Digital Literacy: A Conceptual Framework for Survival Skills in the Digital Era

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Digital literacy involves more than the mere ability to use software or operate a digital device; it includes a large variety of complex cognitive, motor, sociological, and emotional skills, which users need in order to function effectively in digital environments. The tasks required in this context include, for example, "reading" instructions from graphical displays in user interfaces; using digital reproduction to create new, meaningful materials from existing ones; constructing knowledge from a nonlinear, hypertextual navigation; evaluating the quality and validity of information; and have a mature and realistic understanding of the "rules" that prevail in the cyberspace. This newly emerging concept of digital literacy may be used as a measure of the quality of learners' work in digital environments, and provide scholars and developers with a more effective means of communication in designing better user-oriented environments. This article proposes a holistic, refined conceptual framework for digital literacy, which includes photo-visual literacy; reproduction literacy; branching literacy; information literacy; and socio-emotional literacy.

In light of the rapid and continual development of digital technology, individuals are required to use a growing variety of technical, cognitive, and sociological skills in order to perform tasks and solve problems in digital environments. These skills are referred to in the literature as "digital literacy" (Gilster, 1997; Inoue, Naito, & Koshizuka, 1997; Lenham, 1995; Pool, 1997). Like any fashionable term, "digital literacy" has enjoyed a broad

range of uses in the literature, from reference to technical aspects (e.g., Bruce & Peyton, 1999; Davies, Szabo, & Montgomerie, 2002; Swan, Bangert-Drowns, Moore-Cox, & Dugan, 2002), to cognitive, psychological, or sociological meanings (e.g., Gilster, 1997; Papert, 1996; Tapscott, 1998). The indistinct use of the term causes ambiguity, and leads to misunderstandings, misconceptions, and poor communication among researchers and developers involved in the processes of designing and developing learning digital environments (Norton & Wiburg , 1998).

Development of a more clear-cut conceptual framework may improve the understanding of the skills encompassed by the term "digital literacy," and provide designers of digital environments with more precise guidelines for effective planning of learner-oriented digital work environments (Hamburger, 2002). The present article proposes a new conceptual framework for the concept of digital literacy, incorporating five types of literacy: (a) photo-visual literacy; (b) reproduction literacy; (c) information literacy; (d) branching literacy; and (e) socio-emotional literacy. Review of the literature and observation of users at work, as well as many years of experience in planning digital environments for children and adults, in both industry and academia, indicates that these types of digital literacy encompass most of the cognitive skills applied when using digital environments. Accordingly, this conceptual framework may enhance the understanding of how users perform with tasks that require the utilization of different types of digital skills.

The application of the proposed framework among users of digital environments was examined in preliminary empirical research (Eshet, 2002; Eshet-Alkalai & Amichai-Hamburger, 2002). Three groups of participants (10 high-school students, 10 university students, and 10 adults over age 30) were given assignments designed to test their ability to solve problems and perform tasks, each of which required a different type of digital literacy. The results of the research indicated that the conceptual framework contributes considerably to our understanding of how learners work in digital environments.

PHOTO-VISUAL LITERACY: THE ART OF READING VISUAL REPRESENTATIONS

Writing is a means of communication that uses symbols; in the course of history, it developed from an alphabet of pictures, which used symbols with associative visual meanings to represent words, consonants, or letters, and therefore required a relatively low level of cognitive mediation, to the

modern alphabet, which is composed of "meaningless" abstract symbols (letters), and therefore requires a higher level of cognitive mediation. In contrast, the history of visual communication in digital environments reflects the opposite trend, as demonstrated, for example, in computer user interfaces. These developed from text-based, command-guided syntactical interfaces to intuitive graphic user interfaces that implement principles of "using vision to think" (Mullet & Sano, 1995; Shneiderman, 1998; Tuft, 1990) and create an effective photo-visual communication that "speaks the user's language" (Nielsen, 1993). Usability research (e.g., Margono & Shneiderman, 1987) has indicated that it is easier for most users, beginners and experts alike, to learn from graphic interfaces, because they employ natural visual communication with the user.

In many ways, the graphic user interfaces represent a revival of the extinct form of literacy that was prevalent in the era of the ancient picture alphabet: photo-visual reading (Snyder, 1999). The present article suggests that in working with graphic user interfaces, users employ a unique form of digital literacy—photo-visual literacy—that helps them to "read" intuitively and freely, and to understand the instructions and messages represented visually. People with photo-visual literacy have good visual memory and strong intuitive-associative thinking, which help them decode and understand visual messages easily and fluently.

The nature of the photo-visual "reading" process, the performance of learners with tasks that involve photo-visual literacy, as well as their attitude towards photo-visual reading are subjects that have attracted numerous studies. Springer (1987) and Aspillaga (1996) showed that photo-visual work in graphic user interfaces greatly reduced the time required to operate a digital environment, thereby demonstrating the importance of taking such literacy into account in user interface design. Mason (2002) suggested a model for hypertext writing and reading, using different methods for visual presentation of digital data, and McLoughlin and Hutchinson (2002) described the advantages of a visual digital environment for successful foreign language learning.

In light of the recognition of the value of photo-visual communication in learning, together with the development of digital work environments in the past few decades, software companies invested special effort in planning sophisticated interactive multimedia environments that take advantage of the possibility to represent synchronized text, sound, and motion. This led to identification of a special type of photo-visual learning, referred to in this article as *synchronic learning*, because it is based on synchronized stimulation of the learner by means of multimedia. Effective synchronic learning requires a special type of photo-visual literacy, referred to here as *synchronic*

literacy. The nature of synchronic literacy is clearly demonstrated in the "living books" genre, as *Just Grandma and Me* (http:www.thereviewzone.com/grandmame.html). In this genre of educational computer programs for children, an interactive story is narrated in a digital game environment. The text is displayed on the monitor while the story is heard, with each word highlighted as it is read. This makes it possible for the learner to match the pronunciation of each word with its visual appearance.

In the present study, a pilot test was made, to examine the reading ability of three first-grade children from Chile and Israel, for whom English was a foreign language, and who had never studied it in any formal way. All three were "addicted" to living books, and would play *Grandma and Me* and other computer games of this type for hours (four to five hours a day). The children obtained very high scores (between 53% and 79% success) when asked to identify words that had appeared in the digital books when presented to them as isolated words, without context. In comparison, their scores were very low when asked to identify isolated letters presented to them without the context of a word (Table 1). As was found in an in-depth interview with those children, they have learned English by synchronic matching of words they heard with the corresponding "pictures" appearing on the monitor, without any basic understanding of the letters that compose the word, or the basic syntax of the word structure. This case demonstrates how learners apply synchronic literacy in the process of learning to read, by simultaneously adding and synchronizing digital, vocal, and visual stimuli with written text. The findings shed light on the way in which the auditory-verbal and the pictorial-visual channels (Mayer, 2001) join together to create photo-visual comprehension of words, by perceiving them as pictures, rather than as a combination of letters. Beavis (1999) and Snyder (1999) have also studied aspects of synchronic literacy in language learning in digital environments.

Table 1

Synchronic Literacy and Reading: The Ability of Young Children to Learn English from Synchronic Stories (Living Books as *Grandma and Me).* Results Indicate that Children Perceived Words that Were Presented on the Screen as "Pictures" Rather than a Combination of Letters.

Child's name	% of success to identify separate words	% of success to identify separate letters
David	53	5
Jose	64	3
Sharon	79	9

The use of synchronic literacy with digital texts is not limited to young children only, but can also be found in the field of adults training. This is demonstrated in the wide range of computer programs for learning typing skills. In these programs, the learners work in a synchronic digital environment: They are asked to type a text that is projected on the monitor. While typing, they see their actions illuminated on a simulated keyboard, and an automated audio feedback notifies them of mistakes (see example at: http://www.21stsoftware.com/SS_Typing.htm). In a research on digital literacy conducted in a mixed-age group, Eshet (2002) found that photo-visual literacy of the adults, as represented by their ability to decode graphic user interfaces, was much lower than that of the younger participants.

REPRODUCTION LITERACY: THE ART OF CREATIVE RECYCLING OF EXISTING MATERIALS

The invention of the printing press by Gutenberg (1455) marked a great leap in human ability to copy, reproduce, and distribute information on a large scale. Until then, all written or graphic knowledge was stored in a way that could not be reproduced, in libraries and collections. Some traditions and knowledge were not even in written form, but were passed orally from parents to children.

The next great leap in the humans' ability to reproduce knowledge occurred in the twentieth century, with the emergence of computerized digital reproduction (Benjamin, 1994). These new and unlimited possibilities for reproducing and distributing digital information have opened new horizons for scholars and artists, but they have also required the development of a new set of criteria for originality, creativity, and talent in art or academic work. This arouses profound questions, such as, for instance, to what extent can a person copy or revise an existing work of art or text before it is considered plagiarism rather than an original creation? What are the boundaries of creativity in art? When does a creation become a technical act of reproduction? At a more radical level, it is possible to put these questions themselves to the test—are they even important, or has the time perhaps come for "the author to die" (paraphrasing the well-known post-modern demand), and for us to put aside the issue of originality and authenticity in our intellectual endeavors.

Perhaps the most famous example of reproduction in art dates back to the 1960s and the pop artist Andy Warhol, whose work was largely based on reproduction of single elements (such a cans of Coca Cola). Recently, an attempt was made to challenge the boundaries of reproduction in digital-age

art by a group of Italian students, who have invented and presented the fictional Internet artist, Darko Maver (http://www.kapelica.org/maver/main.htm, 1998), whose works were composed of a reproduction of horror visuals (mainly cadavers), downloaded from the Internet. The students' "trick" was so successful that the nonexistent artist Maver was even awarded prestigious prizes for his pioneer work in Internet art.

Should this art be considered legitimate, original, and creative? This question and others like it are relevant not only to the discussion of the plastic arts, but also in assessing the originality of academic writing. In the age of reproduction, researchers and students use parts of texts that have already been published as the basis for new articles. It is easy to identify extreme cases of illegitimate reproduction of academic work, such as the U-banks, Internet sites that sell ready-made academic papers (see, for example, http://www.academon.com). However, what about a paper that constitutes a slightly different version of an article previously published by the same author, or in a more radical case, by a different author? How much change is necessary for such papers to be considered original, real, and legitimate? The constant improvement in the capabilities of computers and digital editing programs presents a growing challenge regarding the use of reproduction to create original, true, and creative work, both in art and in academia, and opens new horizons for discussion of originality and creativity in the era of reproduction.

Writing an original academic work with the aid of digital techniques for text reproduction, requires scholars to master a special type of literacy, referred to in this article as *reproduction literacy*. Digital reproduction literacy is the ability to create a meaningful, authentic, and creative work or interpretation, by integrating existing independent pieces of information (Gilster, 1997; Labbo, Reinking, & McKenna, 1998).

Reproduction literate scholars usually possess a good multi-dimensional synthetic thinking, which helps them create meaningful new combinations from existing information. Eshet (2002) found that reproduction literacy among adults, who were asked to inject new meaning into existing texts, by means of text reproduction, was much higher than that of younger participants. This finding indicates a reverse trend to that previously described for photo-visual literacy, in which the younger participants demonstrated greater ability than the older ones did.

BRANCHING LITERACY: HYPERMEDIA AND NON-LINEAR THINKING

In the time between the end of the Roman era (around the third century AD), and the sixth century AD, two revolutionary technological inventions

were introduced: the first was the replacement of writing on scrolls with separate pages which could be gathered into books, and later—the numbering of the pages. Bound books with numbered pages provided scholars with a new degree of freedom in processing information: They could now navigate easily to defined places in the text, or leaf through distant parts of a text. Page numbering made it possible, for the first time, to crosscheck sources and add a table of contents and index. The invention of books also created a new way of looking at text: Scrolls are read linearly, row by row, but with the bound volume it has become possible to leaf through a book, as well. All these enabled navigation through texts in a nonlinear, easy, and precise manner. Thus the most ancient roots of hypertext use reach back to the dawn of the age of the bound book, in the sixth century AD, considerably earlier than the invention of the printing press, not to mention the computer.

Modern hypermedia technology has presented computer users with new challenges of digital literacy (Gilster, 1997). It enabled scholars to move away from the relatively-linear data searches in traditional digital libraries and databases, to knowledge construction from information that was accessed in a nonlinear manner. Until the early 1990s, work in the restricted computer environments, most of which were not based on the hypermedia technology, promoted relatively linear thinking. This was dictated by inflexible operating systems, and by the fact that the users were used to books, and expected to work in a computer-based environment that would imitate the linear book-reading environment. The modern hypermedia environment provides users with a high degree of freedom in navigating through different domains of knowledge, but also presents them with problems arising from the need to construct knowledge from large quantities of independent pieces of information, reached in a nonlinear, "unordered" manner.

> From the educational perspective, the central importance of the hypermedia-based environment lies not necessarily in the multitasking capabilities that it offers users, but in the possibility of using such environments for associative, branching and non-linear navigation, through different knowledge domains. This ability promotes multidimensional thinking, and it led to development of a new type of digital literacy—*branching*, or *hypermedia literacy*. People with good branching literacy are characterized by a good sense of multidimensional spatial orientation, that is, the ability to avoid loosing orientation when surfing through the labyrinth of lanes that characterizes the hyperspace (Lazar, Bessiere, Ceaparu, Robinson, & Shneiderman, 2003). With the expansion of Internet use, users who lack branching

literacy increasingly complain of spatial disorientation, which hinders effective work in the environment of hypermedia (Daniels, Takach, & Varnhagen, 2002; Horton, 2000; Piacciano, 2001; Lazar et al., 2003). Various studies suggested that people who possess a good branching literacy also have good metaphorical thinking, as well as the ability to create mental models, concept maps, and other abstract representations of the network structure (Jonassen & Henning, 1999; Smilowitz, 2001). Lee and Hsu (2002) found that the use of such cognitive skills considerably improves navigation performance on the net, prevents problems of disorientation, and improves the ability to construct knowledge. In discussions of the influence of hypermedia technology on learning, Rouet and Levonen (1996) described the transition from linear to associative-branching thinking. In their view, this transition requires scholars to acquire branching cognitive skills and develop skills of knowledge construction from independent bits of information, in order to perform complex and demanding tasks. Spiro, Feltovitch, Jacobson, & Coulson (1991) discussed the importance of hypermedia technology in creating multidimensional knowledge based on cognitive flexibility. Other authors (e.g., Salomon, 2000; Salomon & Perkins, 1996) described the limitations of the ability of learners to achieve meaningful learning by navigating in hypermedia environments such as the Internet. Despite all this, branching literacy is increasingly becoming "survival skill," a necessity for learners who are meant to perform knowledge-construction tasks in the information era.

Eshet (2002) explored the ability of users to perform tasks that require branching literacy by testing the ability of representatives of different age groups to perform the task of planning a trip to an unknown country by means of hypermedia navigation on the Internet. The findings reveal that the younger the participants, the higher their ability to perform the task successfully.

INFORMATION LITERACY: THE ART OF SKEPTICISM

With the rapid growth in access to information, the ability of consumers to evaluate and use it wisely has become a key issue in creating educated information consumers (Kerka, 1999; Salomon, 2000). The need to properly evaluate information is not unique to the digital era; it has always been central to successful learning, even before the information revolution. However, in the modern era, with the unlimited exposure to digital information, which can be published easily and manipulated without difficulty, the ability to

evaluate and assess information properly has become a "survival skill" for scholars and information consumers. The main problems in evaluating information lie in the difficulty of assessing the credibility and originality of information and the professional integrity of its presentation. During academic research, decisions are made as to which data items to use, and which to ignore. These decisions are made in the course of retrieving information from databases, or surfing the Internet. User awareness in making these decisions largely determines the quality of the conclusions, positions, opinions, or models constructed from the information. In the absence of effective mechanisms for information evaluation, how can learners decide which of the infinite and conflicting bits of information to choose, and which to doubt? Which political opinions presented on the Internet should be adopted and which rejected? The term *Information literacy*, as used in this article, refers to the cognitive skills that consumers use to evaluate information in an educated and effective manner. Information literacy works as a filter: it identifies erroneous, irrelevant, or biased information, and prevents its infiltration into the learner's system of considerations (Gilster, 1997; Minkel, 2000). Information-literate people think critically, and are always ready to doubt the quality of information. They are not tempted to take information for granted, even when it seems "authoritative" and valid. Unfortunately, most current studies on information literacy have concentrated on strategies and habits of searching for information (e.g., Burnett & McKinley, 1998; Dresang, 1999; Morahan-Martin & Anderson, 2000; Zins, 2000), and only a few focus on the relevant cognitive and pedagogical aspects (e.g., O'Sullivan, 2000; Salomon, 20000).

In his pilot study of digital literacy in different age groups, Eshet (2002) found that adults showed a higher degree of information literacy than younger people, when asked to critically evaluate news events presented by seven different news sources on the Internet. Similar results are reported by Hargittai (2002a; 2002b).

SOCIO-EMOTIONAL LITERACY

The expansion of the Internet and other platforms of digital communication have opened up new dimensions and opportunities for collaborative learning and information sharing in various forms, as learning communities, discussion groups, and chat rooms (Scardamalia & Bereiter, 1996; Mioduser & Nachmias, 2002). However, alongside the opportunities, these new possibilities also present the user with problems, in a proportion unknown prior to

the Internet era. For example, how is it possible to know whether individuals in a chat room are really who they say they are? How can we tell whether a call for blood donations on the net is real or a hoax? Should we open an electronic mail from an unknown person, even if the mail's subject seems to be interesting? It might contain a virus, but then again, it could be genuine.

These questions are only a few examples of the considerations that present-day Internet users must take into account in order to "survive" within the massive communications of the cyberspace, and benefit from true opportunities that come their way. Cyberspace has its own unwritten rules. It is not only a global village; more precisely, it is a jungle of human communication, embracing an infinite quantity of information, true and false, honest and deceptive, based on good will and evil. Activity in cyberspace may be risky for immature, innocent users who do not understand the "rules of the game." Examples of such dangers touch almost every aspect of our life, from surrendering personal information to crooks in the Internet, to users who were gullible enough to open e-mail entitled "I Love You," only to discover that it infected their computer with a fatal virus.

Socially-literate users of the cyberspace know how to avoid "traps" as well as derive benefits from the advantages of digital communication. These users have a relatively new type of digital literacy, which is referred to in this article as *socio-emotional literacy*, because it involves mainly sociological and emotional aspects of work in cyberspace.

Socio-emotional digital literacy appears to be the most complex of all the types of digital literacy described in this article. In order to acquire this skill, users must be very critical, analytical, and mature, and must have a high degree of information literacy and branching literacy. Much research has been devoted to drawing a socio-psychological profile of users in cyberspace (e.g., Amichai-Hamburger, 2002; Hamburger & Ben-Artzi, 2000; Mundrof & Laird, 2002). On the basis of the findings of these studies, socio-emotionally-literate users can be described as those who are willing to share data and knowledge with others, capable of information evaluation and abstract thinking, and able to collaboratively construct knowledge.

DISCUSSION

Digital literacy can be defined as survival skill in the digital era. It constitutes a system of skills and strategies used by learners and users in digital environments. By employing different types of digital literacy, users improve their performance and "survive" a variety of obstacles and stumbling

blocks that lie in the way within this special medium. The literature is inconsistent in its use of the term "digital literacy"; some restrict the concept to the technical aspects of operating in digital environments, while others apply it in the context of cognitive and socio-emotional aspects of work in a computer environment. This article takes a first step towards shaping an integrative conceptual frame of reference that encompasses most of the dimensions of user activity in digital environments, which may serve as a basis for future research on the ever-changing directions of digital culture. Application of this framework may also improve communication among learners and developers, by providing a diagnostic and evaluative tool for use in creating precise, user-directed products.

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