Thinking Skills in the Digital Era

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INTRODUCTION

The fast development in digital technologies during the digital era confronts individuals with situations that require the utilization of an ever-growing assortment of technical, cognitive, and sociological skills that are necessary in order to perform and solve problems in digital environments. These skills have been termed in recent literature *digital literacy* (Bruce and Peyton, 1999; Gilster, 1997; Lenham, 1995; Pool, 1997; Swan, Bangert-Drowns, Moore-Cox, & Dugan, 2002; Tapscott, 1998). But unlike the common attitude toward this term in most of these papers, digital literacy is more than just the technical ability to operate digital devices properly; it comprises a variety of cognitive skills that are utilized in executing tasks in digital environments, such as surfing the Web, deciphering user interfaces, working with databases, and chatting in chat rooms. In fact, digital literacy has become a survival skill in the modern era: a key that helps users to work intuitively in executing complex digital tasks. In recent years, extensive efforts were made to describe and conceptualize the cognitive skills that users employ in digital environments (e.g., Burnett & McKinley, 1998; Cothey, 2002; Hargittai, 2002; Zins, 2000). Unfortunately, these efforts are usually local, focusing on a selected and limited variety of skills—mainly information-seeking skills (e.g., Marchionini, 1989; Zins)—and, therefore, they do not cover the full scope of the term digital literacy. Eshet (2004) has established a holistic conceptual model for digital literacy, arguing that it covers most of the cognitive skills that users and scholars employ while working in digital environments and, therefore, providing researchers and designers of digital environments with a powerful framework and design guidelines. This framework was derived from the analysis of large volumes of empirical and qualitative information regarding the behavior of users in digital environments. Its exclusive nature was discussed by Aviram and Eshet (in press), and its feasibility was tested by Eshet and Amichai-Hamburger (2004), who tested the performance of different groups of computer users with tasks that require the utilization of different digital skills. In these experiments they showed that the range of digital skills is restricted to the five skills discussed in the present paper.

The present paper describes the major cognitive skills that comprise digital literacy, discusses their value in refining our understanding of how people interact in their work and in digital environments, and examines their application in improving communication among users, scholars, and designers of digital environments. The digital thinking skills that are discussed in the paper are the photovisual, reproductive, branching, informational, and socioemotional thinking skills. We suggest that these five digital thinking skills exist in every learner, but their volumes or magnitudes differ from person to person.

PHOTOVISUAL DIGITAL SKILLS

The evolution of digital environments from text-based syntactic to graphic-based semantic environments (Springer, 1987; Nielsen, 1993; Shneiderman, 1998) requires users of modern digital environments to employ cognitive skills of using vision to think (Mullet & Sano, 1995; Tuft, 1990) in order to create an effective photovisual communication with the environment (Margono & Shneiderman, 1998; Nielsen). This unique form of digital thinking skills—the *photovisual skill*—helps users to intuitively and freely read and understand instructions and messages that are presented in a visual-graphical form. Good examples of digital environments that require the utilization of photovisual digital skills can be found in the design of graphic user interfaces (Opperman, 2002; Shneiderman) and in children's modern computer games. In both, all usage instructions are provided through a graphical representation of symbols and icons. Successful photovisual scholars usually have a good visual memory and

strong intuitive-associative thinking that are useful in understanding visual messages. Eshet and Amichai-Hamburger (2004) discovered that young users (school children) of highly graphic digital environments perform much better than adults in tasks that require the utilization of photovisual skills, as in deciphering graphic user interfaces.

REPRODUCTIVE DIGITAL SKILLS

The modern digital technologies provide scholars with new possibilities for creating art and academic works by reproducing and editing existing texts, visuals, and audio pieces (Benjamin, 1978; Gilster, 1997). Besides the ethical and philosophical questions regarding the limits and criteria for legitimate or ingenuine use of digital reproduction, the digital reproduction technologies require modern scholars to master a special assortment of cognitive skills, termed here reproductive digital skills. Reproductive digital skills are defined as the ability to create new meanings or new interpretations by combining preexisting, independent shreds of information in any form of media (text, graphic, or sound; Gilster). These skills are essential in two major fields (Mason, 2002): in writing, where preexisting sentences can be reorganized and rearranged to create new meanings, and in art, where preexisting audio or visual pieces can be edited and manipulated in order to create new art works (as in the case of pop art and the case of the fake Internet artist Drako Maver; http://www.kapelica.org/maver/main.htm). Labbo, Reinking, and McKenna (1998) described problems that learners face in the digital reproduction of text in a variety of work situations. According to them, scholars who have a high level of digital reproduction skills also have a good synthetic and multidimensional thinking that helps them in discovering new combinations for arranging information in new, meaningful ways. Opposite to their findings for the digital photovisual skills, Eshet and Amichai-Hamburger (2004) found that adult scholars own a higher level of digital reproduction skills compared to younger school children when performed with tasks that require the utilization of digital reproduction skills as text rearrangement.

BRANCHING DIGITAL SKILLS

The nonlinear, branching nature of the modern hypermedia technology introduced computer users to new dimensions of thinking that are necessary in order to make an educated use of this elaborate technology. In the past, the limited, non-hypermedia-based computer environments enhanced a more linear way of learning that was dictated by the nonflexible operating systems, and by the fact that users were used to books and expected to work with digital environments in much the same way they read through books. The modern hypermedia environments, such as the Internet, multimedia environments, and digital databases, provide users with a high degree of freedom in navigating through knowledge domains, but at the same time, they confront people with problems that involve the need to utilize nonlinear and branching information-seeking strategies and to construct knowledge from independent shreds of information that were accessed in a nonorderly and nonlinear way (Burnett & McKinley, 1998; Jansen & Pooch, 2001; Zins, 2000). Spiro, Feltovitch, Jacobson, and Coulson (1991) presented the cognitive flexibility theory that described the importance of branching, multidimensional thinking skills in constructing meaningful understanding of complex phenomena. According to them, the hypermedia technology led to the evolution of new types of digital thinking skills, termed here branching digital skills or hypermedia skills. Branching digital skills require scholars to have a good spatial-multidimensional sense of orientation: the ability to stay oriented and avoid getting lost in hyperspace while navigating through complex knowledge domains despite the intricate navigation paths they may take (Daniels, Takach, & Varnhagen, 2002; Lazar, Bessiere, Ceaparu, Robinson, & Shneiderman, 2003). As shown by Lee and Hsu (2002), they also have a good metaphoric thinking and the ability to create mental models, concept maps, and other forms of abstract representation of the Web's structure, which help branching-skilled scholars to overcome disorientation problems in hypermedia environments.