Learning and Instruction 27 (2013) 1–10

Contents lists available at SciVerse ScienceDirect

Learning and Instruction

journal homepage: www.elsevier.com/locate/learninstruc

Animated and static concept maps enhance learning from spoken narration

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ARTICLE INFO

Article history:
Received 1 August 2011
Received in revised form
8 February 2013
Accepted 11 February 2013

Keywords:
Concept map
Multimedia
Animation
Audio
Narration

ABSTRACT

An animated concept map represents verbal information in a node-link diagram that changes over time. The goals of the experiment were to evaluate the instructional effects of presenting an animated concept map concurrently with semantically equivalent spoken narration. The study used a 2 × 2 factorial design in which an animation factor (animated vs. static) was crossed with a representation factor (concept map vs. text). Students ($N = 140$) were randomly assigned to study one of four presentations on the human nervous system. The dependent measures were tests of free recall, knowledge and transfer. The concept map groups significantly outperformed the text groups on free recall and transfer. The animated concept map group did not significantly outperform the static map group. The authors hypothesize that the animated concept map provided no advantage over the static concept map because participants in both conditions were able to use the spoken narrative to sequence their reading.

1. Introduction

Concept maps are node-link diagrams that show concepts as nodes and relationships among the concepts as labeled links. We use the term concept map to refer to knowledge maps, topic maps, semantic networks and similar node-link diagrams. Concept maps have been used as graphic organizers in lectures, as navigational aids in computer-mediated instruction, as adjuncts to individual and group counseling, and as a medium in which learners can individually and collaboratively express knowledge (Adesope & Nesbit, 2009; Cañas et al., 2003; Haugwitz, Nesbit, & Sandmann, 2010; Holley & Dansereau, 1984; Nesbit & Adesope, 2006, 2011, 2013; Newbern, Dansereau, & Dees, 1997; Potelle & Rouet, 2003). More recently, concept maps have been used to improve meta-comprehension accuracy (Redford, Thiede, Wiley, & Griffin, 2012).

There are at least three different ways that concept maps have been used for individual and collaborative learning. First, learners may *construct* concept maps to summarize or integrate information they are studying (Novak, 2002; Okebukola, 1992; Redford et al., 2012). Second, learners may *modify or complete* pre-constructed concept maps (Chang, Sung, & Chen, 2002; Novak, 2002). Third, learners may *study* pre-constructed concept maps (Bahr & Dansereau, 2005; O'Donnell, Dansereau, & Hall, 2002). In a meta-analysis, Nesbit and Adesope (2006) found that, under different instructional conditions, settings and experimental features, constructing or studying concept maps produced increased retention and transfer of knowledge when compared with control conditions in which learners worked with text passages, outlines, lists or lectures. The meta-analysis found that studying instructor- or researcher-generated concept maps rather than text yielded an overall effect size of $d = .40$ standard deviations. Students often report positive attitudes toward learning with concept maps (Nesbit & Adesope, 2006), and there is evidence that using concept mapping as a learning strategy can lower anxiety and frustration while increasing motivation to engage in meaningful learning (Bahr & Dansereau, 2001; Czerniak & Haney, 1998; Okebukola & Jegede, 1988).

1.1. Animated concept maps

Despite their demonstrated effectiveness, the instructional application of pre-constructed concept maps is limited in significant ways. Primary among these limitations is that, unlike text, concept maps have no conventional or pre-determined processing order and instead offer a large number of alternate processing routes depending on the number of constituent nodes and links (Lambiotte, Skaggs, & Dansereau, 1993). Indeed, in research that tracked eye-movements to examine the order of learners' initial processing of nodes in concept maps, we observed widely varying sequential patterns of map reading (Nesbit, Larios, & Adesope, 2007). Although indeterminacy of processing order may provide benefits such as

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0959-4752/$ – see front matter
http://dx.doi.org/10.1016/j.learninstruc.2013.02.002

greater opportunity for learners to exercise self-regulation and adapt the map-reading experience to prior knowledge and individual learning goals, it has also been recognized as a potential disadvantage. Blankenship and Dansereau (2000) coined the term "map shock" to describe the "bewilderment of not knowing where to start or how to penetrate the topography of the map" (Blankenship & Dansereau, 2000, p. 294). When learners approach a complex concept map with several nodes and links, they may find it difficult to process the entire map in a coherent order and may forget which nodes and links they previously visited, leading to redundant or incomplete processing of the concept map. Researchers have hypothesized that the cognitive challenges of reading complex concept maps may produce a negative affective reaction that de-motivates and inhibits learning (Dansereau, Dees, & Simpson, 1994). Consistent with this hypothesis, Amadieu, van Gog, Paas, Tricot, and Mariné (2009) found that low prior knowledge learners reported a significantly higher sense of disorientation while studying a complex, heterarchically-structured concept map than a simpler, hierarchically-structured map, and they acquired less conceptual knowledge from the complex map.

One approach to reducing the disorientation learners may experience when studying a concept map is to present a 'guided tour' through each proposition in the map followed by an opportunity for free study in which learners can revisit regions of the map according to their individual needs. Any one of a variety of multimedia techniques could be used to sequentially signal each proposition in the guided tour – for example, fading or dimming all propositions except the one being signaled. Prior researchers have chosen to implement sequential signaling in concept maps by a type of animation in which a series of slides is ordered so that each slide shows all the nodes and links of the previous slide plus a small number of new nodes and links representing the currently signaled proposition (Blankenship & Dansereau, 2000; Nesbit & Adesope, 2011). Fig. 1 shows an example of two contiguous slides in an animated concept map. Although this sequential signaling technique meets the definition of animation provided by Bétrancourt and Tversky (2000) and Tversky, Morrison, and Betrancourt (2002), it differs significantly in its form and purpose from instructional animations whose goal is to convey an understanding of the dynamics of a physical system such as an engine or an abstract system such as an economy (Bétrancourt, 2005; Höffler & Leutner, 2007; Lowe & Boucheix, 2011; Lowe & Schnotz, 2008; Mayer, Hegarty, Mayer, & Campbell, 2005; Meyer, Rasch, & Schnotz, 2010; Ploetzner & Lowe, 2012). Animated concept maps belong to a separate category of instructional animation in which visual change is used sequentially to signal components in a diagram or chart. Unlike the visual changes in instructional animations that imitate physical or abstract systems, the visual changes in animated concept maps are designed only to support acquisition of information that can be represented statically and are not themselves intended to be learned.

In seminal research on animated concept maps, Blankenship and Dansereau (2000) used a 2 × 2 factorial experiment to investigate the effects of format (map versus text) and presentation mode (static versus animated). There were two treatment conditions that presented text versions of the concept map content, one that presented the text all at once and another text treatment that built up the text by adding one word at a time. One group of participants studied an animated concept map that was built up gradually by adding a new link-node pair in each slide. Another group treatment studied a static map that presented the same concept map all at once. Blankenship and Dansereau reported that their map (shown in Appendix B) was characterized by "poor structural properties, … poor symmetry, as well as a nonhierarchical, crowded distribution of nodes, the grouping of which was not readily apparent" (p. 297). They intentionally used complicated maps to examine the attention-directing effects of animation in processing ill-structured maps. For free recall of central ideas (macrostructure), they found a statistically significant advantage for the animated concept map group compared with the animated text ($d = .71$) and the static

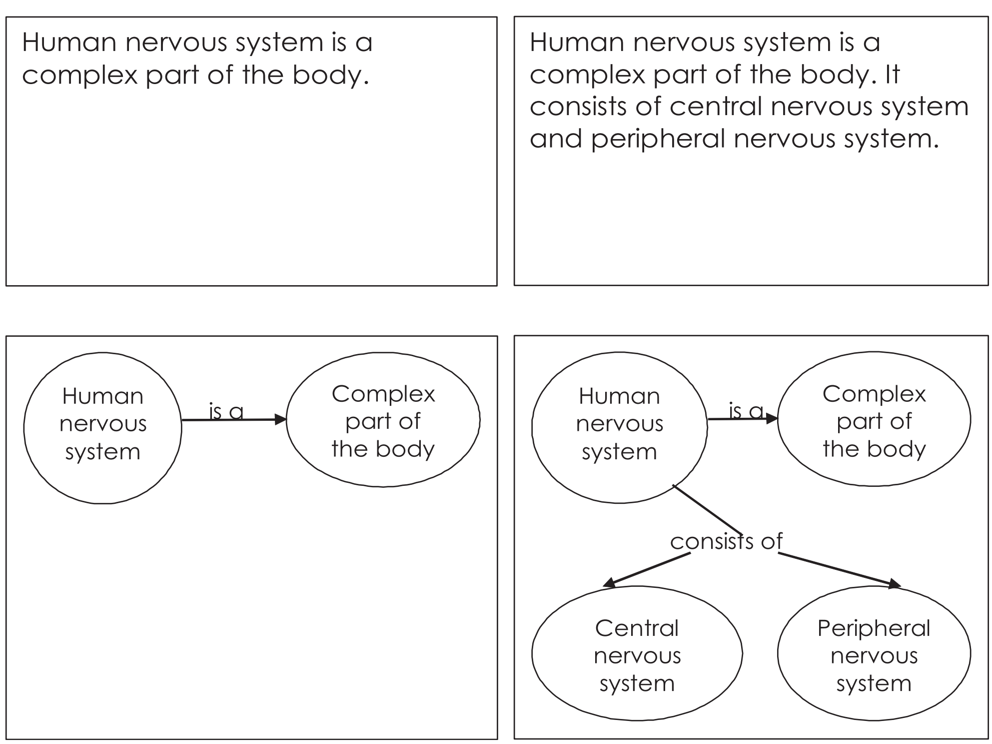

Fig. 1. Example of an animated concept map and animated text presentations. The two upper slides show a transition in a text presentation while the two lower slides show a transition in a semantically equivalent animated concept map.