Chapter XX
Cognitive Perspective on Human-Computer Interface Design

Robert Z. Zheng
University of Utah, USA

Laura B. Dahl
University of Utah, USA

Jill Flygare
University of Utah, USA

ABSTRACT

This chapter focuses on the design of human-computer interface, particularly the software interface design, by examining the relationship between the functionality and features of the interface and the cognitive factors associated with the design of such interface. A design framework is proposed followed by an empirical study to validate some of the theoretical assumptions of the framework. The findings indicate that learners become more perceptually engaged when a multiple sensory-input interface is used. Our study also shows that building affective interaction at the perceptual level could significantly enhance learners' perceptual engagement which further leads them to cognitive engagement. Guidelines for designing an effective interface are proposed. The significance of the study is discussed with some suggestions for future study.

INTRODUCTION

The advancement of new digital technologies has brought a spectrum of changes in our society, particularly in the areas of education, industry, commerce, government, and so forth. According to a recent study, use of computers and Internet access at school rose from 51% in 1998 to 93% in 2003 (National Center for Education Statistics, 2005). The U.S. Department of Labor 2002-2012 employment projections indicate that 8 of the 10 fastest growing occupations require technological fluency (Bureau of Labor Statistics, 2007). Coupled with this increasing computer technology use is the issue of human-computer interface (HCI) design. Wallace and Sinclair (1995) express their concern about the negative cognitions and attitudes towards technology caused by poorly designed human-computer interface related to both hardware and software. Preece, Rogers, and Sharp (2002) argue that the hardware may work effectively from an engineering perspective but can cause “numerous people immense grief” at the expense of “how system will be used by real people” (p. 1). They called for a systematic study of the human-computer interface that focuses on both hardware and software by examining the human factors pertaining to human-computer interaction.

While the hardware issue is worth attention with regard to the physical interactivity between the user and the computer as well as the impact of such interactivity on the user’s information process (Kroemer & Kroemer, 2001; Patterson & Hennessy, 2005), studies on software design and user relations begin to emerge. Numerous studies have been conducted in screening behavior and human cognition (Kearny & Smith, 1999), mental model and computer implementation (Goodwin & Johnson-Laird, 2005), computer-related tasks and human factors (Serenko, 2006), agent-based human-computer interaction (Baylor, 2002, 2004; Moreno & Mayer, 2004), and so forth. There has been a considerable interest in understanding the relationship between human cognition and software interface design. Scholars from computer science and cognitive psychology (Mayer & Moreno, 2003; Norman, 1988; Schneiderman, 1980, 1982) concurred that an appropriately designed software interface can facilitate learners’ cognitive information process. For example, Schneiderman’s theory of direct manipulation and Mayer and Moreno’s principles of multimedia learning design have shown that the learner’s ability to process information can be affected by the mode of interactivity where human cognition is intertwined with the design of the computer interface.

So far, most research has mainly focused on the general relationship between human cognition and computer interface, few studies have been done to explore the underlying operational conditions that facilitate the cognitive information process through the computer interface which has been the key subject in the study of software ergonomics. This chapter describes the characteristics of human perceptions, and how such characteristics affect human information process both in short-term memory and long-term memory. Emphases will be made on the idiosyncratic features of the computer interface and the cognitive attributes associated with such features in human information processing.

The purposes of this chapter are:

1. Defining the software interface design by identifying its underlying concepts;
2. Discussing the issues related to software interface design;
3. Presenting related cognitive theories pertinent to effective interface design; and
4. Proposing guidelines for effective software interface design.

COGNITIVE FUNCTIONS AND SOFTWARE INTERFACE DESIGN

Oftentimes, software designers become confused about what users’ needs are. Part of this is caused by a lack of understanding of the cognitive functions related to the interface. Sugar (2001) conducted a study on novices who designed hypermedia. He found that the novices had difficulty in fixing the flaws identified by the users based on a usability test. Most novice designers used Band-Aid solutions that merely answered direct, obvious problems but hardly addressed and repaired complex, indirect problems. Sugar’s study addressed an important issue that has significant ramifications in human-computer interface design: What is the skill set and knowledge base that are essential for designing an effective software interface?