani, 1994).

Prior knowledge (i.e., long term memory) is thought to reduce cognitive load by making more space for working memory to attend to the most relevant aspects of the learning task (Schwartz & Bransford, 1998; Surber & Schroeder, 2007; Winberg & Hedman, 2008; Wylie & McGuinness, 2004). Prior knowledge may mean knowledge specific to the content matter, but it can also encompass more general prior knowledge as well as implicit knowledge about the learning process itself (e.g., metacognition) that can affect learning outcomes. Lee, Plass, and Homer (2006) found differences in general science knowledge among seventh graders interacted with design strategies to yield differences in learning about a particular science topic. Schwartz and Bransford (1998) found that more sophisticated learners compared to more novice learners spontaneously used organizing representations (e.g., concepts maps) and other strategies for learning complex materials.

In order to reduce the effects of cognitive load or to increase the processing capabilities of working memory, instructional design techniques such as integrated worked examples, elimination of redundancy, and use of multiple modes have been explored (Pass et al., 2003; van Merrieboer & Sweller, 2005, 2010). Yeung, Jin, and Sweller (1997) examined integrated and separated formats of vocabulary definitions on comprehension and vocabulary learning. They found that for less expert students, vocabulary was learned better when vocabulary meanings were separated from the text. Pollock, Sweller, and Chandler (2002) found that studying complex material in two phases, in which isolated concepts were presented prior to their information on their relationships, was more effective for learners with low prior knowledge than was presenting information in its entirety. Similarly, using a two-stage theory of mental model construction, Mayer, Mathias, and Wetzell (2002) found that students who received pre-training on components of a model were better able to build a causal relationship from a narrated animation than were students who did not receive pre-training or who receive training after exposure to the narrated animation.

Another approach to the reduction of cognitive load has been the use of visual representations such as concept maps, which are defined as a visual pattern of relationships that help students clarify their thinking, as well as process, organize and prioritize ideas (Wang & Dywer, 2006; Zheng & Dahl, 2010). The original notion can be traced back to Ausubel’s assimilation theory of cognitive learning (Ausubel, Novak, & Hanesian, 1978) in which he postulated that the human mind organizes information in a hierarchical manner. Although current theories of cognitive learning have extended well beyond Ausubel’s initial ideas, the surprisingly steady interest in concept maps likely reflects the way in which external representations of knowledge have come to be thought of as useful as instructional strategies and as assessment tools. The growth of multimedia environments for formal and informal learning has provided yet an additional impetus for examining the potential benefits of concepts maps.

**About the Study**

This study rests on two assumptions for understanding complex material: (a) presentation of major concepts isolated from the main text permits learners to focus on important elements and (b) visual representations such as concept map can highlight the relationships among these isolated concepts. We explore the use of a hierarchical concept map for facilitating acquisition of complex information about
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