Editorial

Cognitive and affective processes in multimedia learning

A B S T R A C T

This special section focuses on cognitive and affective processes in multimedia learning in a range of learning domains. Expanding previous research that has taken a predominantly cognitive perspective of multimedia learning, recent studies have begun to consider affective aspects of multimedia learning with the aim of integrating emotion, motivation, and other affective variables into cognitive processing models. The articles included in this special section are examples of the various ways in which the cognitive perspective can be enhanced by taking affective aspects of learning into account. Investigations range from the study of confusion as an affective state that can be beneficial to learning, and the consideration of the potential distracting or motivating function of decorative illustrations, to an inquiry into how visual design can induce positive emotions in learners. The results of the studies included in this section are in line with Moreno’s Cognitive-Affective Theory of Learning with Media (CATLM; Moreno, 2006) and show how emotion and interest facilitate cognitive processing and improve cognitive and affective outcomes.

1. Introduction

This special section is based on the invited SIG 6 Symposium on Instructional Design, which took place during the 14th Biennial Conference of the European Association of Research on Learning and Instruction (EARLI) in summer 2011 in Exeter, U.K. This symposium was organized and chaired by Babette Park, Jan L. Plass, and Roland Brünken, and was dedicated to Dr. Roxana Moreno, who had unexpectedly passed away the previous summer. With Dr. Moreno’s untimely death, our community lost one of our most prolific researchers and highly productive scholars, a wonderful human being who will be missed by many (see also Robinson, 2010). With this special section we would like to commemorate Dr. Moreno’s most recent work on a Cognitive-Affective Theory of Learning with Media (CATLM; Moreno, 2005, 2006, 2007, 2009) by presenting papers that have provided empirical evidence for the CATLM and that may inspire more research related to this theory.

CATLM focuses on cognitive and affective processes in multimedia learning. The theory is based on recent theoretical frameworks of multimedia learning and enhances the cognitive perspective by taking motivational and affective aspects into account. The model includes four cognitive assumptions: (1) The existence of verbal and non-verbal information processing channels that are relatively independent of one another, (2) the limited capacity of working memory, as well as a virtually unlimited capacity of long-term memory, (3) enhanced learning through dual coding, and (4) the need for learners to actively process information to construct meaning. These well-known assumptions, which are based on Mayer’s Cognitive Theory of Multimedia Learning (Mayer, 2005), are augmented by three new assumptions: (5) the affective mediation assumption, which suggests that motivational factors mediate learning by increasing or decreasing cognitive engagement (Gottfried, 1990; Moreno, Mayer, Spires, & Lester, 2001; Park, Moreno, Seufert, & Brünken, 2011), (6) the metacognitive mediation assumption, which suggests that metacognitive factors mediate learning by regulating cognitive and affective processes (McGuinness, 1990; Morris, 1990), and (7) the individual differences assumption, which suggests that differences in learners’ prior knowledge (Kalyuga, Ayres, Chandler, & Sweller, 2003; Moreno, 2004) and traits such as cognitive styles and abilities (Moreno & Durán 2004; Plass, Chun, Mayer, & Leutner, 1998; Seufert, Schütze & Brünken, 2009) affect the efficiency of learning with methods and media. The resulting CATLM is shown in Fig. 1.

To consider these affective aspects in research on instructional design, three contributions are presented in this special section that focus on cognitive and affective processes in multimedia learning. D’Mello, Lehman, Pekrun, and Graesser (2013) studied whether confusion is an affective state that can be beneficial to learning. Magner, Schwonke, Alevin, Popescu, and Renkl (2013) investigated the effects of decorative illustrations and their distracting or motivating function. Plass, Heidig, Hayward, Homer, and Um (2013) reported a study on how the design of multimedia learning materials can induce positive emotions in learners, and how these positive emotions facilitate cognitive processing and improve cognitive and affective outcomes.

2. Overview of the studies

Each of the three studies presented in this special section provides empirical support for different aspects of CATLM. D’Mello et al. (2013) conducted a study on the impact of a particular emotion, confusion, on learning. Confusion can be a result of contradictions,
conflicts, anomalies, erroneous information, and other discrepant events in the learning materials, and can result in a state of cognitive disequilibrium. Under specific conditions, however, confusion can be beneficial to learning. These conditions include that confusion must be induced, regulated, and resolved appropriately. The authors examined the hypothesis that confusion could be beneficial to learning in two experiments in which learners engaged in conversations with a tutor and a student peer, both played by animated agents. These “triangulogues on scientific reasoning concepts in a simulated collaborative learning session” (p. 2) were hypothesized to support learning.

D’Mello et al. (2013) induced confusion in the environment via manipulation of the tutor, having the animated agents express opinions that were at times incorrect and/or contradictory. Learners were asked to decide the scientific merit of the different opinions. The study found that these manipulations did not affect learners’ self-reported confusion. However, learner responses that immediately followed contradictions proved to be a more effective indicator of confusion. Performance on post tests (multiple choice comprehension tests and open-ended transfer tests) showed that students learned more when the contradictions introduced by the agent were successful in confusing them. These findings provide evidence in support of the affective mediation assumption (Moreno, 2006), which states that affective factors mediate learning by impacting cognitive engagement, and show that confusion is such an affective state that can be beneficial to learning.

Magner et al. (2013) focused on another affective aspect of the CATML by investigating the impact of decorative illustrations on interest in and learning from computer-based learning environments. The researchers conducted two studies to investigate these questions. The pre-study, involving 87 students in 8th grade, explored the effects of decorative illustrations on situational interest. Based on the results of this study, illustrations that had been rated by students as highly interesting were selected for use in the main study. In the main study, which included 52 participants, Magner et al. investigated the effect of interesting decorative illustrations on immediate and delayed test performance. The researchers found that decorative illustrations resulted in lower near transfer for those students who had low levels of prior knowledge, yet supported students who had very high levels of prior knowledge. Results also showed that the higher performance of students receiving decorative illustrations on far transfer test was due to the enhanced situational interest induced by these illustrations. However, these findings did not persist in the delayed post test.

The findings of this study are in line with other research, such as a study by Park et al. (2011), which found that seductive details either hindered or fostered learning, depending on the level of cognitive load they induced (Moreno & Park, 2010; Plass, Moreno, & Brünen, 2010). Taken together, these findings suggest that the cognitive processes of selecting relevant information and organizing this information into a coherent mental model can be affected not only in a negative way through seductive details or decorative illustrations, but also in a positive way if learners have sufficient available resources to process non-redundant and interesting, but irrelevant, learning material. Cognitive resources may be available as a result of optimized design of the learning environment, which applied established multimedia learning principles (Mayer, 2005), or due to learner differences in prior knowledge, as assumed by the individual differences assumption of CATML (Moreno, 2006). The results of this study therefore support the affective mediation assumption of CATML (Moreno, 2006), suggesting that a deep understanding of multimedia learning effects requires the consideration of the interplay of cognitive and motivational factors, and that the motivational or arousing role of seductive details or decorative illustrations should be taken into account.

Another type of affect was investigated by Plass et al. (2013). This paper focused on methods to induce positive emotions in learners, and thereby to improve learning, through the design of the learning materials. This study had two goals. The first goal was to replicate findings from a previous study, which had shown that the emotional design of multimedia learning environments could induce positive emotions in learners, and that these positive emotions facilitated learning both on a comprehension and a transfer level (Um, Plass, Hayward, & Homer, 2012). The Plass et al. (2013) study aimed to replicate these results with a different procedure for mood induction, and with participants from a different population. It also aimed to examine particular emotions that learners may experience from different mood induction procedures. Study 1 found indeed that the application of emotional design principles, using round face-like shapes and warm colors, was able to induce positive emotions and facilitate comprehension. However, even though Um et al. (2012) had found an effect of emotional design on transfer of learning, the Plass et al. (2013) study was not able to replicate this effect.
Plass et al. (2013) next aimed to decompose the effects of two emotional design elements, color and shape, which had been used in compounded form in study 1. Results from study 2 showed that round, face-like shapes induced positive emotions both alone and in conjunction with warm colors. However, warm colors alone did not affect learners' emotions. Comprehension test results were best for students receiving warm colors, round face-like shapes, or combinations of warm colors and round face-like shapes. Transfer test results were highest for round face-like shapes in combination with neutral colors.

These findings also provide support for the affective mediation assumption of CATLM (Moreno, 2006), suggesting that emotional factors mediate learning by increasing the cognitive engagement of the learner, with resulting gains in learning.

The present special section is discussed by two experts in the field of multimedia learning, Detlev Leutner (2013) and Richard E. Mayer (2013). Both commentaries offer critical reflections on the main issues raised by the included papers, and discuss open questions for future research. These two discussions also provide valuable suggestions on future directions of research and theory development of cognitive and affective processes in multimedia learning.

3. Conclusion and future directions

The papers in this special section demonstrate that the integration of cognitive and affective processes in multimedia learning is a promising area of inquiry that, although still in its infancy, has the potential to significantly broaden our understanding of multimedia learning. Findings suggest that including emotion and other affective variables is not only essential in the process of designing multimedia learning environments, but that these variables are also critical in understanding and investigating learning, opening new perspectives on the integrative nature of learning processes. Within the frame of the resulting studies, which can be more complex than studies focusing only on cognitive aspects, it may be necessary to use more complex data analyses methods that show, for example, indirect effects of mediation (Magner et al., 2013).

In summary, this special section aimed to bridge the gap between research on cognitive processes and research on affective processes in learning and to contribute to the further development of Roxana Moreno’s CATLM as an integrative framework for research on learning and instruction. With the present special section, we would like to provide momentum to research and theory development on how to integrate cognitive and affective processes in research on multimedia learning. We hope that this integrative research field will grow within the next decades, continuing the highly productive work initiated by Roxana Moreno.

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References