Benefits of emotional design in multimedia instruction

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ABSTRACT

Emotional design of multimedia instruction involves making the essential elements in the lesson's graphics more appealing, such as by rendering them with human-like features and with distinct, appealing colors (Um, Plass, Hayward, & Homer, 2012). College students received an 8-slide multimedia lesson on how a virus causes a cold for 5 min (Experiment 1) or for as long as they wanted (Experiment 2). For the control group, the graphics consisted of simple black-and-white drawings in which the host cell was represented as a large circle, and the virus was represented as a small circle with small spikes on the outside and a rectangle on the inside. For the enhanced group, the graphics were redrawn to render the host cell as a red face with expressive eyes (registering surprise, fear, and sickness at various stages in the process), and the virus as a blue face with fierce eyes and with a green dot at the end of each of the blue tentacles surrounding the virus face. The enhanced group performed better than the control group on a subsequent learning test ($d = 0.69$ in Experiment 1, $d = 0.65$ in Experiment 2) and gave higher effort ratings in Experiment 1 ($d = 0.65$) but not in Experiment 2 ($d = -0.10$). The findings are generally consistent with the cognitive affective theory of learning with media, and point to the importance of incorporating motivation into cognitive theories of multimedia learning.

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1. Introduction

1.1. Objective and framework

The goal of the present study is to determine whether using emotional design principles to redesign the graphics in a multimedia lesson will improve student learning outcomes (as measured by performance on a comprehension test). For example, consider a slideshow that explains how a virus causes a cold and contains slides containing black-and-white line drawings along with printed sentences, as exemplified in the top of Fig. 1. In an effort to apply emotional design principles, we could enhance the graphics by rendering the essential characters (e.g., host cell, virus, virus DNA) with human-like characteristics (e.g., faces with expressive eyes) and appealing colors (e.g., red, blue, and yellow), as exemplified in the bottom of Fig. 1 (in the web version).

In this study, we use the term *emotional design* to refer to redesigning the graphics in a multimedia lesson to enhance the level of personification and visual appeal of the essential elements in the lesson. Personification involves rendering essential elements with human-like features such as presenting the host cell as a face

with expressive eyes (indicating surprise, for example, when a virus approaches). Visual appeal involves rendering each element in a distinct, appealing color, such as red for the host cell and blue for the virus.

A rationale for implementing emotional design principles in multimedia lessons is that the revised graphics are intended to increase the learner's motivation to make sense of the essential material and thereby prime deeper learning processes that lead to improved learning outcomes. Motivation refers to the learner's cognitive state that initiates, energizes, and maintains goal directed behavior, which in the present study involves exerting effort to make sense of the lesson by engaging in appropriate cognitive processing during learning. Overall, consideration of emotional design features represents an attempt to integrate motivational processes with cognitive theories of multimedia learning.

1.2. Literature review

The concept of emotional design has a long-standing place in human engineering concerning how to design everyday things (Norman, 2004), but until recently has not been scientifically studied in education. Research on the emotional design of graphics in multimedia lessons is in its infancy, with the main evidence coming from research by Plass and colleagues (Plass, Heidig, Hayward, Homer, & Um, 2014; Um, Plass, Hayward, & Homer,

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Graphic in Control Lesson

STEP 1: Entering the body.
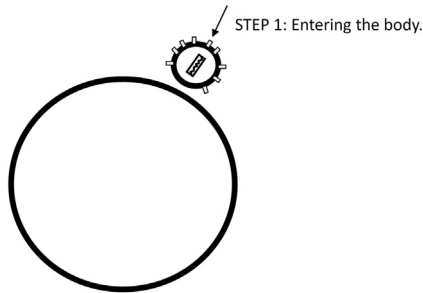
Graphic in Enhanced Lesson
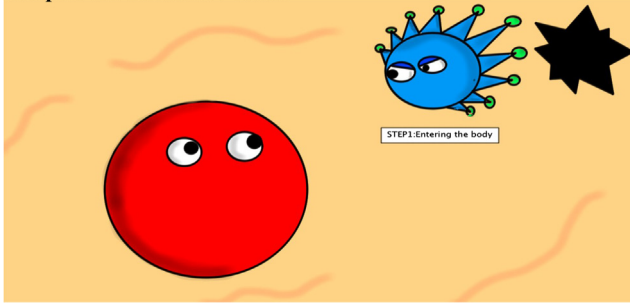
STEP1:Entering the body

Fig. 1. Graphics from control and enhanced group. Note. In the enhanced lesson, the host cell (on left) is in red, and the virus. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

2012). First, Um et al. (2012) implemented emotional design principles in a multimedia lesson on how immunization works by converting the main characters in the illustrations (such as T-Cell, B-cell, and antigens) from gray-tone geometric shapes into little faces with expressive eyes rendered in appealing colors such as purple, blue, and green. In terms of learning outcome tests, students who were given the enhanced lesson performed better that the control group on tests of comprehension ($d = 0.43$). In terms of cognitive load measures, students who received the enhanced lesson reported lower levels of difficulty ($d = 0.42$) and equivalent levels of effort ($d = 0.06$) as compared to the control group.

Plass et al. (2014) replicated the study using the same materials across two experiments, again finding that students given the enhanced lesson performed better on a comprehension test across both experiments ($d = 0.61$ and $d = 0.77$), reported less difficulty in one experiment ($d = 0.49$) but not the other ($d = 0.23$), and reported equivalent effort across both experiments ($d = -0.19$ and $d = 0.08$) as compared to the control group. However, in the Um et al. (2012) study the enhanced group outperformed the control group on a transfer test ($d = 0.80$) whereas no difference was found in the Plass et al. (2014) experiments ($d = 0.01$ and $d = 0.08$).

In contrast to these findings showing the benefits of emotional design in multimedia learning, there is a substantial research base that points to the negative effects of incorporating interesting but irrelevant graphics in a multimedia lesson (Harp & Mayer, 1997, 1998; Mayer, Heiser, & Lonn, 2001; Sung & Mayer, 2012). For example, inserting short color video clips of lighting strikes within a narrated animation explaining how lightning storms develop resulted in poorer transfer test performance ($d = -0.70$; Mayer, Heiser, & Lonn), adding color illustrations showing the results of lightning strikes in a paper-based lesson on how lightning storms develop resulted in poorer transfer test performance across 5 experiments yielding effect sizes greater than $d = -1.0$ (Harp & Mayer, 1997, 1998), and adding interesting but irrelevant graphics to an online lesson on educational technology resulted in poorer comprehension test performance ($d = -0.39$; Sung & Mayer, 2012).

Interesting but irrelevant graphics are a form of *seductive details* (i.e., interesting but irrelevant information added to a lesson) that has been well studied in research on adding seductive text to learning from prose (Garner, Gillingham, & White, 1989), and to some extent in multimedia learning (Mayer, Griffith, Naftaly, & Rothman, 2008). Similarly, adding decorative illustrations (i.e., neutral illustrations that have no instructional role) tends to have no consistent positive effect on learning outcomes (Magner, Schwonke, Aleven, Popescu, & Renkl, 2014; Sung & Mayer, 2012).

An important challenge in applying emotional design principles to redesigning graphics in multimedia lessons is to tap affective processes that prime cognitive processes leading to improvements in learning (as was done in the emotional design research by Plass and colleagues) while not distracting the learner from the essential content of the lesson (as was done in the seductive details research by Mayer and colleagues). The primary difference between interesting illustrations that help learning and those that hurt learning is that in research by Plass and colleagues the interesting graphics concerned the essential content of the lesson whereas in research by Mayer and colleagues the interesting graphics focused the learner's attention on extraneous content. Thus, in applying emotional design principles to the redesign of graphics in multimedia lessons, the focus should be on making the essential elements in the lesson more appealing rather than on adding appealing extraneous graphics.

So far the literature has three studies all from the same research team (i.e., Plass and colleagues) and with the same lesson, showing the benefits of applying emotional design principles to redesigning the graphics in a multimedia lesson on how immunization works. Is a replication of this research needed? According to Shavelson and Towne (2002) scientific research in education is advanced when researchers seek to replicate and extend preliminary findings. The present study seeks to test the emotional design hypothesis using different instructional materials and tests, and in a different lab with different learners. Thus, given the somewhat novel and surprising findings of Plass and colleagues and the importance of appropriately incorporating motivational factors in theories of multimedia learning, we seek to determine the robustness of the benefits of incorporating emotional design in multimedia instruction.

1.3. Theory and predictions

Cognitive theories of multimedia learning, such as Mayer's (2009) cognitive theory of multimedia learning or Sweller's (2005; Sweller, Ayres, & Kalyuga, 2011) cognitive load theory, focus on cognitive processing during learning within a working memory of limited capacity using knowledge activated from a long-term memory with unlimited capacity. Multimedia information from the outside world is assumed to enter through the eyes or ears and register in sensory memory. The learner can attend to some of the fleeting information in sensory memory (which is called the cognitive process of *selecting*), thereby bringing it into working memory. Within working memory, the learner can organize the incoming visual information into a spatial representation and the incoming verbal information into a verbal model (which is called the cognitive process of *organizing*). Finally, the learner can integrate the spatial and verbal representations with each other and with relevant knowledge activated from long-term memory (which is called the cognitive process of *integrating*). According to the cognitive theory of multimedia learning, meaningful learning (e.g., as indicated by test performance) occurs when the learner engages in appropriate selecting, organizing, and integrating during learning. It follows that instructional design should be concerned with priming these cognitive processes during learning, which are