Chapter 1
Cognitive Load Theory, Spacing Effect, and Working Memory Resources Depletion: Implications for Instructional Design

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ABSTRACT

In classroom, student learning is affected by multiple factors that influence information processing. Working memory with its limited capacity and duration plays a key role in learner ability to process information and, therefore, is critical for student performance. Cognitive load theory, based on human cognitive architecture, focuses on the instructional implications of relations between working memory and learner knowledge base in long-term memory. The ultimate goal of this theory is to generate effective instructional methods that allow managing students' working memory load to optimize their learning, indicating the relations between the form of instructional design and the function of instructional design. This chapter considers recent additions to the theory based on working memory resources depletion that occurs after exerting significant cognitive effort and reverses after a rest period. The discussed implications for instructional design include optimal sequencing of learning and assessment tasks using spaced and massed practice tasks, immediate and delayed tests.

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INTRODUCTION

Cognitive Load Theory (CLT) is an instructional theory that explains the effects of information processing load imposed by learning tasks on learners' cognitive system (Sweller, Merriënboer & Paas, 2019). The general goal of cognitive load theory is to generate innovative and effective instructional procedures to reduce learners' working memory load and optimize their information processing ability.

Working memory resources are limited due to its limited capacity, and this characteristic of working memory is central to the main topic of this chapter - the depletion effect. The next section provides a brief review of human cognitive architecture, its characteristics, and operation principles. Working memory and long-term memory are two major components of this architecture. In accordance with human cognitive architecture, the following section introduces the function of instructional design from the perspective of element interactivity and types of cognitive load. As the function of instructional design within the framework of cognitive load theory is to manage cognitive load, some load-reduction instructional methods are presented to address the form of instructional design and its relation with its function. Then, the working memory resources depletion effect is introduced, followed by the spaced practice design and the immediate vs. delayed tests as forms of evidence for the depletion effect. The chapter concludes with educational implications of working memory resources depletion effect for instructional design principles, including optimal sequencing of learning and assessment tasks using spaced and massed practice tasks, immediate and delayed tests.

HUMAN COGNITIVE ARCHITECTURE

Human cognitive architecture is considered as a natural information-processing system that operates based on a set of principles that determine the interaction between the external environment, working memory and long-term memory. These principles might be common to all natural information-processing systems such as human cognition or biological evolution by natural selection (Sweller & Sweller, 2006). The aspects of human cognitive architecture that are relevant to instructional issues can be summarized by five principles.

- **Information Store Principle:** All the natural information-processing systems have large stores of information that govern their behavior within the environment. For example, for biological systems, the information store is their genome (generic code store); for human cognitive architecture - it is the long-term memory's knowledge base. To perform well in a complex

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