Challenges and Opportunities of Computer-Based Learning for Senior Citizens

Panayiotis Zaphiris, PhD
Centre for HCI Design, City University, London, UK

Sri Kurniawan, PhD
Computation Department, UMIST, Manchester, UK

This chapter starts with an argument on how computer-based learning (CBL) can benefit senior citizens, then reviews the effects of aging on computer-based learning (CBL) and finally discusses how the CBL material should be designed for senior citizens to facilitate their learning experience.

Computer-Based Learning for Senior Citizens

The European Union in its recent communication 'eEurope – An Information Society for All" (CEC, 2000) stated that the benefits of the Information Society must reach all Europeans. Developments in Information Society Technology offer great opportunities to overcome social, economic, cultural and other barriers for people with special needs, especially older people and people with disabilities. But as stated by the EU communication, despite the fact that Europe has the world's oldest population structure (UN, 2003), the European industry has so far failed to exploit the full market potential for products and services targeted at people with special needs (CEC, 2000).

CBL products and services are no exception of this trend. When it comes to computer usage, the number of older people who have already gained at least some experience with a PC is considerable. According to SeniorWatch (2003), some 49 million older people across Europe have used a computer at least once in their life and around 27 million currently live in a household with internet access. Similar results have been found in surveys conducted in UK. The so-called silver surfers now represent 12% of Internet users in the UK with 37% of 60 to 64-year-olds now online at home (Guardian, 2003). The survey also revealed a higher level of computer ownership (50%) among the 60-64 age group than among the 18 to 30 year olds (46%) (Guardian, 2003). What is then missing is the availability of services that allow older people to take full advantage of computers in the context of CBL.

Learning in the form of CBL provides both a challenge and an advantage for senior citizens. It can broaden their horizons, allow them to refresh and improve their acquired life experiences and knowledge and give them an opportunity for social interaction. Literature acknowledges that senior citizens are motivated by intellectual stimulation, increased understanding of a field of study and social interaction with peers (Leptak, 1989). However, senior citizens require the CBL products and services to be adapted to their needs and requirements.

The first adaptation is related to the learning method. Seniors learn best if they can contribute to group activities and have some control over what they learn especially by utilizing their own experience and interests (Agruso, 1978; Clark, 1995). Peer learning has been proven (Clark et al., 1997) to be beneficial for senior citizens in face-to-face learning settings. The peer learning model epitomizes three acknowledged theories of adult learning: andragogy, self-directed learning, and perspective transformation (Marriam, 1993). Peer learning is student-directed, planned by the learners themselves, and undertaken to suit their personal circumstances (Clark et al., 1997).

The second adaptation is related to the design of the CBL material. Ageing related decline in perceptual, motor and cognitive abilities experienced by senior citizens dictate that the CBL material incorporates features that can alleviate these declines. To enable the designers to incorporate these features, the following section describes these ageing-related declines to enhance their understanding.

Ageing-Related Declines

Relatively little research exists that relates the effects of aging to CBL. However, there is extensive research that analyzes age-related differences in cognitive, motor and perceptual abilities. In general, cognitive aging literature shows that aging causes decline in the abilities to sense, process information and respond to stimuli. These declines can negatively affect older users' ability to perform computer-related tasks.

In this section we present a summary of available literature that addresses such age declines. It is advised that designers of CBL systems for senior citizens should take these issues into consideration.

Vision and Aging

There are two million people with vision problems in the UK and 90 per cent are over 60 (RNIB, 2003). Fozard (1990) suggests that problems with vision tend to appear in early forties. At this age people have a decline in visual acuity (ability to see fine detail), begin to notice difficulty in adjusting focus for near vision. They usually experience a significant decline in contrast sensitivity (the ability of individuals to detect differences in illumination levels) by the age of fifty (Owsley, Sekuler, & Siemsen, 1983). They may also experience higher sensitivity to glare (Kline & Scialfa, 1996) and reduced sensitivity to color, especially in the blue-green range (Helve & Krause, 1972).

At around 60 years of age, older adults may show a reduction in the width of the visual field (Cerella, 1985), a reduced ability to detect flicker, particularly in the peripheral visual field (Casson, Johnson, & Nelson-Quigg, 1993), and problems with persistence (the sensation of continued presence of the stimulus after presentation of the stimulus has ceased) (McFarland, Warren, & Karis, 1958). Seniors also appear to have a decline in processing visual information (Fozard, 1990; Kline & Szafran, 1975). The ability to recognize figures that are embedded within other figures is reduced (Capitani, Della, Lucchelli, Soave, & Spinnler, 1988), there is a decline in the ability to recognize objects that are fragmented or incomplete (Frazier & Hoyer, 1992; Salthouse & Prill, 1988), and in locating a target figure in a field of distracters (Ellis, Goldberg, & Detweiler, 1996; Hess, Detweiler, & Ellis, 1999; Plude & Hoyer, 1986).

It should be noted that if the target location is constant there is little or no difference due to aging (Carlson, Hasher, Connelly, & Zacks, 1995; Farkaas & Hoyer, 1980). Older people appear to benefit more than younger people when presented with advance cues indicating the future location of a visual search target (Kline & Scialfa, 1996). However older people appear to learn visual searches at the level of the specific targets presented and unlike young people they do not show transfer of learning to new searches where the specific examples have changed but the categories have not (Fisk, Rogers, Cooper, & Gilbert, 1997).

In term of font sizes, Charness and Dijkstra (1999) reported that older adults were slowed more than younger adults by smaller fonts when reading prose text. They proposed using 12- or 14-point type. Ellis and Kurniawan (2000) proposed that the visual sensing limitations of older users could be better addressed if designers:

1. Used only sans serif fonts (Arial, Helvetica, Verdana), and
2. Used black type on a white background

Both Ellis and Kurniawan (2000) and Czaja (1997) recommend that designers should create links that:

1. Are distinct and easy to see,
2. Are fairly large (at least 180 x 22 pixels for a graphic button), and
3. Have plenty of open space around them.

Hearing and Aging

About 20% of people between 45 and 54 years of age have some hearing impairment; this rises to 75% for those between 75 and 79 years of age (Fozard, 1990; Kline & Scialfa, 1996). Seniors show a loss in the ability to detect tones over all frequencies (Rockstein & Sussman, 1979; Schieber, 1992), miss attention-getting sounds with peaks over 2500 Hz. (Berkowitz & Casali, 1990; Huey, Buckley, & Lerner, 1994). By the age of 80 they may miss 25% of the words in a conversation (Feldman & Reger, 1967).

Coren (1994) instructed participants to listen to speech sounds and to indicate the level they preferred for listening. This experiment showed a huge difference in hearing comfort level for younger and older participants (for example, participants of 25 years of age had hearing comfort level of 57 dB, whereas participants of 75 years of age had hearing comfort level of 79 dB).

Cognitive Processing and Aging

As people age, there seems to be a general overall slowing of cognitive processing speed. The larger impact seems to be with tasks that require the most cognitive processing (working memory, overall attention capacity, and visual search performance). Age effects are smallest for tasks where knowledge is an important aspect of the task, and largest for tasks where successful performance is primarily dependent on processing speed (Sharit & Czaja, 1994).

Psychomotor Abilities and Aging

Aging also caused decline in the ability to make fast movements (e.g., in a car racing computer game). The movements also become less reliable and precise. In the context of interaction with the Web and computers, this decline is more pronounced in typing and mouse manipulation speeds.

With age comes lengthening of response times on more complex motor tasks (Light & Spirduso, 1990; Spirduso, 1995). Older adults show poorer performance when asked to track a target (Jagacinski, Liao, & Fayyad, 1995), are less able to cope with demands for repetitive speed (Krampe & Ericsson, 1996), make more sub movements, and are slower in capturing a target with a mouse (Walker, Philbin, & Fisk, 1997). Furthermore, they tend to have some problems with cursor positioning (Charness & Bosman, 1990).

Memory, Learning and Aging

Age gives a slight decline in the number of items which can be held in short term memory, an average of around 6.5 items can be held from the 20s through to the 50s but this then drops to around 5.5 for the 60s and 70s (Botwinick & Storandt, 1974).

However tests of working memory show that there is a stronger decline in the ability to process items in short term memory as distinct from simply recalling them (Dobbs & Rule, 1990; Salthouse, 1994). Light (1990) suggested that working memory decline underlies older peoples' problems in text comprehension. Processing of visual information in short-term memory also slows with age (Hoyer & Rybash, 1992). It has been shown that older adults tend not to adopt strategies for organizing material to be more easily remembered unless prompted to do so (Ratner, Schell, Crimmins, Mittleman, & Baldinelli, 1987). Older adults appear to perform worse on spatial memory tasks (Cherry, Park, & Donaldson, 1993; Denny, Dew, & Kihlstrom, 1992) and tend to have poorer memory for non-verbal items such as faces (Crooke & Larrabee, 1992), or map routes (Lipman & Caplan, 1992).

Design Solution of CBL Material for Senior Citizens

There are several ways of alleviating ageing-related functional decline in the design of CBL material:

1. By incorporating adaptive or adaptable interfaces
2. By applying universal/inclusive design principles
3. By adding on or integrating assistive technology into the applications.

There are some issues and problems related to the application of any of these alternatives into the design process. Adaptive interfaces require some intelligence built into the system, which might mean that it is highly dependent on how sophisticated and accurate the personalization and customisation algorithms involved. Adaptable interface requires some user customisation, which some user studies suggested as quite unlikely to be favourable with older users. The universal design is based on the idea of one-size fits all, which may work very well with younger user group but may not work as well with older users due to large variations in their functional decline. Assistive technology is conventionally designed for people with disabilities, and many of its products assume that help is only needed in one functional dimension. For example, a screen reader, a computer application to help people with declining vision, puts tremendous cognitive load on its users, which makes it helpful for the most-able blind users but may not be useable for older adults.

One of the best design methodologies to ensure that the design choices will produce the best solution for the CBL material is through user-centered design (UCD). UCD is a philosophy and a process. It is a philosophy that places the person (as opposed to the 'thing') at the center; it is a process that focuses on cognitive factors (such as perception, memory, learning, problem-solving, etc.) as they come into play during peoples' interactions with things (Katz-Haas, 1998). UCD seeks to answer questions about users and their tasks and goals, then use the findings to drive development and design.

Zaphiris and Kurniawan (2001) adapted this user-centered design by involving only older users. The methodology was simply called “senior-centered design” (SCD), which refers to a methodology that involves older users in the process of designing products that are targeted towards the aging population. These authors advocated the use of this methodology for designing senior-centered products and services.

References:

Arguso, V.M. (1978) Learning in the later years: Principles of educational gerontology. New York, NY: Academic Press.

Berkowitz, J. P., & Casali, S. P. (1990). Influence of age on the ability to hear telephone ringers of different spectral content. Proceedings of The Human Factors and Ergonomics Society, 34th Annual Meeting. Santa Monica, CA: HFES.

Botwinick, J., & Storandt, M. (1974). Memory Related Functions and Age. Springfield, IL: Charles C. Thomas.

Capitani, E., Della, S. S., Lucchelli, F., Soave, P., & Spinnler, H. (1988). Perceptual attention in aging and dementia measured by Gottschaldt's hidden figures text. Journal of Gerontology: Psychological Sciences(43), 157-163.

Carlson, M. C., Hasher, L., Connelly, S. L., & Zacks, R. T. (1995). Aging, distraction and the benefits of predictable location. Psychology and Aging (10), 427-436.

Casson, E. J., Johnson, C. A., & Nelson-Quigg, J. M. (1993). Temporal modulation perimetry: the effects of aging and eccentricity on sensitivity in normals. Investigative Opthalmology and Visual Science(34), 3096-3102.

CEC (2000). eEurope- An Information Society for All. Communication on a Commission Initiative for the Special European Council in Lisbon, 23 and 24 March 2000.

Cerella, J. (1985). Age-related decline in extrafoveal letter perception. Journal of Gerontology(40), 727-736.

Charness, N., & Bosman, E. (1990). Human Factors and design. In J. E. Birren & K. W. Schaie (Eds.), Handbook of the Psychology of Aging (3rd ed., pp. 446-463). San Diego, CA: Academic Press.

Charness, N., & Dijkstra, K. (1999). Age, luminance, and print legibility in homes, offices and public places. Human Factors, 41(2), 173-193.

Cherry, K. E., Park, D. C., & Donaldson, H. (1993). Adult age differences in spatial memory: Efforts of structural content and practice. Experimental Aging Research(19), 333-350.

Clark, D. (1995). Learning in the third age. Third Age Learning International Studies, 5, 17-24.

Clark, F., Heller, A.F., Rafman, C., Walker, J. (1997). Peer Learning: A popular model for seniors education, Educational Gerontology, 23, 751-762.

Coren, S. (1994). Most confortable listening level as a function of age. Ergonomics, 37(7), 1269-1274.

Crooke, T. H., & Larrabee, G. J. (1992). Changes in facial recognition memory across the adult lifespan. Journal of Gerontology: Psychological Sciences(47), 138-141.

Czaja, S. (1997). Computer technology and older adults. In M. E. Helander & T. K. Landauer & P. Prabhu (Eds.), Handbook of Human-Computer Interaction (2nd ed., pp. 797-812). New York: Elsevier.

Denny, N. W., Dew, J. R., & Kihlstrom, J. F. (1992). An adult development study of encoding of spatial location. Experimental Aging Research(18), 25-32.

Dobbs, A. R., & Rule, B. G. (1990). Adult age differences in working memory. Psychology and Aging(4), 500-503.

Ellis, R. D., Goldberg, J. H., & Detweiler, M. C. (1996). Predicting age-related differences in visual information processing using two-stage queuing model. Journal of Gerontology: Psychological Sciences, 51B(3), 155-165.

Ellis, R. D., & Kurniawan, S. H. (2000). Increasing the usability of online information for older users: A case study in participatory design. International Journal of Human-Computer Interaction, 12(2), 263-276.

Farkaas, M. S., & Hoyer, W. J. (1980). Processing consequences of perceptual grouping in selective attention. Journal of Gerontology(35), 207-216.

Feldman, R. M., & Reger, S. N. (1967). Relations among hearing, reaction time and age. Journal of Speech and Hearing Research(10), 479-495.

Fisk, A. D., Rogers, W. A., Cooper, B. P., & Gilbert, D. K. (1997). Automatic category search and its transfer: Aging, type of search and level of learning. Journal of Gerontology: Psychological Sciences, 52B(2), 91-102.

Fozard, J. L. (1990). Vision and hearing in aging. In J. E. Birren & R. B. Sloane & G. D. Cohen (Eds.), Handbook of Mental Health and Aging (pp. 150-170). San Diego, CA: Academic Press.

Frazier, L., & Hoyer, W. J. (1992). Object recognition by component features. Experimental Aging Research(18), 9-15.

Guardian newspaper (2003). Over 60s reach for the mouse. Available Online: http://www.guardian.co.uk/online/news/o,12597,994115,00.html

Helve, J., & Krause, U. (1972). The influence of age on performance in the Panel D15 colour vision test. Acta Ophalmologica(50), 896-901.

Hess, S., Detweiler, M. C., & Ellis, R. D. (1999). The utility of display space in keeping-track of rapidly changing information. Human Factors, 41(2), 257-281.

Hoyer, W. J., & Rybash, J. M. (1992). Age and visual field differences in computing visual spatial relations. Psychology and Aging(7), 339-342.

Huey, R. W., Buckley, D. S., & Lerner, N. D. (1994). Audible performance of smoke alarm sounds. Proceedings of The Human Factors and Ergonomics Society, 38th Annual Meeting. Santa Monica, CA: HFES.

Jagacinski, R. J., Liao, M. J., & Fayyad, E. A. (1995). Generalized slowing in sinusoidal tracking in older adults. Psychology and Aging 9, 103-112.

Katz-Haas, R. (1998). Ten Guidelines for User-Centered Web Design. Usability Interface 5(1) [on-line]. Available at: http://www.stcsig.org/usability/newsletter/9807-webguide.html.

Kline, D. W., & Scialfa, C. T. (1996). Sensory and perceptual functioning basic research and human factors implications. In A. D. Fisk & W. A. Rogers (Eds.), Handbook of Human Factors and the Older Adult. Sand Diego, CA: Academic Press.

Kline, D. W., & Szafran, S. (1975). Age differences in backward monoptic masking. Journal of Gerontology(30), 307-311.

Krampe, R. T., & Ericsson, K. A. (1996). Maintaining excellence: deliberate prectice and elite performance in young and older pianists. Journal of Experimental Psychology: General(125), 331-359.

Leptak, J. (1989). The academy grows gray: A review of the research on older adults in higher education. Continuing Higher Education Review, 53, 99-111.

Light, K. E., & Spirduso, W. W. (1990). Effects of adult aging on the movement complexity factor in response programming. Journal of Gerontology: Psychological Sciences, 45(3), 107-109.

Light, L. L. (1990). Memory and language in old age. In J. E. Birren & K. W. Schaie (Eds.), Handbook of the Psychology of Aging (3rd ed., pp. 275-290). San Diego, CA: Academic Press.

Lipman, P. D., & Caplan, L. J. (1992). Adult age differences in memory for routes: Effects of instruction and spatial diagram. Psychology and Aging(7), 435-442.

Marriam, S.B. (Ed.) (1993). An update on adult learning theory. (New Directions for Adult and Continuing Education No. 57). San Francisco: Jossey-Bass.

McFarland, R. A., Warren, A. B., & Karis, C. (1958). Alteration in critical flicker frequency as a function of age and light. Journal of Experimental Psychology(56), 529-538.

Owsley, C., Sekuler, R., & Siemsen, D. (1983). Contrast sensitivity throughout adulthood. Vision Research(23), 689-699.

Plude, D. J., & Hoyer, W. J. (1986). Aging and the selectivity of visual information processing. Psychology and Aging(1), 1-9.

Ratner, H. H., Schell, D. A., Crimmins, A., Mittleman, D., & Baldinelli, L. (1987). Changes in adult prose recall: aging or cognitive demands. Developmental Psychology(23), 521-525.

Rockstein, M. J., & Sussman, M. (1979). Biology of Aging. Belmont, CA: Wandsworth.

Royal National Institute for the Blind (RNIB) (2003). Older people [on-line]. Available at: http://www.rnib.org.uk/xpedio/groups/public/documents/code/public_rnib002034.hcsp.

Salthouse, T. A., & Prill, K. A. (1988). Effects of aging on perceptual closure. American Journal of Psychology(101), 217-238.

Schieber, F. (1992). Aging and the senses. In J. E. Birren & R. B. Sloane & G. D. Cohen (Eds.), Handbook of Mental Health and Aging. San Diego, CA: Academic Press.

SeniorWatch (2003). http://www.seniorwatch.de/

Sharit, J., & Czaja, S. (1994). Ageing, computer-based task performance, and stress: Issues and challenges. Ergonomics, 37(4), 559-577.

Spirduso, W. W. (1995). Aging and motor control. In D. R. Lamb & C. V. Gisolfi & E. Nadel (Eds.), Perspectives in Exercise Science and Sports Medicine: Exercise in Older Adults (pp. 53-114). Carmel, IN: Cooper.

UN (2003). UN World Population Report, Available Online: http://www.unfpa.org/swp/swpmain.htm

Walker, N., Philbin, D. A., & Fisk, A. D. (1997). Age-related differences in movement control: adjusting submovement structure to optimize performance. Journal of Gerontology: Psychological Sciences, 52B(1), 40-52.

Zaphiris, P., Kurniawan, S.H. (2001). Using Card Sorting Technique to Define the Best Web Hierarchy for Seniors. Proceedings of the CHI 2001 Conference on Human Factors in Computing Systems. New York, NY: ACM.

Terms and Definitions

Adaptive Interfaces: Interfaces that allow for some user customisation and personalization .

Ageing-Related Declines: Age-related differences in cognitive, motor and perceptual abilities.

Assistive technology: Any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities.

Peer Learning: A learning style that supports the concept of peers learning from each other.

Senior-Centered Design: A methodology that involves older users in the process of designing products that are targeted towards the aging population

Universal Design: A concept or philosophy for designing and delivering products and services that are usable by people with the widest possible range of functional capabilities.

User-Centered Design: It is a philosophy that places the person (as opposed to the 'thing') at the center of the design process.

Dr. Panayiotis Zaphiris

Panayiotis is a Senior Lecturer at the Centre for Human-Computer Interaction Design at City University, London. Before joining City University, he was a researcher at the Institute of Gerontology at Wayne State University from where he also got his Ph.D. in Industrial Engineering specializing in Human Computer Interaction (HCI). His research interests lie in Human-Computer Interaction with an emphasis on issues related to the elderly and people with disabilities. He is also interested in internet related research (web usability, mathematical modelling of browsing behaviour in hierarchical online information systems, online communities, e-learning, Computer Aided Language Learning (CALL) and social network analysis of online human-to-human interactions).

Dr. Sri Kurniawan

Sri is a lecturer in human-computer interaction at the Department of Computation, UMIST. She received her BEng (Electronics Engineering) from Indonesia, her MPhil (Industrial Engineering and Engineering Management) from Hong Kong, and her Ph.D. (Industrial and Manufacturing Engineering) from Michigan where she was also a Research Assistant at the Institute of Gerontology. While pursuing her Ph.D. degree, she also attended classes led by the leading librarians and information scientists from the School of Informatics, University of Michigan. Sri's primary research concerns the design and evaluation of computer and Web interfaces for elderly people and people with disabilities.