Situated Multimedia Learning for Older Adults: Exploring the Benefits of Age-Specific Instructional Design

Cordula Orth, Theo J. Bastiaens, FernUniversitaet in Hagen, Department of Instructional Technology and Media, Universitaetsstr. 11, 58084 Hagen
Email: cordula.orth@fernuni-hagen.de, theo.bastiaens@fernuni-hagen.de

Abstract: This study explores advantages of situated multimedia learning environments with age-specific modifications for older adults. With the strong increase of the ageing population in Western societies the number of active older adults willing to learn is growing. Furthermore, due to the increase of ICT older adults will be more and more confronted with multimedia applications that are not tailored to this specific user group and might therefore not be as efficient as they could be. A design that combines adjustments towards the physical decline and adapts cognitive load theory to minimise cognitive overload embedded in an authentic context provides a fruitful basis for learning environments addressing older adults. However, situated learning approaches vary widely in the support given to the learner and the aim is to establish a framework that enables instructional designers to administer the appropriate amount of support for the special abilities and needs of older adults.

Introduction

The term older adult has frequently been aligned with people over the age of 50 and it is being recognised that a growing number of this group is not only capable, but also interested in lifelong learning. The concept of lifelong learning regards education as not being limited to specific age parameters. With the growth in the older adult's population using the Internet the opportunity for senior learners to access online learning environments increases dramatically. When older adults use multimedia-based learning environments they usually have to work with products that are not particularly designed for them. Unfortunately developers of online materials all too often design materials for the "average" user, without the user group of older adults in mind. Older adults seem to be disadvantaged proportionately more than younger learners when they have to work with learning materials that do not address their unique abilities and needs. For example younger adults may find certain incoherencies in a learning environment also irritating but might just be more effective to deal with those barriers. Thus, it is not sufficient to design a learning environment and adopt it for older adults if it was not developed for this specific learner group. As learning environments are differentially effective for different age groups the demographic change and the necessity for lifelong learning require instructional designers to rethink their approach to developing learning environments.

Theoretical Framework

Providing better-designed, i.e. adaptive learning environments will especially benefit older learners but also improve the quality for all user groups. Especially the growing importance of complex learning cannot be solely addressed with technical solutions that have been developed without an understanding of the user group. Most educational research is in agreement that not everybody learns or approaches learning in the same way which is especially true for older adults (Truluck & Courtenay, 1999). The potential of learners, their limitations, and their learning needs including those of older adults have to be addressed. Although older adults do not constitute a heterogeneous group there are certain factors that potentially contribute to difficulties they might encounter with online learning materials. Besides the normal age-related decrements in perception, cognition and psychomotor abilities a generation-related lack of experience with such technologies have an effect on this user group.

The perceptual and psychomotor changes and their impact on lifelong learning have been well documented (Charness & Schaie, 2003; Fisk, Rogers, Charness, Czaja, & Sharit, 2004). As older adults' cognitive ability might already be limited their cognitive activity should not be utilized to cope with inadequate design (Hawthorn, 2000). Although these aspects are important to ensure that the learner is able to fully utilise the learning materials, one should not focus primarily on design issues while ignoring cognitive challenges of older adults using online materials to acquire complex skills.

These cognitive challenges are at least partially caused by cognitive ageing, the normal, age-related decline associated with a reduced capacity of working-memory to store, retrieve, and manipulate information. In this regard, Gerven, Paas, Merriënboer, and Schmidt (2000) propose a framework in which cognitive load theory (CLT) is merged with significant findings of cognitive ageing research. CLT which is based upon the work of Sweller (1994) states that learners should be stimulated to use their limited working-memory efficiently, especially when acquiring complex skills in order to reduce cognitive load. Although there are

important interplays between the findings from cognitive aging research and CLT, the principles of multimedia learning have not been integrated into learning environments for older adults. It would however be worthwhile to examine whether they apply to learning environments that require many hours of participation (Clark & Mayer, 2003). To bridge this gap, i.e. to develop a framework for older adults learning needs, an instructional design model has to be selected to imbed the learning materials that are especially suited to older adults.

Knowles developed a theory of andragogy to understand and support adult learning. It emphasises that adults are self-directed and anticipate taking responsibility for their decisions. Online learning environments for older adults should therefore not only state why learners need to learn and how the knowledge will be immediately applicable but should also facilitate for a self directed learning process in which the learner can utilize their life experiences (Knowles, 1975). As learning research in general has stated the importance of providing students with an authentic context for supporting learning and andragogy find this especially poignant for older adults (Knowles, 1984a, 1984b) the concept of situated learning should be considered as a possible framework.

Concerning this matter, the concept of situated learning might offer the possibilities to compensate for age-related deficits in memory by enriching learning contexts. Collins, Brown and Newman (1989) developed the theory of situated learning to increase the knowledge transfer from classroom instructions to real-life applications (Park & Hannafin, 1993; Young, 1993). Beneficial learning effects of situated multimedia learning have already been obtained in young adults (Griffin, 1995; Lampert, 1986) however, there is a gap in research concerning older learners. Intelligence, one factor assumed to predict learning performance is divided into fluid and crystallised intelligence. Whereas fluid intelligence necessary for attention and short-term memory decreases with age, crystallized intelligence essential to solve familiar cognitive problems based on knowledge and experience increases or at least stabilises with age (Kliegel & Altgassen, 2006; Schaie, 2005). Taking further findings of gerontology into account that adults rather accept learning materials that relate to their pre-existing knowledge and experiences and can transfer what they learn relate immediately to real life situations giving them purpose and satisfaction make it plausible that they might prefer authentic tasks embedded into virtual learning environments are more motivating for older adults than conventional task. As there are huge variations in situated learning environments it remains to be seen if older learners really prefer to use the resources rather independently or if they prefer a rather controlled learning environment with more scaffolding.

To integrate theories of situated learning, Herrington and Oliver (2000) suggest an instructional design framework with nine design recommendations for authentic learning environments. It is conceived as a guideline for the design of multimedia-based environments that incorporates the characteristics of authentic learning. The authentic learning environment should therefore be characterised by real world relevance where learning is embedded in social practice. The tasks should be authentic and have a diversity of possible outcomes and authentic assessment that is seamlessly integrated with these tasks. Opportunities for students to examine content and tasks from a variety of perspectives and to collaborate, articulate, and reflect on the knowledge.

Moreover, models of self-regulated learning emphasise that students are more effective when they take a purposeful role in their own learning. The framework from Herrington offers learners an open structure where they can autonomously direct their own learning and apply their learning strategies to move through the rather compartmentalised offering of materials. In this regard, it has been shown that volitional skills, i.e. the ability to self-regulate the learning process, are important prerequisites for learning (Deimann & Keller, 2006). As motivation is an essential factor in older adults' learning (Wlodkowski, 1986) it has to bee seen if this freedom outweighs the problematic that some learners may lack the necessary learning strategies for effective learning.

Additionally older adults tend to become less active and hands-on while learning and more reflective and observant instead (Truluck & Courtenay, 1999). Minimal guidance where learners must discover or construct essential information for themselves (Bruner, 1961; Papert, 1980) might therefore be challenging. In contrast direct instructional guidance (Mayer, 2004; J. Sweller, 2003) provides information that explains concepts and procedures to the learners might be more compatible with older adults.

Modern instructional design models assume that realistic and rich learning tasks are the driving force for learning (Merrill, 2002). Well-designed learning tasks stimulate learners to integrate and coordinate required skills, knowledge and attitudes. This finally leads to a rich knowledge base that allows for transfer to daily life and future work settings (J. v. Merriënboer, Bastiaens, & Hoogveld, 2004). These developments put forward the need for a design model to accommodate complex learning (Jeroen J. G. van Merriënboer, Clark, & Croock, 2002). However, such design methodologies or models are rare, so designers often have to fall back on their own ideas and intuition, thereby often neglecting systematic analysis, design and evaluation (van Merriënboer & Martens, 2002). Moreover, constructivist learning approaches almost always have an implicit or explicit combination of both cognitive and motivational effects of the learning materials. This makes it even more complicated to design constructivist learning environments and to predict and understand its effects.

The Four-Components Instructional Design Model (4C/ID) of van Merriënboer (J. J. G. van Merriënboer, 1997) offers such designers' guidelines. It supports the development of complex tasks for learning that are often used in higher education. The model distinguishes between non-recurrent aspects of learning and

performance, which differ from problem to problem situation, and recurrent aspects, which are identical from one problem situation to another. The model in general exists of four interrelated blueprint components. The backbone of the model is formed by learning tasks which are defined as concrete, authentic and meaningful 'whole task experiences'. They are sequenced in simple-to-complex task classes. Ideally, they confront learners with all aspects of a professional competency. The second component is called supportive information. This is information that is supportive to the learning and performance of non-recurrent aspects of learning tasks (e.g. problem solving and reasoning) within the same task class. It helps to develop mental models and cognitive strategies. Just-in-time information is the third component and is prerequisite to the learning and performance of recurrent aspects of learning tasks. It is relevant to the performance of routine aspects of the learning tasks. In general these are small information units and presented to learners - just-in-time- while working on the learning tasks. The last component is called part task practice. These are in fact additional exercises for recurrent aspects of learning tasks for which a very high level of automation is required after instruction. Although the 4C/ID model is acknowledged as one of the most effective instructional design models (Merrill, 2002) there is little or no empirical research about the effectiveness of 4C/ID multimedia learning environments for older learners.

Like the framework from Herrington it is based on the tradition of situated learning and has been acknowledged as one of the most effective instructional design models for learning environments that facilitate the acquisition of constituent skills that are not dealt with separately but in an integrated fashion. Difficulties in learning especially for older adults can be caused by the lack of a suitable framework from which learners can anticipate what to expect and how the learning materials interrelate with each other and with existing knowledge (Botwinick, 1978). Older adults have been found to be less able to organise learning materials or the learning material may be structured inadequately by the older learner due to the absence of learning strategies resulting in lower performance (Zacks, Hasher, & Li, 2000).

In summary, both learning environments considered adhere to situated learning as older adults benefit from contextualised learning in order to connect new information to existing. However, as there are different perspectives in gerontology the question remains how much instruction and scaffolding is needed. This leads to two areas of research questions. The first part to be investigated is to compare the two aforementioned situated learning environments in order to gather which instructional design is more efficient for the older learners on the one hand and the younger user groups on the other, or even for both learner groups.

As age is an integral part of this study it will have to be examined if differences between the younger and the older age groups can be solely explained by chronological age. The belonging to a generation and personal experiences of a lifetime are important factors to consider since the ageing process is culturally and socially defined. This study will take into account that the experience in using complex systems might play an important role in the handling of technology. A specific form of experience is embodied by the concept of technology generation that is distinguished following general sociological methodology by age effects (Rama, de Ridder, & Bouma, 2001). Sackmann and Weymann (1994) investigated whether generations can be distinguished from subsequent birth cohorts that currently display similar behaviour towards technology based on macro-technological events in their formative period. They found evidence that people who experienced the availability of the same types of consumer product during their formative period (age 10 to 25 years) in some respect display similar technology usage many years later. So different technology generations appear to behave differently with respect to technology and it is the rather sudden discontinuous changes in society that allow the differentiation between age and technology generation effects. The age groups relevant for this study can be divided into four groups (see Table 1) according to their birth cohorts. The two older age groups are part of the “electric generation”, the two younger age groups already belong to the “digital generation”(Goor & Becker, 2001).

Table 1: Technology generation and chronological age.

Technology generation	Age	
	Birth cohort	Age in years at the time of the data collection
Electric generation	1941–1950	58-67
Electric generation	1951–1960	48-57
Digital generation	1961-1970	38-47
Digital generation	1971-1980	28-37

The second part of research question focuses on the differences between the age differences and technology generation age effects of the users when trained with an identical learning environment.

Research questions

The interface design of the two learning environments is in accordance with the reviewed body of literature concerning the special affordances of older learners. However, most of the research done so far has dealt with web pages or even more general media such as print. This study will implement the recommendations into two learning environments for complex learning and it will be investigated if the older learners will indeed benefit from these design adjustments (Hawthorn, 2000). Additionally, the reactions of the younger learners will be captured t confirm that the recommendations for older adults allow for a barrier free design that is beneficial for all users. Thus, it is expected that the research will question the myth that younger adults might dislike the easy to use design that supports older adults. In particular, the following questions will be dealt with:

- Are the older age groups comfortable with the interface that is designed for their special needs, i.e. do they find it easy to navigate within the learning materials when these recommendations are integrated into a multimedia environment?
- How do the younger age groups react to the age-specific interface design for older adults?

The guidelines for the "authentic learning environment" have been qualitatively researched on younger adults (Herrington & Oliver, 2000). It will be of interest if the data can be confirmed quantitatively in this study for the younger user group. It will also be of utmost interest how older adults will learn with this situated learning environment and which parts of the framework might be especially beneficial or indeed problematic. It is also interesting if there is a relationship in the acceptance of the learning environment in terms of age or if the perceived usefulness will be more on a personal level. The authentic assessment will give further information about the learning efficiency of the users, with regard to the following aspects:

- How important to learners within the "authentic learning environment" is each of the nine critical characteristics of authenticity in the framework?
- Are there differences in the performance between the age groups within the "authentic learning environment" learning environment?

In general, there have been very few research studies about the 4C/ID model on younger adults and none at all with older adults. It will be of interest if the data can be confirmed quantitatively in this study for the younger user group and to gain new data about older adults as a user group. Again, it will be researched how all age groups perceive this environment in general but also which parts of the framework might be especially beneficial or indeed problematic. The authentic assessment will give further information about the learning efficiency of the users, concerning the following aspects:

- How important to learners within the "4C/ID learning environment" is each of the four critical characteristics of the 4C/ID framework?
- Are there differences in the performance between the age groups within the "4C/ID learning environment"?

The main subjective of the research is to compare the two learning environments, the "authentic learning environment" and the "4C/ID learning environment" in terms of the efficiency for all user groups. The literature is very ambiguous in the recommendations for learning materials, in particular from a constructivist point of view to allow the utmost of freedom to build upon their prior life experiences to a more restricted attitude that older adults need more scaffolding than younger adults. However, it is expected that the younger participants will outperform the older participants in both learning environments. It is to be seen which learning environment will enable the older ones to reduce the gap between the older and younger age groups as a more efficient learning environment.

- Is there a learning environment that is for all age groups preferable in terms of learning efficiency or is one better for the older age groups whereas the other is better for the younger age groups?

In order to get a better understanding of the influence of age on a learner in a complex learning environment it will be looked at the different birth cohorts.

- Can possible differences between the age groups be explained with increasing age or will discontinuous change point to the effects of technology generations?

Method

To investigate the research questions an experimental study will be conducted with 320 German primary and secondary school teachers between 28 and 67 years of age. These recruited participants will be a rather homogeneous group in terms of educational level.

Design

Participants will be randomly assigned to one of the two experimental training conditions. Independent variables are the four age groups and the two learning environments. This will yield a four (age group) x two (training format) between-groups design, with age group comprising the levels 28-37; 38-47; 48-57; and 58-67 years of age, and training format comprising the levels "authentic" and "4C/ID" (see Table 2).

Table 2: Design of the experimental study.

		Training format	
		"4C/ID"	"authentic"
Age group	28-37	n=40	n=40
	38-47	n=40	n=40
	48-57	n=40	n=40
	58-67	n=40	n=40

Measures

The dependent variables are subjective cognitive load (SCL) during the training and performance on the task. SCL will be evaluated with a nine-point symmetrical category scale that has been developed by Paas, van Merriënboer, and Adam (1994). Performance will be rated in terms of successful knowledge transfer with the completion and qualitatively high standard of the authentic assessment. The training format will be considered as inefficient when the subjective cognitive load during the usage of the learning environment is relatively high and performance is relatively low.

The control variables motivation, computer literacy, and working memory computation span of the participants will be collected in a pre-test. The reactions of both the younger and the older user groups will be gathered in an online questionnaire after the training has been completed. An online questionnaire after the training has completed will gather information about the acceptance of all users towards the each of the two learning environments. Data will be extracted from the database connected to the learning environment to control which elements of the framework have been used for how long.

Treatment

A complete instructional package is needed to incorporate the framework of complex learning for older learners in multimedia-based learning environments. Two versions of a situated learning environment will be developed for the studies. They will provide training for primary and secondary school teachers regarding the usage of interactive whiteboards in classroom situations. While the content area for the development of the learning environment was not critical, the domain of interactive whiteboards has been chosen and proven to be particularly appropriate. The lack of training in the use of interactive whiteboards for teachers was obvious as the technology is still in its infancy (Beauchamp & Parkinson, 2005; Cogill, 2006). Besides this lack the fact that if training was provided the transfer of pedagogical skills from the theory of teacher training to the practical reality of the classroom has been a source of concern to teacher educators for some time. Especially the seamless integration of video into multimedia learning environments enables learners to get acquainted with interactive whiteboards through behavioural modelling.

The learning environments offer therefore video and audio resources as well as software examples to integrate case studies reflecting various perspectives from experts to novices. The interface of both learning environments has the same special age-related design adjustments for the specific user group of older adults to address for sensory deficits such as vision and hearing and other adjustments to counteract the normal decline of ageing.

Learning materials in the "4C/ID learning environment" (see Figure 1) are organised into five modules. Each module starts with a mindmap with links to:

- *Supportive information* necessary for the non-recurrent aspects of this module in form of a classroom video, audio files with the "theory" and software examples.
- *Learning tasks* authentic, whole-task experiences including worked examples in form of case studies and goal-free problems with *just-in-time information* available for the recurrent elements and *part-task practice* additionally provided.

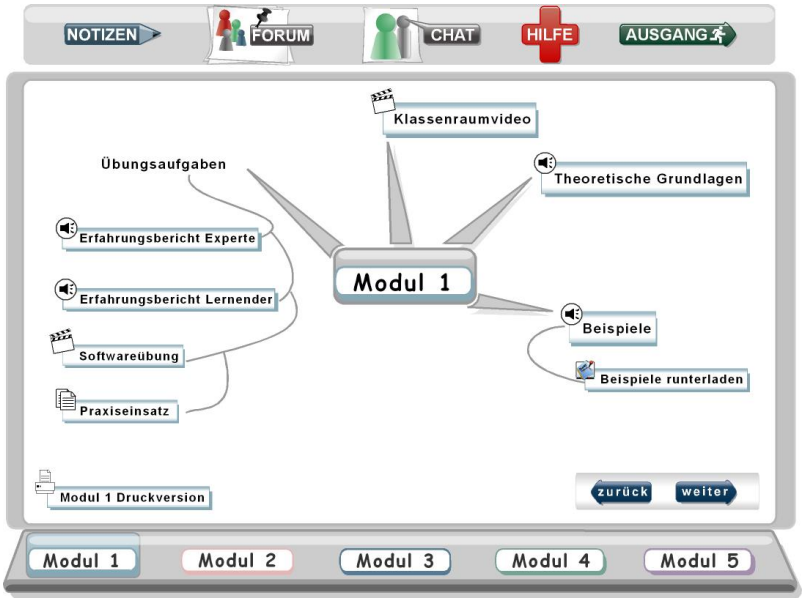

Figure 1. The interface of the first module from the "4C/ID learning environment".

Although the learning materials in both environments are identical, the sequencing and inherent scaffolding varies extensively. The "4C/ID learning environment" is structured into five modules that build upon each other with increasing complexity. In contrast to this the "authentic learning environment" is divided into "rooms" using the metaphor of a school. The rooms are:

- *Headmaster's office*: answers frequently asked questions and hands out the authentic assessment;
- *Individual working space:* facilitates note taking and offers further supportive tools such as a glossary or a link list with relevant websites;
- *Smartboard*: videos including a technical introduction and a variety of software examples;
- *Classroom:* videos of experienced teachers using the interactive whiteboard in classroom situations;
- *Staff room:* a chat and a forum allow synchronous and asynchronous communication between the learners.

The content is organised according to topics and the learner is only minimally guided in the utilisation of the resources.

The two web-based learning environments will be developed with Adobe FreeHand, Adobe Flash and a MySQL Database. They have been created to run on all standard browsers and will be made available for the participants on the University website.

Results

Two multimedia learning environments will be developed to integrate existing theories of situated learning and age-specific design for older adults. They form the basis for the data collection for which the first observations are expected shortly. The pilot study will enable a discussion about the influence that age and training format have on the performance of younger and older adults. It is expected that findings identify preferences of older adults when given alternative situated learning environments and recommendations will be drawn towards an integrative framework for age-adjusted situated learning.

Discussion

The increased longevity and the growing dependence on technology provide interesting challenges for instructional design. This study deals with two central topics in educational research, older learners with their special needs in relation to multimedia learning environments and the increasingly popular concept of situated learning. Although there are empirical studies into authentic learning environments on the one hand and CLT applied to older learners on the other hand there seems to be a lack of research into the possibilities of a combination of these two frameworks, especially for learning materials designed for complex skills. Research is necessary to gain insight into the actual benefits of age-adjusted authentic multimedia-based learning environments for senior learners.

References

Beauchamp, G., & Parkinson, J. (2005). Beyond the 'wow' factor: developing interactivity with the interactive whiteboard. *School Science Review, 86*(316), 97-103.

Botwinick, J. (1978). *Aging and behavior*. New York: Springer.

Bruner, J. S. (1961). The art of discovery. *Harvard Educational Review, 31*, 21-32.

Charness, N., & Schaie, K. W. (Eds.). (2003). *Impact of technology on successful aging*. New York: Springer.

Clark, R. C., & Mayer, R. E. (2003). *E-Learning and the science of instruction: Proven guidelines for consumers and designers of multimedia*. San Francisco: Jossey-Bass/Pfeiffer.
Cogill, J. (2006). Pedagogy, models of teacher knowledge and use of the interactive whiteboard. *Education Today, 56*(3), 6-13.
Collins, A., Brown, J. S., & Newman, S. E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In L. B. Resnick (Ed.), *Knowing, learning and instruction: Essays in honour of Robert Glaser* (pp. 453-494). Hillsdale, NJ: LEA.
Deimann, M., & Keller, J. (2006). Volitional aspects of multimedia learning. *Journal of Educational Multimedia and Hypermedia, 15*(2), 137-158.
Fisk, A. D., Rogers, W. A., Charness, N., Czaja, S. J., & Sharit, J. (2004). *Designing for older adults: Principles and creative human factors approaches*. Boca Raton: CRC Press.
Gerven, P. W. M. v., Paas, F., Merrienboer, J. J. G. v., & Schmidt, H. G. (2000). Cognitive load theory and the acquisition of complex cognitive skills in the elderly: Towards an integrative framework. *Educational Gerontology, 26*, 503-521.
Goor, A.-G. v. d., & Becker, H. (2001). *Technology generations in the Netherlands: A sociological analysis*. Maastricht: Shaker.
Griffin, M. M. (1995). You can't get there from here: Situated learning, transfer and map skills. *Contemporary Educational Psychology, 20*, 65-87.
Hawthorn, D. (2000). Possible implications of aging for interface designers. *Interacting with Computers, 12*, 507–528.
Herrington, J., & Oliver, R. (2000). An instructional design framework for authentic learning environments. *Educational Technology, Research and Development, 48*(3), 23-48.
Kliegel, M., & Altgassen, M. (2006). Interindividual differences in learning performance: The effects of age, intelligence, and strategic task approach. *Educational Gerontology, 32*, 111–124.
Knowles, M. (1975). *Self-Directed Learning*. Chicago: Follet.
Knowles, M. (1984a). *The Adult Learner: A Neglected Species* (Vol. 3). Houston: Gulf Publishing.
Knowles, M. (1984b). *Andragogy in Action*. San Francisco: Jossey-Bass.
Lampert, M. (1986). Knowing, doing, and teaching multiplication. *Cognition and Instructional Science, 3*(4), 305-342.
Mayer, R. (2004). Should there be a three-strikers rule against pure discovery learning? The case for guided methods of instruction. *American Psychologist, 59*, 14-18.
Merriënboer, J. J. G. v. (1997). *Training complex cognitive skills: A four-component instructional design model for technical training*. Englewood Cliffs, N. J.: Educational Technology Publications.
Merriënboer, J. J. G. v., Clark, R. E., & Croock, M. B. M. d. (2002). Blueprints for Complex Learning: The 4C/ID-Model. *ETR&D, 50*(2), 39-64.
Merriënboer, J. v., Bastiaens, T., & Hoogveld, A. (2004). Instructional design for integrated e-learning. In W. Jochems, J. v. Merriënboer & R. Koper (Eds.), *Integrated E-learning. Implications for Pedagogy, Technology & Organization* (pp. 13-24). London: Routledge Falmer.
Merrill, M. D. (2002). First Principles of Instruction. *Educational Technology Research & Development, 50*(3), 43–59.
Paas, F., van Merriënboer, J. J. G., & Adam, J. J. (1994). Measurement of cognitive load in instructional research. *Perceptual and Motor Skills, 79*, 419-430.
Papert, S. (1980). *Mindstorms: Children, computers, and powerful ideas*. New York: Basic Books.
Park, I., & Hannafin, M. J. (1993). Empirically-based guidelines for the design of interactive multimedia. *Educational Technology Research and Development, 41*(3), 63-85.
Rama, M. D., de Ridder, H., & Bouma, H. (2001). Technology generation and age in using layered user interfaces. *Gerontechnology, 1*(1), 25-40.
Sackmann, R., & Weymann, A. (1994). *Die Technisierung des Alltags: Generationen und technische Innovationen*. Bremen: BMFT.
Schaie, K. W. (2005). *Developmental influences on adult intelligences: The Seattle longitudinal study*. New York: Oxford University Press.
Sweller, J. (1994). Cognitive load theory, learning difficulty, and instructional design. *Learning and Instruction, 4*, 295-312.
Sweller, J. (2003). Evolution of human cognitive architecture. In B. Ross (Ed.), *The psychology of learning and motivation* (Vol. 43, pp. 215-266). San Diego, CA: Academic.
Truluck, J. E., & Courtenay, B. C. (1999). Learning style preferences among older adults. *Educational Gerontology, 25*, 221-236.
van Merriënboer, J. J. G., & Martens, R. L. (2002). Computer-based tools for instructional design. *Educational Technology Research & Development, 50, Special Issue*.
Wlodkowski, R. (1986). *Enhancing adult motivation to learn*. San Francisco: Jossey-Bass.

Young, M. F. (1993). Instructional design for situated learning. *Educational Technology Research and Development, 41*(1), 43-58.

Zacks, R. T., Hasher, L., & Li, K. Z. H. (2000). Human memory. In F. I. M. Craik & T. A. Salthouse (Eds.), *The handbook of aging and cognition* (pp. 293-357). Mahwah, N.J: Lawrence Erlbaum.