Chapter I
Human Cognitive Processes

INTRODUCTION

One of the major components of our cognitive architecture, working memory, becomes overloaded if more than a few chunks of information are processed simultaneously. For example, we all experience this cognitive overload when trying to keep in memory an unfamiliar telephone number or add two four-digit numbers in the absence of a pen and paper. Similar in nature processing limitations of working memory represent a major factor influencing the effectiveness of human learning and performance, particularly in complex environments that require concurrent performance of multiple tasks.

The learner prior domain-specific knowledge structures and associated levels of expertise are considered as means of reducing these limitations and guiding high-level knowledge-based cognitive activities. One of the most important results of studies in human cognition is that the available knowledge is a single most significant learner cognitive characteristic that influences learning and cognitive performance. Understanding the key role of long-term memory knowledge base in our cognition is important to the successful management of cognitive load in multimedia learning.

This chapter provides a general overview of our cognitive architecture and its implications for performance of cognitively-rich tasks and learning new information. It outlines major structural components of our cognitive systems and their functions in cognition. The role of our knowledge base and the nature of expertise are considered in more detail. This knowledge would serve as a theoretical foundation for the analysis and evaluation of various means of managing cognitive load for learners with different levels of expertise described in the following chapters.

MAIN FEATURES OF OUR COGNITIVE ARCHITECTURE

Current theoretical models of human cognitive architecture and available empirical evidence about its functioning in learning and performance indicate several major characteristics that underline operation of this system. These features could be associated with corresponding general principles that may govern all natural information processing systems (another example of a natural information processing system is evolution by natural selection in biology; see Sweller, 2003; 2004; Sweller & Sweller, 2006; van Merriënboer & Sweller, 2005, for more detailed descriptions of these principles and their general implications for the design of information presentations). Some of these features will be explained in more details in the following sections of this chapter.

The first feature defines our cognitive system as an essentially knowledge-based one. Our cognitive architecture includes a large store of organized information with effectively unlimited storage capacity and duration. Long-term memory as a repository of organized knowledge base represents that store of information. It contains a huge number of various schematic knowledge structures that effectively determine our capabilities to function successfully in complex environments. Generally, schemas are organized knowledge structures that are used for mentally categorizing and representing concepts and procedures in long-term memory. Most of our cognitive activities in everyday situations, professional life, learning, etc. are based on available domain- and task-specific knowledge base. We know what to do when buying things at a supermarket, eating at a restaurant, filling in a car. We easily understand fiction books we read, however certainly encounter huge problems when reading specialist books in unfamiliar domains. This is because we have a massive knowledge base for dealing with our natural and social environment in everyday life which is usually sufficient for understanding fiction books, but no specific knowledge in many professional domains.

The second feature of our cognitive architecture is a functional mechanism that drastically limits the scope of immediate changes to that store of organized knowledge. The concept of working memory represents this mechanism at a psychological