Chapter XVII
Multimedia, Cognitive Load, and Pedagogy

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ABSTRACT

The current emphasis, in education and training, on the use of instructional technology has fostered a shift in focus and renewed interest in integrating human learning and pedagogical research. This shift has involved the technological and pedagogical integration between learner cognition, instructional design, and instructional technology, with much of this integration focusing on the role of working memory and cognitive load in the development of comprehension and performance. Specifically, working memory, dual coding theory, and cognitive load are examined in order to provide the underpinnings of Mayer's (2001) Cognitive Theory of Multimedia Learning. The bulk of the chapter then addresses various principles based on Mayer's work and provides well documented web-based examples.

INTRODUCTION

Improving the efficiency and effectiveness of instruction has consistently been a primary goal of education and training. In pursuit of this goal, cognitive psychology has provided considerable insight regarding the processes that underlie efficient and effective instruction. The past 50 years are replete with empirical studies addressing the characteristics inherent in human learning and the influence of these characteristics on instruction. Unfortunately (Anderson, Reder, & Simon, 1998), this "science of human learning has never had a large influence upon the *practice* of education [or training]" (p. 227; italics added). This gap between research and practice is lamentable and serves to deny learners and teachers access to powerful forms of teaching, training, and learning.

Fortunately, the current emphasis on the use of instructional technology has fostered renewed interest in integrating human learning and pedagogical research (see Abbey, 2000; Rouet, Levonen, & Biardeau 2001). As Doolittle (2001) has stated, "it is time to stop professing technological and pedagogical integration and to start integrating with purpose and forethought" (p. 502). One area within instructional technology that has begun this integration is multimedia. The domain of multimedia has matured beyond technology-driven applications into the realm of cognition and instruction. As stated in Rouet, Levonen, and Biardeau (2001), "There is a subtle shift of attention from what *can* be done with the technology to what *should* be done in order to design meaningful instructional applications" (p. 1). This shift has involved the technological and pedagogical integration between learner cognition, instructional design, and instructional technology, with much of this integration focusing on the role of working memory in the development of comprehension and performance.

Specifically, a focus has developed addressing the limited resource nature of working memory and cognitive load. Cognitive load simply refers to the working memory demands implicitly and explicitly created by instruction and how these demands affect the learning process. Those learning tasks that are poorly designed or involve the complex integration of multiple ideas, skills, or attributes result in increased cognitive load and decreased learning. This relationship between cognitive load, working memory, and instruction/training has proved to be especially significant when the instruction is in the form of multimedia. According to Mayer (2001), "the central work of multimedia learning takes place in working memory" (p. 44).

This chapter focuses on multimedia and the mitigating effects of cognitive load on teaching, training, and learning. A central organizing theme throughout the chapter is the development of theoretically sound pedagogy (see Figure 1). Theoretically sound pedagogy involves instruction that is based on empirical research and sound theory designed to illuminate the nature of human learning and behavior. Such theoretically sound pedagogy may then be molded to fit specific learning environments, learning goals and objectives, and learners.

WORKING MEMORY, DUAL CODING AND COGNITIVE LOAD

When pursuing theoretically sound pedagogy, it is essential to ground one's conclusions in the human memory literature. Unfortunately, while there is a plethora of research findings exemplifying the structure and function of human memory, a singular model of memory to which one can refer has yet to emerge. Currently, the three most prevalent models are Atkinson and Shiffrin's (1968) dual-store model, Baddeley's (Baddeley, 1986; Baddeley & Hitch, 1974) working memory model, and Anderson's (1983, 1990, 1993) functional ACT-R model. Each of these models has roots in the early information-processing work of Broadbent (1958) and Peterson and Peterson (1959).