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Experiments in Digital Literacy

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ABSTRACT

Having digital literacy requires more than just the ability to use software or to operate a digital device; it includes a large variety of complex skills such as cognitive, motoric, sociological, and emotional that users need to have in order to use digital environments effectively. A conceptual model that was recently described by the authors suggests that digital literacy comprises five major digital skills: photo-visual skills ("reading" instructions from graphical displays), reproduction skills (utilizing digital reproduction to create new, meaningful materials from preexisting ones), branching skills (constructing knowledge from non-linear, hypertextual navigation), information skills (evaluating the quality and validity of information), and socio-emotional skills (understanding the "rules" that prevail in cyberspace and applying this understanding in online cyberspace communication). The present paper presents results from a performance-based pioneer study that investigated the application of the above digital literacy skills conceptual model among different groups of scholars. Results clearly indicate that the younger participants performed better than the older ones, with photo-visual and branching literacy tasks, whereas the older participants were found to be more literate in reproduction and information literacy tasks. Research results shed light on the cognitive skills that users utilize in performing with digital environments, and provide educators and software developers with helpful guidelines for designing better user-centered digital environments.

INTRODUCTION

THE FAST DEVELOPMENT of 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 "digital literacy" in recent literature.[1–9] 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. Digital literacy has become a "survival skill" in the technological era—a key that helps users to work intuitively in executing complex digital tasks. In recent years, extensive efforts have been made to describe and conceptualize the cognitive skills that users employ in digital environments.[10–15] Unfortunately, these efforts are usualy local, focusing on a selected and limited variety of skills, mainly information-seeking skills,[12,16] and, therefore, they do not cover the full scope of the term "digital literacy." Eshet[17] has established a 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 researchers and designers of digital environments

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with a powerful framework and design guidelines. The model consists of the five digital literacy skills discussed next.

Photo-visual literacy skill

The evolution of digital environments from text-based, syntactic to graphic-based semantic environments[18,19] requires modern scholars to employ cognitive skills of "using vision to think"[20–22] in order to create photo-visual communication with the environment.[19,23] This unique form of digital literacy skill—the photo-visual skill—helps users to intuitively and freely "read" and understand instructions and messages that are presented in a visual-graphical form. Good examples of utilizing photo-visual skills in digital environments can be found in user interfaces[24] and in children's modern computer games; in both, all usage instructions are provided through a graphical representation of symbols and icons. Successful photo-visual scholars usually have a good visual memory and strong intuitive-associative thinking, which are both useful in understanding visual messages.

Reproduction literacy skill

The modern digital technologies provide scholars with new possibilities for creating art and academic work by reproducing and editing texts, visuals, and audio pieces.[3,25] Besides the ethical and philosophical questions regarding the limits and criteria for legitimate–ingenuine use of digital reproduction, the digital reproduction technologies require modern scholars to master a special kind of digital literacy, termed "reproduction literacy."[17] Digital reproduction literacy is 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).[3] Reproduction literacy is essential in two major fields[26]—in writing, where preexisting sentences can be reorganized and rearranged to create new meanings, and in visual 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 Internet artist Drako Maver (www.kapelica.org/maver/main.htm). Labbo et al.[27] described problems that learners face in the digital reproduction of text in a variety of work situations. According to them, digitally reproduction literate scholars have good synthetical, and multidimensional thinking that helps them in discovering new combinations for arranging information in new, meaningful ways.

Branching literacy

The non-linear nature of 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 non-flexible 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, confront them with problems that involve the need to utilize non-linear and branching information-seeking strategies and to construct knowledge from independent shreds of information that were accessed in a non-orderly and non-linear way.[10,12,28,29] Spiro et al.[30] and Rouet and Levonen[31] presented the cognitive flexibility theory, which described the importance of branching multidimensional thinking skills in constructing meaningful understanding of complex phenomena and led to the evolution of a new kind of digital literacy skill, termed "branching literacy skill," or "hypermedia literacy skill." Branching literacy requires that scholars who have good spatial-multidimensional sense of orientation stay oriented and avoid getting lost in the hyperspace while navigating through complex knowledge domains, despite the intricate navigation paths they may take.[32–35] They must also have 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-literate scholars to overcome disorientation problems in hypermedia environments.[36]

Information literacy skill

Today, with the exponential growth in available information, the 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.[37,38] Information assessment is made in almost every work we do in digital environments, such as in data queries or in navigational decisions we make in the Web. It is the awareness of the users of their decisions that will determine the actual quality of the conclusions, positions, opinions, or models that they construct from the information. The ability of

information consumers to make educated, smart information assessment requires a special kind of literacy skill, termed "information literacy skill."[17] Unfortunately, most studies of information literacy skills focus on the information search strategies and habits of users,[12,39,40] and only a few stress the cognitive and pedagogical aspects that are relevant to this skill.[10,38,41,42] The information literacy skill acts as a filter: it identifies false, irrelevant, or biased information, and avoids its penetration into the learner's cognition. Information-literate consumers are critical thinkers—people who always question information and never take it for granted.[43] It is true that information literacy is not unique to the digital era; it was always a crucial trait of successful scholars, even before the information revolution. However, in the digital era, with the unlimited exposure of humans to digital information, it has become a survival skill that enables learners to make an educated use of information.

Socio-emotional literacy

The expansion of the Internet and other platforms of digital commiunication have opened new dimensions and opportunities for learning through knowledge-sharing groups, discussion groups, knowledge communities, chat rooms, and many other forms of collaborative learning.[44,45] But these new opportunities face users with challenges that require them to employ sociological and emotional skills in order to "understand the rules of the game" and "survive" the hurdles that await them in the mass communication of the cyberspace.[46] 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 as a hoax and malicious Internet viruses. These require users to own a relatively new kind of digital literacy skill, termed 'Socio-emotional skill,'[17] because it involves primarily emotional and sociological aspects of working in cyberspace. Among all types of digital literacy skills described here, socio-emotional literacy is probably the highest and most complex. It requires users who are very critical and analytical, very mature, and have a good command of information, branching, and photo-visual literacy skills. A large variety of studies focuses on efforts to portray a sociological and psychological profile of the literate cyberspace user.[47–49,53] From the results of these studies, we can describe digitally literate, socio-emotional users as being willing to share their own data and knowledge with others, capable of evaluating data, possessing an abstract thinking, and able to design knowledge through virtual collaboration.

The present paper reports on a pioneering research that was designated to examine the performance of users of different age groups in tasks that require the utilization of the different types of digital literacy skills. Our basic assumption is that the level of digital literacy is affected mainly by the cognitive developmental stage and experience of users and, hence, the hypothesis is that differences in digital literacy would be found for different age and gender groups[14,15] of similar background and experience. Until today, very little empirical information has been available on digital literacy skills of different ages and genders, and our research's results may shed light on this relatively new assortment of cognitive skills that learners cope with in the digital era. Results will improve our understanding of users' needs under different digital situations and provide designers of digital environments with powerful guidelines in designing better user-oriented digital environments.

MATERIALS AND METHODS

Participants

Participants of the research were 60 individuals of a similar demographic background: They all live in Upper Galilee, in agricultural communities (kibbutz or moshav). All participants were selected randomly and volunteered for the research. They consisted of three groups:

1. Twenty 11th grade high school students (average age, 16.9 years) from a regional high school
2. Twenty 3rd year college students (all from Tel Hai Academic College, Education and Economics departments, ages 24–30; average age, 26.4 years)
3. Twenty 30–40 year old adults who graduated from a college or university (average age, 36.5 years)

Each participant group was composed of 10 males and 10 females. All participants had advanced computer skills; they all used computers in everyday life for word processing, E-mail communication, and Internet surfing. All had some experience in working with databases and preparing computer presentations using *PowerPoint*.

Tasks

To investigate the utilization of digital literacy by computer users under different digital circumstances,

a task-oriented research approach, in which participants were required to perform with real-life authentic tasks, was preferred.[50,51] A set of five tasks was designed and assigned to each participant. Each task required the utilization of a different type of digital literacy skill. Participants' performance in each task was assessed and graded by the authors, based on the analysis of the task's outcomes, aided by a list of evaluation guidelines (Table 1). To test the fidelity of the assignments' grading guidelines, a random selection of 20% of the participants was graded independently by three different referees who used the same guidelines for evaluation (Table 1). The close similarity between the referees' grades and the grades given by the authors (correlation range, r = 0.91–0.98) suggests a high coherence of the evaluation criteria utilized in the present research.

Photo-visual literacy experiment: create a theater stage

Each participant was asked to create a theater stage, using a multimedia computer program they had never used before, called *Opening Night*. No guidance or further instructions were provided. The program allows users to design their own theater stage, including the overall setting, the characters, their features, affinities, costumes, and the text they say. It is highly interactive and entertaining, designed with high-level graphic user interfaces. The user interface follows the traditional design of *Microsoft Office* programs, with toolbars and pull-down menus. Fulfilling the task required the utilization of photo-visual literacy in order to decipher the graphic user interfaces and to learn how to use the programs effectively. Outcomes of the task (screen shots of the stage design) were assessed and graded according to their completeness and complexity (Table 1).

Reproduction literacy experiments: text reproduction

Participants were assigned a seven-line paragraph (about 100 words) that described a "neutral" situation of a child getting ready for school. They were asked to give the paragraph a new meaning by rearranging sentences, words, and letters, allowing the addition of no more than 25 words of their own. Grading the task was based on the degree of success of creating a new meaning to the paragraph and on the complexity of reproduction as represented by the amount of reorganization that was exercised in the task (Table 1).

TABLE 1. LIST OF MAJOR GUIDELINES UTILIZED IN THE EVALUATION OF DIGITAL LITERACY TASKS

Task	*Evaluation guidelines*
Photo-visual literacy: creating a theatre stage	• How complete is the stage? • How many elements appear in the stage? • Complexity of stage design
Reproduction literacy: creating new meaning by text reproduction	• Quality and ingenuity of reproduced text • Complexity of reproduced text • Amount of reproductions made in executing the task • Amount of additional words added
Information literacy: analyze a news event	• Amount of biased or false elements identified in news event • Overall estimation of ability to critically analyze the news event
Lateral literacy	• Completeness of task • Complexity and richness of tour • Coherence in suggested tour • Quality of suggested tour • Presence of map • Number of days in tour • Number of sites in tour
Socio-emotional literacy	• Analysis of participants' record during chat into cognitive, social, and emotional presence • Analysis of each participants' perception report

Information literacy experiment: analyzing news events

Participants were assigned seven Internet news resources, including right-wing, left-wing, Israeli, Arab, European, and American resources. Some of the resources are clearly politically motivated; some are more "mainstream-neutral"; some tend to present bias or even false information; others contain more "reliable" news. All participants were assigned a news event that was reported in all seven resources, and were asked to analyze it, looking for biased attitudes, false and contradicting elements, and to write an overall summary of their opinion of the quality and reliability of the news report. The task was graded based on the amount of biased and false pieces of information that were identified and on the overall participant's ability to critically analyze the information (Table 1).

Branching literacy experiment: plan a trip to Spain

Participants were assigned an Internet touristic site (Lonely Planet Destinations: www.lonelyplanet.com/destinations) and were asked to plan a detailed 1-week trip to Spain—a country they had never visited. The plan should include a map and an itinerary for visits every day, as well as information about every place. Executing the task required the learner to employ branching literacy skills in order to construct a body of knowledge (tour plan) from a non-linear, hypertextual navigation through a (geography) knowledge domain (the Internet site). The task was graded based on the completeness, richness, and complexity of the task's outcomes: map, coherence of the suggested tour, number of days in the tour, number of sites, and availability and quality of information on every site (Table 1).

Socio-emotional literacy: chat in the room

The socio-emotional literacy of participants was examined by exposing them to a chat-room situation, where socio-emotional skills play a major role in determining the level and meaningfulness of interaction that occurs. Participants conducted ten-minute chat sessions, in groups of 10 people each time. Each participant was identified by a false name (real identity known to the researchers only). The chat topic was a hot political issue that was in the news headlines of the month. The performance of each participant was graded, based on analyzing each participant's record during the chat and clustering it into "cognitive presence," "social presence," and "emotional presence," using a modification of the content analysis model of Garrison et al.[52] In addition, each participant submitted a short paragraph that reported on his/her experience in the chat. The report was graded and averaged in the participant's grade (Table 1).

RESULTS

In order to test for the signficance of age differences, a one-way MANOVA with age as the independent factor was computed. The overall model was signifcant, Wilks' lambda = 0.015, $F(14,102) = 75.45$, $p < 0.00$. The univariate F values are shown in Table 2. As shown in Table 2, all measurements were signficant, but a Scheffe comparsion revealed a different pattern of results for some of the measurments as discussed below.

Photo-visual literacy skill

There were no significant differences found between high school students' and college students'

TABLE 2. MEAN AND STANDARD DEVIATIONS OF DIGITAL LITERACY MEASURMENTS

	High school students		*College students*		*Adult college graduates*		
	M	*SD*	*M*	*SD*	*M*	*SD*	*F(2,57)*
Photo-visual	87.7[b]	7.52	83.75[b]	6.14	59.7[c]	7.57	90.77*
Reproduction	48.65[a]	7.22	65.45[b]	7.92	72.95[c]	4.38	69.26*
Branching	84.6[b]	4.36	80.35[b]	8.13	57.4[a]	4.58	120.82*
Information	57.65[a]	6.45	70.25[b]	6.45	85.6[c]	3.67	121.45*
Socio-emotional	55.7[b]	8.31	63.8[c]	8.41	42.75[a]	4.24	42.85*

*$p < 0.00$.

[a,b,c]results of the Scheffe' comparisons. The alphabetic order represents the size of scores from low to high The use of the same letter indicates no difference between the groups.

scores, and both scored signicantly higher on the task in comparsion with the adult group of participants (M = 87.7, M = 83.75, and M = 59.7, respectively).

Reproduction literacy skill

The groups of participants differed significantly from one another. The high school students scored the lowest number of points, the college students scored higher, and the adults received the highest scores (M = 48.64, M = 65.45, and M = 72.95, respectively).

Branching literacy skill

No significant differences were found between the scores of the high school students and the college students and both scored significantly higher compared with the adults (M = 84.6, M = 80.35, and M = 57.4, respectively).

Information literacy skill

Each group of participants differed from one another. While the high school students scored the lowest, college students scored higher, and the adults the highest (M = 57.65, M = 70.25, and M = 85.6, respectively).

Socio-emotional literacy

All groups of participants significantly differed from one another. The adults scored the lowest, the college students scored the highest, and the high school students scored in-between (M = 42.75, M = 63.8, and M = 55.75, respecively).

DISCUSSION

Results from the various digital literacy experiments clearly show that digital literacy is not equally shared among all age groups and that the commonly used notion that the younger generation is more digitally literate than the older ages[6] should be examined with care. Our findings emphasize the importance of the refined conceptual framework for digital literacy investigated in the present paper as a powerful tool for improving our understanding of how different users perform with tasks that require the utilization of different digital literacy skills.

The superiority of the young participants with photo-visual literacy tasks reflects their ability to cope better with tasks that involve visual communication, such as deciphering user interfaces or "reading" instructions from graphical displays. This is well illustrated by their high performance with the intuitive user interface of *Opening Night*. These findings should guide software designers in designing tailor-made, user-oriented interfaces and work environments.

The low level of text reproduction literacy skills, exhibited by the young participants, should alert educators who are engaged in teaching or training computer skills and computer literacy. It is a common practice among educators and researchers to regard digital literacy as a mastery in the technical aspects of using computer programs or digital devices.[8] From our findings, it is evident that mastering technical skills, such as text editing, is not enough to make creative scholars who are capable of using text manipulation tools to generate meaningful and ingenuine essays. More than that, the fact that the adult group scored much higher than the younger groups, and that the youngest participants performed the lowest, suggests that educators, especially in young ages, should put a stronger emphasis in developing cognitive rather than technical digital skills.[27]

In the branching literacy task, our findings clearly show a trend of decreasing literacy skills from the younger to the older participants, as indicated by their ability to plan an "Internet trip" to a foreign country. This probably represents the more extensive exposure of younger users to the Internet and other hypermedia environments, in which they are required to construct knowledge by a hypermedia, non-linear navigation through knowledge domains. These findings provide valuable design guidelines for educators and software developers; they emphasize that hypermedia digital environments for adults should be designed with regard to their relatively low branching literacy; such environments should include modules and tutorials to facilitate the users' work. On the other hand, digital environments for youth can allow for more challenging and complex tasks that suit their highly literate users.

If our findings for information literacy skills represent scholars worldwide, then they should alarm educators and information providers; the observed low information literacy of the young participants clearly reveals their weakness as educated consumers of information and suggests that they can be easily manipulated by biased or false information. This suggests the crucial role of the educational system in giving priority to programs that develop critical thinking and promote information literacy, and the responsibility of news and marketing agencies, in considering the way they design, present, and deliver information.

The lack, in our results, of a consistent pattern or trend for socio-emotional literacy skills should be regarded as an indication of our lack of understanding of this new and rapidly-evolving digital skill. Among all other digital literacy skills discussed in the present paper, the socio-emotional one is the "youngest," and with the rapid changes in the digital communication environments, it is the most rapidly evolving one. Therefore, it is not surprising that the oldest participants, who are usually the least to be exposed to Internet communication,[3] scored the lowest. On the other hand, the high scores of the college students and the medium success of the high school students cannot be explained by the assumptions of the present research. More research is needed in order to better understand the factors that affect this type of digital literacy skill.

CONCLUSION

The following conclusions can be drawn from the research findings:

1. The refined conceptual framework for digital literacy, tested in this research, provides a powerful tool for understanding the complexity of the cognitive skills and strategies that scholars employ in different digital tasks.
2. Results of the present study provide educators and software developers with guidelines for designing better user-oriented environments.
3. The widely accepted notion that younger scholars are better than older scholars in executing tasks with digital environments was not always supported in our findings.
4. Our findings indicate that younger scholars are usually best at tasks that require photo-visual and branching literacy skills. On the other hand, adults perform better in tasks that require high information and reproduction literacy skills. No obvious trend could be identified for the socio-emotional literacy, which, as the "youngest" and most rapidly evolving digital skill, is still not fully understood.
5. Our findings suggest the role of the education system in teaching specific digital skills, mainly information and reproduction skills.
6. Our findings suggest that, in the future, we shall use the Internet interactive capabilities and design the web in a much more user-friendly manner to answer the users' specific needs and abilities without demanding further skills from the user.[48]

REFERENCES

1. Lenham, R. (1995). Digital literacy. *Scientific American* 273:253–255.
2. Papert, S. (1996). *The connected family*. Atlanta: Longstreet Press.
3. Gilster, P. (1997). *Digital literacy*. New York: Wiley Computer Publishing.
4. Inoue, H., Naito, E., & Koshizuka, M. (1997). Mediacy: What it is? Where to go? *International Information & Library Review* 29:403–413.
5. Pool, C.R. (1997). A new digital literacy: a conversation with Paul Gilster. *Educational Leadership* 55:6–11.
6. Tapscott, D. (1998). *Growing up digital: the rise of the net generation*. New York: McGraw-Hill.
7. Bruce, B., & Peyton, J.K. (1999). Literacy development in network-based classrooms: innovation and realizations. *International Journal of Educational Technology* [On-line]. Available: www.outreach.uiuc.edu/ijet/v1n2/bruce/index.html.
8. Davies, J., Szabo, M., & Montgomerie, C., (2002). Assessing Information and communication technology literacy of education undergraduates: instrument development. In: Barker, P., Rebelsky, S. (eds.), *Proceedings of ED-MEDIA, 2001 World Conference on Educational Multimedia, Hypermedia & Telecommunications*. Norfolk, VA: Association for the Advancement of Computing in Education, pp. 377–383.
9. Swan, K., Bangert-Drowns, J.B., Moore-Cox, A., et al. (2002). Technology and literacy learning: a national survey of classrom use. In: Barker, P., Rebelsky, S. (eds.), *Proceedings of ED-MEDIA, 2001 World Conference on Educational Multimedia, Hypermedia & Telecommunications*. Norfolk, VA: Association for the Advancement of Computing in Education, pp. 221–223.
10. Burnett, K., & McKinley, E.G. (1998). Modeling information seeking. *Interacting with Computers* 10:285–302.
11. Wang, P., Hawk, W.B., & Tenopir, C. (2000). Users' interactions with World Wide Web resources: an exploratory study using a holistic approach. *Information Processing and Management* 36:229–251.
12. Zins, C. (2000). Success, a structured search strategy rationale, principles and implications. *Journal of the American Society for Information Science* 51:1232–1247.
13. Cothey, V. (2002). A longitudinal study of World Wide Web users' information-searching behavior. *Journal of the American Society for Information Science and Technology* 53:67–78.
14. Hargittai, E. (2002). Second-level digital divide: differences in people's online skills. *First Monday* 7 [On-line]. Available: http://firstmonday.org/issues/issue7_4/hargittai/index.html.
15. Hargittai, E. (2002). Beyond logs and surveys: in-depth measures of people's Web use skills. *Journal of the American Society for Information Science and Technology* 53:1239–1244.
16. Marchionini, G. (1989). Information-seeking strategies of novices using a full-text electronic encyclopedia. *Journal of the American Society for Information Science* 40:54–66.

17. Eshet, Y. (2002). Digital literacy: a new terminology framework and its application to the design of meaningful technology-based learning environments. In: Barker, P., Rebelsky, S. (eds.), *Educational Multimedia and Hypermedia* Norfolk, VA: Association for the Advancement of Computing in Education, pp. 493–498.
18. Springer, C.J. (1987). Review of information from complex alphanumeric displays: screen formatting variables' effects on target identification time. In: Salvendy, G. (ed.), *Cognitive engineering in the design of human-computer interaction and expert systems*. Amsterdam: Elsevier Science Publishers, pp. 375–382.
19. Nielsen, J. (1993). *Usability engineering*. San Diego: Morgan Kaufman.
20. Tuft, E.R., (1990). *Envisioning information*. Cheshire, CT: Graphic Press.
21. Mullet, K., & Sano, D. (1995). *Designing visual interfaces*. Engelwood Cliff, NJ: Prentice-Hall.
22. Schneiderman, B. (1998). *Designing the user interface*. Reading, MA: Addison-Wesley.
23. Margono, S., & Shneiderman, B. (1987). A study of file manipulation by novices using direct command versus direct manipulation. Presented at the 26th Annual Technical Symposium, ACM, Washington, DC.
24. Opperman, R. (2002). User interface design. In: Adelsberger, H.H., Collis, B., Pawlowski, J.M. (eds.), *Handbook on information technologies for education and training*. Berlin: Springer-Verlag, pp. 233–248.
25. Benjamin W. (1994). *The work of art in the age of technical reproduction* [Hebrew translation from German]. Tel Aviv: Teamin Publishers.
26. Mason, J.M. (2002). From Gutenberg's galaxy to cyberspace: a new model for a new writing space. In: Barker, P., Rebelsky, S. (eds.), *Proceedings of ED-MEDIA, 2001 World Conference on Educational Multimedia, Hypermedia & Telecommunications.* Norfolk, VA: Association for the Advancement of Computing in Education, pp. 1230–1236.
27. Labbo, L.D., Reinking, D., & McKenna, M.C. (1998). Technology and literacy Education in the next century: exploring the connection between work and schooling. *Peabody Journal of Education* 73:273–289.
28. Schank, R.C. (1984). *The cognitive computer: on language, learning and artificial intelligence.* Reading, MA: Addison-Wesley.
29. Jansen, B.J., & Pooch, U. (2001). A review of web searching studies and a framework for future research. *Journal of the American Society for Information Science and Technology* 52:235–246.
30. Spiro, R.J., Feltovitch, P.L., Jacobson, M.J., et al. (1991). Cognitive flexibility, constructivism and hypertext: random access instruction for advanced knowledge acquisition in ill-structured domains. *Educational Technology* 31:24–33.
31. Rouet, J.F., & Levonen, J.J. (1996). Studying and learning with hypertext: empirical studies and their implications. In: Rouet, J.F., Levonen, J.J., Dillon, A., et al. (eds.), *Hypertext and cognition.* New York: Lawrence Erlbaum Associates, pp. 9–23.
32. Horton, W. (2000). *Designing web-based training*. New York: Wiley & Sons.
33. Piacciano, A. (2001). *Distance learning*. Englewood Cliffs, NJ: Merril, Prentice-Hall.
34. Daniels, J., Takach, B.S., & Varnhagen, C. (2002). Getting stuck in the world wide web: the impact of design on navigation. In: Barker, P., Rebelsky, S. (eds.), *Proceedings of ED-MEDIA, 2001 World Conference on Educational Multimedia, Hypermedia & Telecommunications.* Norfolk, VA: Association for the Advancement of Computing in Education, pp. 371–372.
35. Lazar, J., Bessiere, K., Ceaparu, I., et al. (2003). Help! I'm lost: user frustration in web navigation. *IT & Society* 1:18–26.
36. Lee, J.J., & Hsu, Y. (2002). Web navigation: the role of metaphor, concept map and individual differences. In: Barker, P., Rebelsky, S. (eds.), *Proceedings of ED-MEDIA, 2001 World Conference on Educational Multimedia, Hypermedia & Telecommunications.* Norfolk, VA: Association for the Advancement of Computing in Education, pp. 1000–1001.
37. Kerka, S. (1999). Consumer education for the information age. *Practice Application Brief* 4:12–15.
38. Salomon, G. (2000). *Technology and education in the information age* [in Hebrew]. Tel Aviv: Haifa University/Zemora-Bitan Publishers.
39. Dresang, E.T. (1999). More research needed: informal seeking-behavior of youth on the Internet. *Journal of the American Society for Information Science* 50:1123–1124.
40. Morahan-Martin, J., & Anderson, C.D. (2000). Information and misinformation online: recommendations for facilitating accurate mental health information retrieval and evaluation. *CyberPsychology & Behavior* 3:731–746.
41. Minkel, W. (2000). No, it's not all true! *Library Journal* August:33–34.
42. O'Sullivan, M. (2000). Teaching Internet information literacy: a collaborative approach (Part III). *Multimedia Schools* 7:34–37.
43. Mardis, M.A. (2002). Mind the gap: an overview of perceptual barriers to K–12 information literacy. In: Barker, P., Rebelsky, S. (eds.), *Proceedings of ED-MEDIA, 2001 World Conference on Educational Multimedia, Hypermedia & Telecommunications.* Norfolk, VA: Association for the Advancement of Computing in Education, pp. 1221–1222.
44. Mioduser, D., & Nachmias, R. (2002). WWW in education. In: Adelsberger, H.H., Collis, B., Pawlowski, J.M. (eds). *Handbook on Information Technologies for Education and Training.* Berlin: Springer-Verlag, pp. 23–44.
45. Scardamalia, M., & Bereiter, C. (1996). Engaging students in a knowledge society. *Educational Leadership* 54:6–10.
46. Wallace, P. (1999). *The psychology of the Internet*. Cambridge: University Press.
47. Hamburger, Y.A., & Ben-Artzi, E. (2000). The relationships between extraversion and neuroticism and the different uses of the Internet. *Computers in Human Behavior* 16:441–449.

48. Amichai-Hamburger, Y. (2002). Internet and personality. *Computers in Human Behavior* 18:1–10.
49. Mundrof, N., & Laird, K.R. (2002). Social and Psychological effects of information technologies and other interactive media. In: Bryant, J., Zillman, D. (eds.), *Media effects: advances in theory and research,* 2nd ed. Mahwah, NJ: Erlbaum, pp. 231–255.
50. Wiggins, G. (1992). Creating tests worth taking. *Educational Leadership* 49:26–31.
51. Wiggins, G. (1993). *Assessing student performance: exploring the purpose and limits of testing.* San Francisco: Jossey-Bass.
52. Garrison, D.R., Anderson, T., & Archer, W. (2000). Critical inquiry in a text-based environment: computer conferencing in higher education. *The Internet and Higher Education* 2:85–105.
53. Amichai-Hamburger, Y., & Ben-Artzi, E. (2003). Loneliness and Internet use. *Computers in Human Behavior* 19:71–80.
54. Amichai-Hamburger, Y., Fine, A., & Goldstein, A. (2004). The impact of Internet interactivity and need for closure on consumer preference. *Computers in Human Behavior* 20:103–117.
55. Aspillaga, M. (1996). Perceptual foundations in the design of visual displays. *Computers in Human Behavior* 12:587–600.
56. Beavis, C. (1999). English and computer games. Presented at the Biennial Conference of the International Federation for the Teaching of English, Warwick, UK.
57. Bordia, P., & Rosnow, R. (1998). Rumor rest stops on the information highway: transmission patterns in a computer-mediated rumor chain. *Human Communication Research* 25:163–179.
58. Mayer, R.E. (2001). *Multimedia learning.* Cambridge, MA: Cambridge University Press.
59. McLoughlin, C., & Hutchinson, H. (2002). Language learning in different modes: does technology make a difference? In: Barker, P., Rebelsky, S. (eds.), *Proceedings of ED-MEDIA, 2001 World Conference on Educational Multimedia, Hypermedia & Telecommunication.* Norfolk, VA: Association for the Advancement of Computing in Education, pp. 1279–1280.
60. Norton, P., & Wiburg, K.M. (1998). *Teaching with technology.* New York: Harcourt Brace.
61. Salomon, G. (1996). Learning is wonderful: what computers really offer in education. In: Kerr, S. (ed.), *Technology and future of education.* Chicago: University of Chicago Press, pp. 111–130.
62. Snyder, I. (1999). Renegotiating the visual and the verbal communication. *Prospect* 1:13–23.

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