Thinking Skills and Creativity 13 (2014) 9–19

Contents lists available at ScienceDirect

Thinking Skills and Creativity

journal homepage: http://www.elsevier.com/locate/tsc

Using a multimedia learning tool to improve creative performance

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ARTICLE INFO

Article history:
Received 10 March 2013
Received in revised form 22 February 2014
Accepted 23 February 2014
Available online 2 March 2014

Keywords:
Multimedia learning
Cognitive load
Creative thinking
Product creativity
Cognitive system

ABSTRACT

This study explored the effects of using computer-based multimedia learning materials on creative performance. A multimedia learning tool (MLT) was developed as part of a specific mechanical engineering subject taking into consideration appropriate load on the cognitive system for effective information and creative cognitive processing. The theoretical perspectives and design principles of Cognitive Theory of Multimedia Learning (CTML) shaped the development of the MLT. Students' creative thinking and product creativity were measured using established creativity instruments namely the Torrance Tests of Creative Thinking (TTCT) and Creative Product Semantic Scale (CPSS). For creative thinking the results showed that the MLT was instrumental for students to generate flexible and original ideas, but not fluent ideas. This was reflected through students' product creativity which showed novel and aesthetic qualities, but lacked practicality. Students' perceptions supported the MLT's partial influence especially through the use of animations. The findings suggest possible effects of dynamic learning materials on creative performance which however require further exploration.

1. Introduction

Creativity researchers have argued that the creative cognitive process involves both the processing of information and the construction of knowledge (Guildford, 1975; Wallas, 1926). Further, a high volume of in-depth knowledge is deemed essential for the enhancement of creativity performance (Guildford, 1975; Mednick, 1962; Runco & Chand, 1995). Therefore, one of the educational measures to enhance creative potential among students is providing learning materials that can help them to cognitively construct sufficient knowledge representations for creative process.

Complementary research in multimedia learning emphasises developing learning materials that consider the cognitive system and its functions to support effective knowledge construction for understanding and meaningful learning (Mayer, 2009). To date, most studies in multimedia learning have looked at students' performance in retention and transfer tests (De Koning, Tabbers, Rikers, & Paas, 2007; Mayer, 2009; Moreno, 2007). Although Mayer, 2009 defined performance in

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http://dx.doi.org/10.1016/j.tsc.2014.02.004
1871-1871/

transfer tests as students' ability to utilise their knowledge in a new situation or to solve problems in novel ways, he did not specifically define creativity.

This study therefore aims to utilise the principles of multimedia learning in order to design learning materials that can help enhance students' creative performance. This paper reports a study that developed a multimedia learning tool (MLT) of a mechanical engineering subject based on the Cognitive Theory of Multimedia Learning (CTML) (Mayer, 2009). The focus was on the effects of using the MLT on engineering students' creative thinking and product creativity. It is assumed that if students' creative performances were achieved by using the MLT, the multimedia learning materials would have helped students to generate and construct sufficient knowledge representations for understanding and creative cognitive processing.

2. Theoretical background

2.1. Creative cognitive processing

There are four key theoretical perspectives on creativity (e.g. Guildford, 1975; Mednick, 1962; Torrance, 1965; Wallas, 1926), which emphasise creative process as cognitive processing of information, and the importance of the construction of knowledge representations for creative performance. Wallas, 1926 discussed the creative process through *stage theory*. This theory proposes that requisite knowledge, skills and experiences need to be gathered and acquired in the preparation stage. This can be done through learning activities such as watching multimedia, listening to lectures or reading. Mental knowledge representations gathered at this stage can determine creative performance in later stages (Armbruster, 1989; Wallas, 1926). The high volume of knowledge representations becomes flexible in later stages of the creative process when it can be freely reassembled into new mental structures. This theory therefore assumes the importance of acquiring a high volume of knowledge representations for effective cognitive processing to support creativity.

Guildford, 1975 discussed the creative process as a divergent thinking process. Using his *Structure-of-Intellect* (SOI) model, Guildford, 1975 suggested five basic intellectual operations associated with divergent information processing. Creativeness emerges through an intellectual operation called divergent production, a broad operation which requires fluency and flexibility in thinking. The whole creative cognitive process is characterised by the ability to fluently and flexibly organise, integrate and retrieve knowledge representations. Elements of information, which can be flexibly and divergently connected and integrated, can produce mental structures that are novel and useful. This ability differentiates creative individuals from less creative individuals (Gardner, 1988; Guildford, 1975).

Reflecting a different perspective, Torrance, 1965 discussed the creative process as a process of *problem-solving*. He argued that the creative process involves identifying and searching for problems, making hypotheses concerning the problems and possibly modifying and testing a hypothesis. He also associated the creative process of problem-solving with divergent thinking, defining the later construct as the production of multiple unexpected answers from available information and making unexpected remote combinations and associations, which are often novel and original (Cropley and Cropley, 2008). Knowledge is identified as an important factor that can help a person identify problems, and later provides their solutions. The creative process therefore involves the ability to fluently, flexibly and divergently generate ideas from the available knowledge representations in memory.

Finally, Mednick, 1962 described the creative process as *an associative process* where knowledge representations or ideas are linked through remote associations. This theory hypothesises that knowledge representations need to be remotely associated into something useful or which meet the task requirement. The more remote the association, the more creative is the combination (Mednick, 1962; Runco, 2004). Creative individuals possess a high level of responses to the associations compared to less creative individuals, and a higher and steady number of associations can help the person solve problems (Martindale, 1989; Mednick, 1962). This theoretical framework also emphasises the importance of having sufficient knowledge representations in the cognitive system for creative associations to be produced.

All four theoretical perspectives discussed above state that the creative process involves cognitive processing of information. Knowledge representations need to be acquired and constructed for the creative process to occur. Higher volume of knowledge representations acquired and constructed in the memory permit novel and unique integration of mental structures. Creative potential therefore depends on the construction of knowledge representations and the ability to flexibly and divergently integrate and associate them for new mental structures of information.

2.2. Cognitive system models for information processing and creativity

To ensure effective cognitive processing, it is important to understand the cognitive system. The Cognitive Theory of Multimedia Learning (CTML) (Mayer, 2009) presents a theoretical framework which considers the structure of the cognitive system to determine appropriate design of learning materials for meaningful learning to occur. CTML proposes a cognitive model for information processing (as depicted in Fig. 1). This model considers the differences between verbal and graphical information representations presented in learning materials and how these differing information representations are processed by the cognitive system. This model assumes and considers the separate channels for receiving and processing information, limitation of working memory and its active processing system. This model looks at the effectiveness of information processing in the working memory by considering cognitive load imposed on working memory.