



Commentary

Incorporating motivation into multimedia learning[☆]Richard E. Mayer^{*}

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ABSTRACT

What is the role of motivation in multimedia learning? Cognitive theories of multimedia learning tend to focus on instructional methods aimed at reducing extraneous processing (such as highlighting the essential material) or managing essential processing (such as breaking a lesson into parts), whereas motivational theories tend to focus on instructional methods aimed at fostering generative processing (such as adding appealing graphics or challenging scenarios). Moreno's (2005) cognitive affective theory of learning from media is intended to better incorporate motivation and metacognition into theories of multimedia learning, helping to extend or clarify Mayer's (2009) cognitive theory of multimedia learning and Sweller's (Sweller, Ayres, & Kaluga, 2011) cognitive load theory. The research presented in this special section examines motivating instructional features intended to promote generative processing—such as adding appealing graphics (Magner, Schwonke, Alevan, Popescu, & Renkl, 2013; Plass, Heidig, Hayward, Homer, & Um, 2013) or challenging scenarios (D'Mello, Lehman, Pekrun, & Graesser, 2013). Overall, motivational features can improve student learning by fostering generative processing as long as the learner is not continually overloaded with extraneous processing or overly distracted from essential processing.

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1. Introduction

Multimedia learning involves learning from words and pictures and includes learning from textbooks that contain text and illustrations, computer-based lessons that contain animation and narration, and face-to-face slide presentations that contain graphics and spoken words (Mayer, 2009). Theories of multimedia learning (e.g., Mayer, 2009; Schnotz, 2005; Sweller, 2005) tend to focus on the cognitive processes involved in learning, such as selecting relevant information, mentally organizing the material into a coherent organization, and integrating it with relevant prior knowledge activated from long-term memory, as proposed in Mayer's (2009) cognitive theory of multimedia learning (CTML). However, an important underspecified aspect of cognitive theories concerns the role of motivation in multimedia learning—that is, the internal state that initiates, maintains, and energizes the learner's effort to engage in learning processes. The goal of this special section is to explore how theories of multimedia learning can be expanded to include the role of motivation, by exploring techniques for priming the learner's motivation to learn with multimedia lessons.

The cognitive theory of multimedia learning (Mayer, 2009), following cognitive load theory (Sweller, Ayres, & Kalyuga, 2011), distinguishes among three kinds of processing demands on the learner's cognitive system during learning: *extraneous processing*, which is cognitive processing that does not serve the instructional objective and is caused by poor instructional design; *essential processing*, which is cognitive processing aimed at mentally representing the presented material and is caused by the complexity of the material; and *generative processing*, which is cognitive processing aimed at making sense of the material and is caused by the learner's effort to engage in learning processes such as selecting, organizing, and integrating. In light of the cognitive processing limitations of working memory, three important instructional design goals are to reduce extraneous processing, manage essential processing, and foster generative processing (Mayer, 2009).

Based on cognitive theories of multimedia learning, research on instructional design principles initially focused on techniques for minimizing extraneous processing (such as placing printed text next to the corresponding graphics or reducing extraneous words and graphics or highlighting the key material), and gradually expanded to include techniques for managing essential processing (such as breaking a complex lesson into manageable parts or providing pre-training in key concepts). In contrast, this special section highlights recent work on instructional design principles that focus mainly on the third goal of fostering generative

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processing, which has been somewhat understudied compared to the others.

2. The case for motivation in multimedia learning

When focusing on instructional design techniques that foster generative processing, researchers are challenged to more fully consider the role of motivation in multimedia learning (Mayer, 2011). In short, an important question concerns what motivates learners to engage in the cognitive processes of selecting, organizing, and integrating that—according to the cognitive theory of multimedia learning—are required for meaningful learning. Moreno's (2005, 2006, 2007, 2009; Moreno & Mayer, 2007) cognitive affective theory of learning with media (CATLM) is designed to include motivational and metacognitive factors that are somewhat underspecified in the cognitive theory of multimedia learning (Mayer, 2005, 2009) and cognitive load theory (Sweller, 2005; Sweller et al., 2011). In particular, Moreno and Mayer (2007, p. 310) note that “motivational factors mediate learning by increasing or decreasing cognitive engagement” and “metacognitive factors mediate learning by regulating cognitive processing and affect.” In a review of cognitive load theory, Brunken, Plass, and Moreno (2010, p. 262) noted: “Although it is well known that metacognitive, affective, and motivational constructs are central to learning, they have not been the focus of cognitive load research...Therefore, there is great potential to test specific hypotheses about the relation among motivation, cognition, cognitive load, and learning...”

A central theme in CATLM—and of this special section—is that affective features of an instructional message can influence the level of learner engagement in cognitive processing during learning. Table 1 lists three conceptualizations of the effects of adding affective features to a lesson that are intended to increase learner motivation: less-is-more, more-is-more, and focused-more-is-more. The less-is-more approach focuses on instructional design techniques aimed at reducing extraneous processing (such as eliminating extraneous material) and managing essential processing (such as segmenting a lesson into manageable parts). To the extent that motivational features create extraneous processing or distract the learner from essential processing, they are unwelcomed. The more-is-more approach focuses on instructional design techniques aimed at fostering generative processing (such as adding appealing graphics or challenging scenarios). This approach calls for incorporating motivational features, in spite of their potential to overload and distract learners. The focused-more-is-more approach embraces all three instructional design goals—using design features that motivate learners to engage in generative

processing while also providing enough guidance to preclude an overloading amount of extraneous processing. Although Moreno's CATLM highlights the role of motivation in multimedia learning, both CATLM and CTML propose that effective instructional design consists of both techniques for priming generative processing and techniques for ensuring that cognitive capacity is not continually overloaded and the learner is able to learn the essential material.

3. The emotional design hypothesis: does embedding emotionally appealing elements in a multimedia lesson foster learning?

Suppose we take a 7-min computer-based multimedia lesson on how immunization works, and incorporate positive emotional design by using appealing colors and round face-like shapes to depict the main elements such as T-cells. This is the approach taken by Plass, Heidig, Hayward, Homer, and Um (2013) in a partial replication of Um, Plass, Hayward, and Homer (2011). The results show that incorporating emotional design increased learner performance on a comprehension test and self-ratings of motivation. These findings are consistent with CMTLM, and point to the potentially important role of affective features of instructional design in improving motivation and learning outcomes.

4. The interest hypothesis: does incorporating decorative illustrations in a multimedia lesson foster learning?

The foregoing study supports the emotional design hypothesis in which increasing the appeal of graphics that are essential for the lesson has a positive effect on learning. Magner, Schwonke, Aleven, Popescu, and Renkl (2013) take the emotional design hypothesis one step further by examining the learning effects of adding interesting but irrelevant illustrations to a computer-based cognitive tutor on geometry. On the one hand, Moreno's CATLM proposes that affective features of a lesson can increase learner engagement (i.e., what can be called generative processing), which leads to deeper learning. On the other hand, Moreno's CATLM and Mayer's CTML propose that extraneous features in a lesson can distract and disrupt effective cognitive processing (i.e., creating what can be called extraneous processing), leading to less learning of the essential material. The results showed adding decorative illustrations to a computer-based lesson resulted in higher ratings of interest, but did not result in higher performance on an immediate test of near or far transfer or a delayed test.

This study points to some limitations of adding emotionally appealing elements to a multimedia lesson in which the costs (in terms of creating extraneous processing) counteracted the benefits (in terms of promoting generative processing). Importantly, the decorative illustrations were particularly harmful for low prior knowledge learners, who are more subject to cognitive overload. Consistent with research on seductive details (Mayer, 2009), it may be more effective to incorporate emotionally appealing graphics that are relevant rather than irrelevant to the instructional goal.

5. Confusion hypothesis: does posing challenging learning tasks improve learning?

Suppose we wish to teach students basic concepts of scientific research by asking them to analyze research studies with the aid of an onscreen agent and onscreen peer. Do students learn better when both onscreen characters express correct opinions that the learner has to critique or when the agent or peer or both initially express an incorrect opinion that the learner has to critique and which is ultimately corrected? This is the issue investigated by D'Mello, Lehman, Pekrun, and Graesser (2013).

Table 1
Three approaches to instructional design.

Approach	Description	Example
Less is more	Use design features that minimize extraneous processing and manage essential processing	Delete extraneous illustrations and text or highlight essential material
More is more	Use design features that motivate learners to engage in generative processing	Add appealing graphics or challenging learning situations
Focused more is more	Use design features that motivate learners to engage in generative processing while also providing enough guidance to mitigate excessive extraneous processing	Add appealing graphics that are relevant to the instructional objective; include challenging learning situations but provide sufficient time and guidance to attain the learning objective

On the one hand, Moreno's CATML proposes that creating a challenging learning situation (such as when a peer expresses an incorrect opinion) can increase student motivation to learn, resulting in deeper engagement (i.e., generative processing), and ultimately in deeper learning outcomes. On the other hand, Moreno's CATML and Mayer's CTML propose that the learning situation should be designed to minimize unneeded cognitive processing that is not related to the instructional objective (i.e., extraneous processing) and that can distract the learner from learning the core material (i.e., essential processing).

Although the results are somewhat complicated, there is evidence that students report being less bored, more confused and more engaged when the on-screen peer makes incorrect statements that contradict the on-screen tutor than when the on-screen peer agrees with the on-screen tutor. Importantly, there is also evidence that having to resolve the contradiction caused by a peer making incorrect statements can help learners perform better on posttests of learning outcome, but only when they experience initial confusion during learning.

The results are consistent with the idea that some forms of confusion can foster learning, particularly when contradictions or disagreements about the essential material lead the learner to engage in "deep inquiry and effortful deliberation." In the present study, the need to engage in extraneous processing was mitigated by providing sufficient learning time and by eventually presenting the correct material, whereas the contradictions provided learners with the opportunity to engage in generative processing. Similar to research on guided discovery techniques (Mayer, 2008) and guided learning with erroneous examples (Grosse & Renkl, 2007), this work shows that motivational techniques can improve learning when they can mitigate the potential for extraneous processing or distraction from essential processing.

6. Conclusion

The papers in this special section propose that designing effective instruction may involve cognitive principles that go beyond minimizing extraneous processing and managing essential processing. In particular each of the papers explores techniques for fostering generative processing through embedding features intended to prime affect and motivation. Overall, the papers encourage us to consider instructional design features aimed at priming motivation to engage in deep processing during learning, while not overloading the learner's information processing system.

Consistent with Moreno's CATML, the papers in this special section focus on motivational factors as well as cognitive factors in promoting learning with computer-based multimedia lessons. The papers show that not all forms of motivational aids are effective in promoting learning, and help encourage further work on pinpointing the conditions under which motivational features in

multimedia lessons can engage learners in deeper processing during learning (i.e., foster generative processing) without overloading them (i.e., control extraneous processing) or distracting them from the core material (i.e., guide essential processing).

Consistent with the focused-more-is-more approach in Table 1, motivational features can improve student learning by fostering generative processing as long as the learner is not continually overloaded with extraneous processing or overly distracted from essential processing.

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