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Navigating web-based environments: Differentiating internal spatial representations from external spatial displays

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Abstract

Fifty-five undergraduate students read pages on a website presenting text about familiar and unfamiliar geographic locations in the United States. Learners navigated the site by having available or unavailable navigational buttons showing the cardinal compass directions between the map locations in the presence or absence of a cartographic map enabling them to click specifically on the map locations. Learners navigated the site with the goal of learning as much information as they could about the geographic locations described on each page. Results revealed that learners remembered significantly more page content when the geographic map was present and the geography of the area was unfamiliar. However, when the geographic area was familiar, learners remembered more page content when the navigational map was absent regardless of whether the directional links to each page were present or not. The findings: (1) support the contention that maps are used differently as graphic displays for navigating a website than for comprehending associated text, and (2) reveal that learners develop a cognitive model of text and graphics when the content familiar is high, but simply use an image as a mnemonic when content familiarity is low.
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1. Introduction

Much of the research on learning in web-based environments is concerned with the ability of learners to develop a cognitive representation of the navigational structure of a website. By cognitive representation we mean the internal model a learner constructs from the semantic, spatial, and imaginal elements of the web-based environment. Navigational structure refers to the layout of the site, defined by the articulation of webpages via hyperlinks and nodes. Navigational structure is important to consider because learners spend much of their cognitive effort orienting to the structure of the site at the expense of the elaborative processes necessary for deriving deep levels of comprehension of website information (Eveland & Dunwoody, 2000). McDonald and Stevenson (1998), for example, showed that the learning outcomes of learners navigating a web environment are decreased when the navigational structure of the environment is unavailable. Even forcing learners to think about the structure of the environment does not necessarily lead to better comprehension (Nilsson & Mayer, 2002). The problem has led many instructional designers to design navigational maps—spatially based graphic displays intended to assist learners in deriving a website's navigational structure and finding the locations of pertinent pages within it (cf. Brusilovsky & Rizzo, 2002). The maps are intended to decrease cognitive load (cf. Paas, Renkl, & Sweller, 2003).

This investigation was designed to examine how learners cognitively process the graphics designed to help them navigate these sites. Theoretically, we were interested in how the graphics are cognitively represented, and how these representations are used during learning—whether they are encoded as a unitary image learners scan in working memory to navigate from one website location to the next; or whether they are integrated into a more complex representation where website semantic and location information must be integrated with the same information already represented in memory. We make the assumption that the representation contains: (a) previous knowledge about the spatial relations between locations, (b) semantic elements of knowledge previously associated with those locations, and (c) multiple idiosyncratic images integrated with the two. We also assume that the representation is fundamentally different for learners who have prior knowledge of the elements of information associated with the knowledge domain. Thus, the purpose of this investigation was to determine whether learners navigating a website use an internal cognitive representation constructed from the integration of text content and the spatial layout of the site, or an externally derived image from a map of the site, to encode the text-based information contained on site pages. In short, it is unclear how learners process spatially based graphics when the graphics are used for purposes of website navigation. It is equally unclear whether the graphic displays are processed in the same way as graphic displays accompanying text when the graphics are used exclusively for purposes of text comprehension.

Two lines of research can be used to illuminate the role of graphics and text when graphics are used for purposes of navigation. One line addresses the role of graphics in the comprehension of text. The other is concerned exclusively with the navigational function of the graphics. While both lines of research have examined graphics and text within hypermedia environments, each has ignored the role of graphics when the graphics serve *both* navigation and text-comprehension functions. Thus, in the present investigation, we used geographic information in both webpage text and a site map graphic to tease apart the contribution of the graphic in text comprehension and web navigation. Our choice of