

# Chapter 10

## Factors Influencing Learners' Cognitive and Affective Processes in Visual Learning

**Robert Zheng**  
University of Utah, USA

### ABSTRACT

*This chapter focuses on the cognitive and affective factors that may influence learners' performance in visual learning. Both cognitive and affective factors were identified with cognitive factors aiming to reduce cognitive load, making meaningful learning through schema connection and activation. The affective factors focused on meeting the psychological and self-fulfillment needs in visual learning. Discussions were made on the implications of the chapter in terms of supporting professionals and educators in their design of effective visual learning in education.*

### INTRODUCTION

Visual representations including multimedia, animation, videos, educational gaming, etc. can benefit students' learning in ways that differ from traditional approaches (Kambouri, Pampoulou, & Pieridou, 2016; Tippet, 2016; Wilson, Copeland-Solas, & Guthrie-Dixon, 2016; Zheng & Wang, 2016). Studies have shown that visualization can promote active learning, knowledge construction, creative and deep thinking (Bergman, Sieben, & Smailbegovic, 2013; Pesic & Pesic, 2015; Wiles, 2016). However, there is a misconception in visualization research believing that visual representations will bring with cognitive and affective benefits when they are applied in learning (Ferreira & Arroio, 2009; Sinatra, Kienhues, & Hofer, 2014). In his well-known 1994 media debate with Kozma, Clark (1994) argued that media did not influence learning, instructional methods did. He pointed out that "an instructional method is any way to shape information that activates, supplants or compensates for the cognitive processes necessary for achievement or motivation" (Clark, 1994, p. 23). Clark believed it was the instructional method, rather than the media, that generated the cognitive benefits. He further claimed that "media not only fail to influence learning, they are also not directly responsible for motivating learning" (Clark, 1994,

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p.23). Kozma (1994) countered that “learning is an active, constructive, cognitive and social process by which the learner strategically manages available cognitive, physical, and social resources to create new knowledge by interacting with information in the environment and integrating it with information already stored in memory” (Kozma, 1994). Although the debate on media occurred twenty some years ago, the argument on the affective and cognitive functions of media have been continued to date. Studies (e.g., Jonassen, Compbell, & Davidson, 1994; Liew & Tan, 2016; Raiser, 1994; Thompson & McGill, 2008; Zheng, McAlack, Wilmes, Kohler-Evans, & Williamson, 2009) have shown that media, due to their unique attributes, may contribute significantly to the cognitive and affective processes in learning. Given the mixed findings in the research on visualization, this chapter examines the roles and attributes of media by exploring how visualization promotes cognitive and affective learning in science learning.

## **VISUALIZATION: A COGNITIVE PERSPECTIVE**

As discussed early there are mixed views on the role of visualization including the benefits associated with visualization in learning. Some believe it is the instructional methods that promote learning, others argue that media such as visual representations facilitate active, constructive, cognitive and social process as the attributes of the media enable learners to strategically manage cognitive, physical, and social resources in the learning process (Clark, 1994; Jonassen, Compbell, & Davidson, 1994; Kozma, 1994; Reiser, 1994). Reiser (1994) pointed out, “certain media attributes make certain methods possible” (Reiser, 1994, p. 45). He further added, “the successful delivery of instructional methods ... is dependent, in part, on the attributes of the medium...” (Reiser, 1994, p.45). Reiser explicated the cognitive role of media showing that visuals can significantly enhance the function of instructional strategy and that in many situations instructional strategy may not even be able to accomplish its goals without visuals. In the following sections we thereby examine the cognitive function of visuals with case studies showing how visuals support learners’ learning.

Studies have demonstrated the superiority of visuals over non-visuals (Mayer, 2001; Mayer, Bove, Bryman, & Tapangco, 1996; Mayer & Gallini, 1990). Research on visualization derives its underlying theoretical assumption from Mayer’s (2001) multimedia learning principle which posits that visuals are more effective than non-visuals. Mayer and colleagues (Mayer et al., 1996; Mayer & Gallini, 1990) found that learning with visual representations can significantly improve learners’ recall and knowledge transfer. Recent studies further show that visuals can offload the mental load, thus making cognitive resources available for learners during learning (Zheng, 2007; Zheng, Miller, Snelbecker, & Cohen, 2006).

Based on Mayer’s multimedia learning principle, Zheng and colleagues (Zheng & Cook, 2012; Zheng & Dahl, 2010; Zheng, Yang, Garcia, & McCadden, 2008) studied the cognitive function of visual representations in complex problem solving. It has been recognized that working memory plays a vital role in learning (Baddeley, 1997; Baddeley & Logie, 1992; Paivio, 1986). Sweller and colleagues (Sweller, 1994; 2010; Sweller & Chandler, 1994; Sweller, van Merrienboer, & Paas, 1998) pointed out when the learner experienced high cognitive load either due to the difficulty of the content or improper design in instruction, the learner’s learning suffered. There would be few cognitive resources left in working memory, which would consequently affect learner’s information processing and performance in learning. Appropriately designed visual tools can help reduce the cognitive load and improve learners’ information processing and performance in complex learning like math and science.

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