

Real-Time Thinking in the Digital Era

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INTRODUCTION

In 2004, Eshet-Alkalai published a 5-skill holistic conceptual model for digital literacy, arguing that it covers most of the cognitive skills that users and scholars employ in digital environments, and therefore providing scholars, researchers, and designers with a powerful framework and design guidelines. This model was later reinforced by task-based empirical research (Eshet-Alkalai & Amichai-Hamburger, 2004). Until today, it is considered one of the most complete and coherent models for digital literacy (Akers, 2005); it is used as the conceptual design infrastructure in a variety of educational multimedia companies and was also described in the *Encyclopedia of Distance Learning* (Eshet-Alkalai, 2005). The conceptual model of Eshet-Alkalai consists of the following five digital literacy thinking skills:

1. **Photo-Visual Digital Thinking Skill:** Modern graphic-based digital environments require scholars to employ cognitive skills of “using vision to think” in order to create photo-visual communication with the environment. This unique form of digital thinking skill helps users to intuitively “read” and understand instructions and messages that are presented in a visual-graphical form, as in user interfaces and in children’s computer games.
2. **Reproduction Digital Thinking Skill:** Modern digital technologies provide users with opportunities to create visual art and written works by reproducing and manipulating texts, visuals, and audio pieces. This requires the utilization of a digital reproduction thinking skill, defined as the ability to create new meanings or new interpretations by combining preexisting, independent shreds of digital information as text, graphic, and sound.
3. **Branching Digital Thinking Skill:** In hypermedia environments, users navigate in a branching, nonlinear way through knowledge domains. This form of navigation confronts them with problems that involve the need to construct knowledge from independent shreds of information that were accessed in a nonorderly and nonlinear way. The terms *branching* or *hypermedia thinking* are used to describe the cognitive skills that users of such digital environments employ.
4. **Information Digital Thinking Skill:** Today, with the exponential growth in available information, consumers’ ability to assess information by sorting out subjective, biased, or even false information has become a key issue in training people to become smart information consumers. The ability of information consumers to make educated assessments requires the utilization of a special kind of digital thinking skill, termed *information skill*.
5. **Socio-Emotional Digital Thinking Skill:** The expansion of digital communication in recent years has opened new dimensions and opportunities for collaborative learning through environments such as knowledge communities, discussion groups, and chat rooms. In these environments, users face challenges that require them to employ sociological and emotional skills in order to *survive* the hurdles that await them in the mass communication of cyberspace. Such challenges include not only the ability to share formal knowledge, but also to share emotions in digital communication, to identify pretentious people in chat rooms, and to avoid Internet traps such as hoaxes and malicious Internet viruses. These require users to acquire a relatively new kind of digital thinking skill, termed *socio-emotional*, because it primarily involves sociological and emotional aspects of working in cyberspace.

The publication of Eshet-Alkalai’s (2004) model of digital thinking skills has led to an extensive debate within the community of instructional technology designers, researchers, and educators, as to its validity and completeness, and a special panel in *ED MEDIA2005 Conference* (Montreal) was dedicated to it. This discussion (Aviram & Eshet-Alkalai, 2006) confirmed the validity and value of the model, but indicated that it lacked a sixth thinking skill: the *real-time thinking skill*, which relates to the ability of users to perform effectively in advanced digital environments, mainly high-tech machines, multimedia games, and multimedia training environments that require the user to process simultaneously large volumes of stimuli which appear in real time and at high speed. In the present article, real-time thinking is introduced as the sixth digital thinking skill, which completes the conceptual model of digital thinking skills.

BACKGROUND

The rapid development in digital technologies in recent decades confronts users with situations that require them to master a variety of technical, sociological, and cognitive skills, collectively termed *digital literacy* (Hargittai, 2002; Lanham, 1995), that are necessary to perform effectively in digital environments. 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, and chatting in chat rooms. Digital literacy has become a “survival skill” in the technological era—a key that helps users to work intuitively and effectively in executing complex digital tasks (Lazar, Bessiere, Ceaparu, Robinson, & Shneiderman, 2003).

In recent years, extensive efforts have been made to establish models that describe the cognitive skills that users employ in digital environments (e.g., Hargittai, 2002; Wegerif, 2004; Zins, 2000). Unfortunately, these efforts are usually local, focusing on a selected and limited variety of skills, mainly information-seeking skills (Zins, 2000) and, therefore, they do not cover the full scope of digital literacy. The present article presents real-time thinking, as an additional, sixth skill, in Eshet-Alkalai's (2004) holistic conceptual model of thinking skills in the digital era.

WORKING IN REAL-TIME ENVIRONMENTS

Imagine a pilot flying a jet, a driver driving a car, or a child playing a video game. In all these situations the users are exposed to a large flux of stimuli that *bombard* their cognition in real time, at very high speed, and in random temporal and spatial distribution. In all these situations the key to the users' successful performance is their ability to manage and synchronize these stimuli effectively. When operating such environments, users need to split their attention, reacting to various kinds of stimuli that appear simultaneously in different places on the monitor; they have to be able to execute different tasks simultaneously (multitasking); they need to be able to rapidly change their angle of view and perspective of the environment; and they have to respond to feedback that appears in real time. And above all—they have to quickly and effectively synchronize the chaotic multimedia stimuli into one coherent body of knowledge.

Today, situations that require real-time and high-speed processing of simultaneous large fluxes of information have become common in our lives, mainly in operating multimedia computer programs and advanced machines. This requires that users of today's digital environments master a special kind of thinking skill, here termed *real-time thinking*. Of

course, real-time thinking is not new; it has been utilized ever since humans began to think and to synchronize information simultaneously in order to create knowledge. But in the digital era, with the central role of fast computers, multimedia environments, and devices that can process and present information in real time and at high speed, real-time thinking has become a critical skill. Real-time thinking situations usually require the utilization of split-attention skills in order to manage simultaneously large volumes of stimuli (text, sound, and images) that appear in real time and at a very high speed.

Today, most studies of real-time situations are conducted by researchers in the field of operations research, who explore human performance in aircrafts (Hamblin, Naidu, & Miller, 2006; Roessingh, 2005), cars (Casimir & Gilchrist, 2002) and other real-time working environments. Very little research has been done on the “soft” pedagogic aspects of real-time learning, such as digital games and language acquisition in real-time environments (Eshet-Alkalai, & Chajut, 2006; Pemberton, Fallahkhair, & Masthoff, 2004).

DIMENSIONS OF REAL-TIME THINKING

Simultaneous Synchronization

According to the *dual channel model* (Mayer, 2001), in multimedia environments, real-time stimuli are processed in parallel, independent channels (auditory-verbal and visual-pictorial), and the users' ability to synchronize them effectively is a major factor in their performance (Gopher, Weil, & Bareket, 2004). This model is useful for describing information processing in most multimedia environments such as microworld simulations (e.g., flight or driving simulations, in which the users operate a simulated aircraft or car). In the operation of these simulations, the users employ real-time thinking as they process large volumes of digital information simultaneously. Studies show that practicing real-time thinking in such real-time simulations is useful for improving synchronization ability, and therefore performance, of pilots (Gopher et al., 2004) and drivers (Barkan, Zohar, & Erev, 2003). However, information processing is not limited to these two channels only; in real-life situations, people utilize additional channels for processing real-time information, such as emotions and tactile information, which makes real-time thinking much more complex. Leuchter and Urbas (2002) showed that effective real-time thinkers are capable of synchronizing many channels of information processing simultaneously. One of the common applications of real-time synchronization is the case of language acquisition from subtitled films and from *living books*—computer-based storytelling multimedia programs (<http://www.livingbooks.com>). In living books, children simultaneously hear a story and watch its text on the monitor. Studies have shown that

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