When graphics improve liking but not learning from online lessons

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ABSTRACT

The multimedia principle states that adding graphics to text can improve student learning (Mayer, 2009), but all graphics are not equally effective. In the present study, students studied a short online lesson on distance education that contained instructive graphics (i.e., directly relevant to the instructional goal), seductive graphics (i.e., highly interesting but not directly relevant to the instructional goal), decorative graphics (i.e., neutral but not directly relevant to the instructional goal), or no graphics. Following instruction, students who received any kind of graphic produced significantly higher satisfaction ratings than the no graphics group, indicating that adding any kind of graphic greatly improves positive feelings. However, on a recall posttest, students who received instructive graphics performed significantly better than the other three groups, indicating that the relevance of graphics affects learning outcomes. The three kinds of graphics had similar effects on affective measures but different effects on cognitive measures. Thus, the multimedia effect is qualified by a version of the coherence principle: Adding relevant graphics to words helps learning but adding irrelevant graphics does not.

1. Introduction

People learn better from words and pictures than from words alone. This is the major tenet of the multimedia principle, which has been supported in numerous experimental studies (Butcher, 2006; Mayer, 1989; Mayer & Anderson, 1991, 1992; Mayer, Bove, Bryman, Mars, & Tapangco, 1996; Mayer & Gallini, 1990; Moreno & Mayer, 1999; Moreno & Valdez, 2005). Evidence for the multimedia principle comes from experimental comparisons showing that adding graphics to a text lesson can improve performance on a transfer posttest by more than one standard deviation (Fletcher & Tobias, 2005; Mayer, 2009).

1.1. Three types of graphics in multimedia lessons

However, all kinds of graphics may not be equally effective in promoting learning (Butcher, 2006; Hegarty, Carpenter, & Just, 1991; Hegarty & Just, 1993). For example, Table 1 summarizes three kinds of graphics that vary in their relevance and interestingness. First, instructive graphics are relevant to the instructional goal and intended to facilitate learning the essential material in the lesson, such as showing a picture of the pony express in a lesson on early correspondence study programs of distance education that relied on the development of mail delivery systems. This picture is intended to activate prior knowledge about the role of mail delivery systems in correspondence schools. Second, seductive graphics are highly interesting but not directly relevant to the lesson, such as showing a photo of a popular movie star in a lesson on the role of early mail delivery systems in correspondence study programs for distance education. The famous face may draw the learner's attention away from the essential material in the text and thereby diminish learning. Third, decorative graphics present cognitively neutral material that is not directly relevant to the essential material, such as showing a photo of a sunrise or waterfall in the same lesson on early mail delivery systems. Although the nature photo is not related to the content of the lesson, it is intended to create a pleasing tone without being overly distracting. In short, it is intended to be neutral in cognitive impact but pleasing in affective impact.

The goal of the present study is to compare the effects of adding each of these kinds of graphics to an online instructional lesson, all in a single experimental study. Although some previous studies have investigated the effects of adding instructive graphics (i.e., sometimes yielding the multimedia effect), the effects of adding interesting but irrelevant graphics (i.e., sometimes yielding the seductive details effect), or even the effects of adding decorative graphics (i.e., sometimes yielding a null effect), our goal in the present study is to combine all three conditions in a single study so we can gauge the relative impact of each. We focus on the role of three kinds of photos, because photos are widely available and often inserted within multimedia presentations, sometimes without consideration of their relevance to the instructional goal.

Table 1
Three types of graphics in multimedia lessons.

Type	Description	Example
Instructive	Directly relevant to the instructional goal	Photo of pony express in a lesson on early mail delivery systems
Seductive	Highly interesting but not directly relevant to the instructional goal	Photo of popular movie star in a lesson on early mail delivery systems
Decorative	Neutral but not directly relevant to the instructional goal	Photo of a waterfall in a lesson on early mail delivery systems

1.2. Theory and predictions

Table 2 is based on the theoretical idea that graphics produce motivational effects (i.e., affecting the amount of effort the learner is willing to devote to cognitive processing during learning) and cognitive effects (i.e., affecting how the learner allocates effort during learning, such as toward appropriate cognitive processing that supports the learning goal or inappropriate cognitive processing that does not support the learning goal). As shown in the first and second columns, adding any kind of graphic can improve the learner's affect for the lesson and thereby increase the learner's motivation to engage in cognitive processing. This increase in positive inclination towards the lesson is indicated by increases in learner satisfaction ratings of the lesson as compared to a no graphics group. As shown in the third and fourth columns, adding relevant graphics is predicted to direct the learner toward engaging in appropriate cognitive processing which helps learning, whereas adding seductive graphics is predicted to direct the learner toward engaging in inappropriate cognitive processing which hurts learning, and adding decorative graphics is predicted to have little effect on cognitive processing during learning and thus little effect on learning.

The three kinds of graphics summarized in Tables 1 and 2 differ in terms of their relevance to the instructional goal. *Relevance* refers to the degree to which the content of a graphic corresponds to the essential content needed to support the instructional goal (Mayer, 2011), so instructive graphics have high relevance whereas seductive and decorative graphics have low relevance. In particular, relevance refers to the degree to which relations among the elements in the text (such as a discussion of early mail delivery systems) are analogous to the relations among the elements in the graphic (such as graphic showing mail being moved from one place to another by horseback). The two low-relevance graphics also differ with respect to interestingness. *Interestingness* refers to the degree to which the graphic draws the learner's attention (Anderson, Shirey, Wilson, & Fielding, 1987; Hidi & Baird, 1988; Mayer, Griffith, Jurkowitz, & Rothman, 2008), so seductive graphics have high interestingness whereas decorative graphics have low interestingness. In short, seductive graphics are low in relevance and high in interestingness, decorative graphics are low in relevance and low in interestingness, and instructive graphics are high in relevance and may be low to high in interestingness.

For example, if the goal of a section on distance learning is to describe early mail delivery systems such as the pony express, then a photo depicting a mail carrier riding a horse is relevant because it helps to concretize the essential content of the lesson (e.g., that distance learning involves moving communications across great distances), and thereby primes appropriate cognitive processing such as attending to the relevant information, organizing it, and

integrating it with relevant prior knowledge. In contrast, a photo of a famous celebrity is irrelevant because it does not draw the learner's attention towards the essential content of the lesson or foster cognitive processing that is appropriate to the learning objective. In short, seductive graphics can prevent the learner's construction of appropriate knowledge because the learner is directing cognitive processing towards irrelevant material. Finally, decorative graphics may cause the learner to waste some cognitive processing that could have been used for learning, but not as much as seductive graphics because learners are less likely to devote large amounts of attention to an uninteresting graphic.

The case for adding graphics—even irrelevant ones—to text comes from arousal theory and emotional interest theory, which hold that students learn better when they are emotionally aroused because they are energized to pay more attention overall (Dewey, 1913; Harp & Mayer, 1998; Kintsch, 1980; Weiner, 1992). Similarly, Norman's (2004) emotional interest theory holds that attractive design features can create positive emotion in the learner, which impacts learning by increasing the learners' willingness to actively engage in the learning process.

Several existing theories seek to explain the cognitive processes underlying how people learn from words and graphics, including Paivio's dual coding theory (Paivio, 1986; Sadoski & Paivio, 2001), Sweller's cognitive load theory (Sweller, 1999, 2005), and Mayer's cognitive theory of multimedia learning (Mayer, 2009). These theories are based on the idea that humans possess separate information-processing channels for processing visual materials (such as graphics) and verbal material (such as words), but possess limited capacity for processing within each channel. Meaningful learning occurs when learners engage in appropriate cognitive processing during learning, which includes attending to relevant words and pictures, organizing them, and integrating them with each other and with knowledge from long-term memory.

Aspects of these theories suggest that adding relevant graphics to text can improve learning by encouraging these appropriate cognitive processes, whereas adding attention-grabbing irrelevant graphics can hurt learning by encouraging inappropriate cognitive processing such as attending to graphics that have nothing to do with the instructional goal and organizing the lesson content around them. In short, instructive illustrations encourage germane cognitive load (or generative cognitive processing) in which the learner makes connections between corresponding portions of the graphics and the text that support the instructional goal (Mayer, 2009; Sweller, 2005). In contrast, seductive graphics do their damage by grabbing and holding the learner's limited attention, thereby creating extraneous cognitive load (or extraneous processing) for the learner—that is, cognitive processing that does not support the instructional goal (Chandler & Sweller, 1991; Mayer, 2009, 2011; Sweller, 1988, 1999, 2005)—and by disrupting

Table 2
Motivational and cognitive effects of three types of graphics in multimedia lessons.

Type	Motivational effects	Predicted satisfaction rating	Cognitive effects	Predicted learning score
Instructive	+	+	+	+
Seductive	+	+	−	−
Decorative	+	+	0	0