Chapter I
Cognitive Architecture and Instructional Design in a Multimedia Context

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ABSTRACT

Our knowledge of human cognitive architecture has advanced dramatically in the last few decades. In turn, that knowledge has implications for instructional design in multimedia contexts. In this chapter, we will analyse human cognitive architecture within an evolutionary framework. That framework can be used as a base for cognitive load theory that uses human cognitive architecture to provide testable hypotheses concerning instructional design issues. Human cognition can be characterised as a natural information processing system. The core of such systems can be described using 5 principles: (a) information store principle, (b) borrowing principle and reorganizing principle, (c) randomness as genesis principle, (d) narrow limits of change principle, and (e) environment organizing and linking principle. These 5 principles lead directly to the instructional effects generated by cognitive load theory. Some of these effects are concerned with multimedia learning. The particular ones discussed in the chapter are the split-attention, modality, redundancy, element interactivity, and expertise reversal effects.

INTRODUCTION

Instructional design recommendations not based on our knowledge of human cognitive architecture are likely to be limited in their effectiveness or may even have negative consequences. In this chapter, we will use an evolutionary approach to human cognition (see Sweller 2003; Sweller 2004; Sweller and Sweller 2006). Evolution by natural selection can be used to determine categories of knowledge that humans are particularly adept at gaining because we have evolved to acquire that knowledge. Furthermore, the basic logic that underlies evolutionary biology is shared by human cognition and so can be used to analyse our cognitive processes. Those cognitive processes, in turn, determine the effectiveness of particular instructional procedures. We will begin by discussing two categories of knowledge from an evolutionary perspective.

BIOLOGICALLY PRIMARY AND BIOLOGICALLY SECONDARY KNOWLEDGE

Geary (2007) divides knowledge into biologically primary knowledge that we have evolved to acquire easily and automatically and biologically secondary knowledge that relies on primary knowledge but that we have not evolved to acquire. Examples of activities driven by primary knowledge are listening and speaking our first language, recognising faces, using general problem solving techniques and engaging in basic social relations. We have evolved over millennia to acquire massive amounts of knowledge associated with these activities easily, quickly and without conscious effort. We can acquire biologically primary knowledge simply by being immersed in a normal human society. Explicit instruction is unnecessary.

In contrast, biologically secondary knowledge tends to be associated with a more advanced stage of development of civilization. It has only been required since the rise of civilisation and so we have not evolved to acquire specific examples of biologically secondary knowledge. We can acquire such knowledge using biologically primary knowledge but it is acquired relatively slowly and with conscious effort. In contrast to biologically primary knowledge, biologically secondary knowledge requires explicit instruction and conscious effort on the part of learners. The bulk of knowledge acquired in educational institutions such as schools consists of biologically secondary knowledge.

HUMAN COGNITIVE ARCHITECTURE WHEN DEALING WITH BIOLOGICALLY SECONDARY KNOWLEDGE

There is a basic logic associated with the acquisition of biologically secondary knowledge and that logic is identical to the logic that underlies the processes of evolution by natural selection. Both are examples of natural information processing systems (Sweller & Sweller, 2006). There are many ways of describing that logic. In this chapter we will use five basic principles.

Information Store Principle

In order to function, natural information processing systems require a massive store of information used to govern activity. In the case of human cognition, long-term memory provides that store. The well-known work of De Groot (1965) and Chase and Simon (1973) on the knowledge chess masters have for board configurations taken from real games provides evidence for the importance of long-term memory for most facets of cognition, including problem solving. A genome provides the same function for evolution by natural selection.

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