Effects of response prompts and diagram comprehension ability on text and diagram learning in a college biology course

Peggy N. Van Meter a,*, Chelsea Cameron b, John R. Waters c

a Pennsylvania State University, 226 Cedar Bldg., University Park, PA 16803, USA
b Pennsylvania State University, 125 Cedar Bldg., University Park, PA 16803, USA
c Pennsylvania State University, 208 Mueller Laboratory, University Park, PA 16803, USA

ABSTRACT

Embedded response prompts are an effective method to support multimedia learning. Response prompts are directives situated within instructional material. Responding to these prompts affects learners’ cognitive operations. Different types of prompts affect learning differently due to variations in stimulated cognitive operations. This study compared three types of experimental response prompts; prompts to self-explain the contents of a page, prompts to attend to diagrams and text-diagram relations, and prompts to self-explanation text-diagram relations; and two control conditions. Three tasks that measure verbal text knowledge, diagram knowledge, or knowledge of text-diagram relations assessed learning. The effects of diagram comprehension ability were also considered. A 5 X 3 mixed model ANCOVA revealed an interaction between prompting conditions and posttest tasks. Diagram comprehension ability was associated with task performance but did not interact with conditions.

© 2017 Elsevier Ltd. All rights reserved.

1. Introduction

College students must often learn from multimedia material that includes both text and diagrams [Mayer, 2014]. A biology student learning about skeletal muscle, for example, may read text that identifies key structures and their functions alongside diagrams depicting many of these same elements. This student’s learning can be deepened by efforts to comprehend and integrate the text and diagrams [Ainsworth, 1999, 2006]. College students who achieve this type of multimedia learning perform better on measures such as problem solving [Berthold, Eysink, & Renkl, 2009] and mental model revision [Butcher, 2006].

Many students do not take full advantage of multimedia, however (e.g., Cromley, Snyder-Hogan, & Luciw-Dubas, 2010; Mason, Pluchino, Tornatora, & Ariasi, 2013). The current study tests methods to improve multimedia learning and factors that may affect this learning. Specifically, we embed different types of response prompts in the material with these prompts intended to affect how learners study multimedia. This research is influenced by the instructional fit hypothesis [Nokes, Hausmann, VanLehn, & Gershman, 2011], which encourages attention to not only the types of response prompts tested but also the tasks that assess learning and relevant individual differences.

1.1. Response prompts and the instructional fit hypothesis

Response prompts are directives situated within instructional material that require the learner to generate some response. A variety of response prompts are possible including adjunct questions, (Hamaker, 1986), metacognitive prompts [Fiorella & Mayer, 2012], and elaboration questions [Van Meter et al., 2016]. In the context of multimedia learning, self-explanation prompts are the most frequently studied. These stimulate self-explanation by requiring learners to respond to prompts such as “Why?” questions (Berthold et al., 2009) or directives to explain a particular relationship (van der Meij & de Jong, 2011). Self-explanation supports performance on a variety of tasks (e.g., Litzinger et al., 2010; Schworm & Renkl, 2007) because this strategy increases inference generation [Chi, 2000] and active knowledge construction [Ainsworth & Burcham, 2007]. Self-explanation may be particularly well suited to multimedia learning because generated inferences form connections both within and between verbal and nonverbal representations [Wylie & Chi, 2014]. Indeed, college students who generate elaborate explanations learn more from text and diagrams than students who self-explain less frequently (Butcher, 2006; Cromley et al., 2010).

Researchers have tested a variety of self-explanation prompts...
The multimedia effect notwithstanding, there is substantial evidence that learners often fail to maximize the potential benefits of combined verbal and nonverbal representations. For example, studies comparing instructional material that provides some support for integrating representations (e.g., hyperlinks) to materials that provide no support, find an advantage for the supported conditions (Seufert, Jänen, & Brünken, 2007; Exp; 3; Bodemer & Faust, 2006; Exp. 2). Furthermore, learners may fail to integrate studied verbal text and visualizations during problem solving (Tabachneck-Schijf & Simon, 1998) and struggle to generate accurate text-diagram connections in the absence of prior knowledge (Bodemer & Faust, 2006; Exp. 1). While a number of causes may underlie these shortcomings, the focus of this study is on the cognitive operations of multimedia learning. In particular, this study considers two possible reasons that learners struggle to apply selection, organization, and integration to multimedia. First, learners must be aware that these operations are valuable and should be applied. This awareness must include an understanding that diagrams and text-diagram relations should be studied. Unfortunately, empirical evidence suggests learners’ lack diagram awareness. Both eye movement (e.g., Mason et al., 2013) and think aloud (e.g., Cromley et al., 2010) studies have demonstrated that multimedia study is largely text driven and many learners put little effort toward text-diagram integration. More optimistically, these same studies show that attention to diagrams improves learning: Learners generate a greater number of higher-order inferences when attending to diagrams than when attending to text (Ainsworth & Loizou, 2003; Cromley et al., 2010) and learners who make more effort to connect text and diagrams score better on higher-order posttests (Butcher, 2006; Mason et al., 2013). Thus, one means to improve learners’ execution of multimedia cognitive operations could be to increase their awareness of these operations (Bartholomé & Bromme, 2009; Mason, Pluchino, & Tornatora, 2015).

The second possibility is that learners lack an effective strategy to facilitate the selection of key elements, the organization of these elements, and integration to establish coherence within and between multimedia representations and with prior knowledge. In this case, a learner may realize that multimedia content should be organized and integrated, but lacks knowledge of just how to achieve this goal. This possibility is consistent with the previously described research on self-explanation, which shows that stimulating learners to self-explain supports multimedia learning (e.g., Berthold et al., 2009; van der Meij & de Jong, 2011). Presumably, because self-explanation requires the selection of to-be-explained elements and generation of organizational and integrative inferences.

There is a third possibility, of course, which is that learners lack both diagram awareness and an effective learning strategy. If this is the case, then neither drawing learners’ attention to diagrams nor prompting self-explanation alone will be sufficient to maximize multimedia learning. A learner who employs self-explanation, for instance, may under-utilize multimedia if explanations do not require knowledge derived from diagrams. Likewise, a learner may attend to diagrams but not know how to effectively work with the two representations.

The three experimental prompting conditions tested in this study align with these possibilities. These conditions either direct attention to diagrams and text-diagram relations, prompt self-explanation, or both. Comparisons across these conditions will provide insight into the degree of support learners need to successfully use multimedia. That is, is it sufficient to increase learners’ attention to diagrams or do learners require the additional support of being directed to use a particular learning strategy?

In addition to the cognitive operations that may be affected by response prompts, the instructional fit hypothesis also predicts that...
دریافت فوری
متن کامل مقاله

امکان دانلود نسخه تمام متن مقالات انگلیسی
امکان دانلود نسخه ترجمه شده مقالات
پذیرش سفارش ترجمه تخصصی
امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
امکان دانلود رایگان ۲ صفحه اول هر مقاله
امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
دانلود فوری مقاله پس از پرداخت آنلاین
پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات