Are serious video games something more than a game? A review on the effectiveness of serious games to facilitate intergenerational learning

**Antonia Ypsilanti · Ana B. Vivas · Teppo Räisänen ·
Matti Viitala · Tuula Ijäs · Donald Ropes**

Abstract Aging diversity in organizations creates potential challenges, particularly for knowledge management, skills update and skills obsolescence. Intergenerational learning (IGL) involves knowledge building, innovation and knowledge transfer between generations within an organization (Ropes 2011). Serious games refer to the use of computer games in raising awareness about educational topics, acquiring new knowledge and skills by enabling learners to engage and participate in situations that would otherwise be impossible to experience (Corti 2006). Although learning with the use of serious games is similar to traditional learning in several cognitive respects, there are noted differences in the learning style and structure of learning using serious games. The success of learning using serious games lies in the actual involvement of a participant playing the game, which in turn, creates increased cognitive links with real-life situations allowing the individual to make relevant associations, to use mnemonic strategies with the facilitation of multi-dimensional educational aids (e.g., visual, auditory). Some of the beneficial aspects of learning with the use of serious games include the elevation of several cognitive skills, which are directly or indirectly implicated in the learning process. Among them are attention and visuo-spatial abilities, memory and motor skills. However, several barriers have been noted that fall into two general categories: a) health issues (e.g., cognitive strain, headaches) and b) psychological issues (e.g., social isolation, emotional disturbances). Since the training

A. Ypsilanti (✉)
South East European Research Center, Thessaloniki, Greece
e-mail: aypsilan@phed.auth.gr

A. B. Vivas
Psychology Department, City College (International Faculty of the University of Sheffield UK),
Sheffield, UK

T. Räisänen · M. Viitala · T. Ijäs
Oulu University of Applied Sciences, Oulu, Finland

D. Ropes
Inholland University of Applied Sciences, Leiden, The Netherlands

conditions are learner-centered and highly determined by the individual, there is increased need for evaluating the learning outcomes using specific success indicators. Examples of games that are designed to facilitate IGL are scarce, while there are no examples of IGL games in most EU countries. The purpose of this paper is to critically evaluate the current literature of theories on learning through serious games in adults and the elderly with reference to the cognitive mechanisms implicated, benefits and barriers in learning using new technologies in different generations. Secondly, this paper reviews the existence of serious games designed to facilitate IGL in Europe, as well as the characteristics of serious games in raising awareness that could be used to facilitate IGL. In doing so, specific focus is placed on the development of success indicators that determine the effectiveness of serious games on raising awareness on IGL.

1 Introduction

Managing the aging workforce in Europe calls for novel innovative measures of knowledge transfer in organizations. Aging diversity in organizations creates potential challenges, particularly for knowledge management, skills update and skills obsolescence. Research indicates that lifelong learning decreases knowledge loss in an organization and promotes effective educational environments (Ropes 2011). Informal learning has become the basis for developing organizations and can be achieved in different ways, including sharing of experiences, interaction and involvement. Intergenerational learning (IGL) involves knowledge building, transfer and innovation between generations within an organization (Ropes 2011).

In this paper IGL is defined as "…an interactive process that takes place between different generations resulting in the acquisition of new knowledge, skills and values." (Ropes 2013, p. 714) IGL in organizations considers that learning is beneficial to both the individual and the organization. Individuals gain new skills and knowledge for improved performance, which in turn adds to organizational capability (Wright, McMahan, and McWilliams 1994). Furthermore, new knowledge important for innovation is built during IGL processes (Baily 2007), also contributing to organizational competitiveness. Examples of IGL are; mentoring programs, mixed-age teams, and training programs specifically aimed at promoting interaction and learning between different age groups.

Several reports show that intergenerational learning is an effective way that people from different ages, learning styles, values and motivations learn together (Garavan and McGuire 2001; Ng and Feldman 2007; Ropes 2013; In this sense, IGL seems like a promising chance for organizations to capitalize on the experiences of the ageing workers as well as, promoting learning and development among other generations.

This paper reviews existing knowledge on serious games designed to facilitate IGL and specifies how these are implemented and whether they are effective in different cultures. In doing so, information is drawn from six EU countries about serious games in an attempt to address two questions: 1) What serious games have been designed to

facilitate IGL and to raise awareness and in what contexts? 2) What has proven effective and why (success indicators)?

1.1 Is learning possible with serious games?

Learning is a cognitive process that implicates numerous abilities. At first glance, learning involves a permanent change of knowledge often built on existing constructs that allows the individual to amplify or alter what s/he already knows (Kimble 1961). In social sciences, learning usually takes the form of communication between teacher and student with a transfer of information between two or more parties. According to the traditional transmission approaches the learner should acquire facts and concepts, by repetitive mnemonic techniques in a systematic fashion Ravitz et al. (2000). Constructivists believe that learning is a prolonged self-directed process, during which the individual adjusts or changes beliefs based on new ideas (Ravitz, Becker, and Wong 2000).

Learning involves several cognitive and affective processes including, attention, memory (e.g., mnemonic strategies), motivation, emotionality and communication (verbal and non-verbal). Moreover, learning can be experiential, leading to a holistic adaptation to the environment, which encompasses broader learning settings and concepts such as creativity, innovation, flexibility and decision-making (Kolb 1984). Central to the concept of learning is the acquisition of new skills and competences, through interactions and engagement in formal, non-formal and informal educational/training settings. According to surveys, informal training constitutes more than two-thirds of workplace learning (Kim et al. 2004).

The educational method employed in a learning environment depends on the learning objectives. From a pedagogical perspective the traditional teacher-student based approach appears to be ineffective and rather passive, compared to more modern learning techniques such as "learning by doing" or "experiential learning" (Aldrich 2005; Pannese and Carlesi 2007).

Serious games refer to the use of computer games in raising awareness about educational topics, and developing new knowledge and skills by enabling learners to engage and participate in situations that would otherwise be impossible to experience (Corti 2006). Although there is no consensus in the definition of serious games, most researchers agree that serious games are designed for training, stimulation and education in virtual environments, with an element of engagement and pre-defined learning objectives (Susi, Johannesson, and Backlund 2007).

Although learning with the use of serious games is similar to traditional learning in several cognitive respects, implicating common processes and mechanisms, there are noted differences in the learning style and structure. Learning with serious games relies more on "trial and error" with minimal instruction, freedom to manipulate the learning conditions (start-end), and a differential role to the trainer being more of a facilitator rather than a knowledge transferor (Hetzner and Pannese 2009). As such, knowledge building encapsulates the notion of entertainment and reflection without the challenge of being evaluated on performance by authorities.

The success of learning using serious games lies in the actual involvement of the player, which in turn, creates increased cognitive links with real-life situations allowing the individual to make relevant associations, to use mnemonic strategies with the facilitation of multi-dimensional educational aids (e.g., visual, auditory) (Gee 2003).

This pedagogical approach promotes engagement, familiarity, and intrinsic learning (i.e., unintentional learning), applicability to work-related situations by transforming the individual from a passive to an active state (de Freitas and Levene 2004; de Freitas and Oliver 2006). Moreover, personal relevancy and content relevancy seem to enhance the learning experience by increasing the levels of motivation and interest to the learner (Bainbridge-Frymier and Shulman 1995).

New technologies have been introduced to our daily activities especially in younger generations thus learning with serious games seems to be a good candidate for training in the workplace.

1.2 Benefits and barriers of game-based learning

In a review, Mitchell and Savill-Smith (2004) discuss the benefits and barriers of using computer and video games for learning. Some of the beneficial aspects of game-based learning include the enhancement of several cognitive skills, directly or indirectly implicated in the learning process, such as attention and working memory. For instance, research has shown that a few hours of training on a video game improves several aspects of attention, such as the ability to effectively allocate attentional resources among different tasks and locations in the search of a target (see Hubert-Wallander, Green, and Bavelier 2010 for a review). Exposure to new technologies and adaptation to new learning environments has been a challenge for older workers although digital games are considered a means for social inclusion (Stewart et al. 2013). Older generations optimize their learning ability by benefiting both from the content of the training as well as from the exposure to new technologies.

However, several barriers have been noted that fall into two general categories: a) health issues (e.g., cognitive strain, headaches) and b) psychological issues (e.g., social isolation, emotional disturbances). Since the training conditions are learner-centered and highly determined by the individual, there is increased need for evaluating the learning outcomes using specific success indicators. Thus, successful implementation of game-based learning includes determining the specific learning objectives and measuring the learning outcomes in a quantitative and qualitative way. For example, in games, which entail levels of difficulty, or the ability to change scenarios, success indicators have to be adapted to measure individual outcome. Some of these success indicators should measure cognitive engagement and motivation, the acquisition of new skills/knowledge (whether learning objectives have been met), usability and perceived applicability.

1.3 Cognitive demands and serious games in older adults

When considering the effectiveness of serious video games to facilitate IGL, some attention must be given to the capacity of older workers to cope with the cognitive demands imposed by these games. A considerable amount of studies support changes on several cognitive processes as part of the aging process. In particular, working memory and attention control or executive functions seem to be most impaired in the older adults (Andrés and Van der Linden 2000; Grady 2012; Hahn and Kramer 1995; McAuliffe, Chasteen, and Pratt 2006). These two processes are important to maintain cognitive flexibility and cope with a demanding environment that requires monitoring and switching among different tasks or sources of information and dealing with

irrelevant and distracting information (e.g., driving a car in a rush hour or unfamiliar environment) (Charness 2008). To our knowledge, there are no studies investigating the beneficial effects of serious games in elderly populations, but studies suggest that training with complex video games may have a beneficial effect on cognitive function of older adults. For instance, an study conducted by Basak, Boot, Voss and Kramer (2008) reported improved performance on tasks that tapped executive functions (e.g., attentional control, working memory) in older adults after training (23.5 h) on a strategy-based-real-time video game. Interestingly, the authors also found a significant positive correlation between game performance (the ability to learn the game) and improvement on cognitive tasks. Thus, attention must paid to the complexity of video games designed for older adults, since the ability of older adults to perform well on these games is directly related to their beneficial effects on cognitive function (Basak et al. 2008).

1.4 Computer-anxiety and technology acceptance in older adults

In recent years, older employees have been introduced to new technological advances, creating a shift from traditional paper and pen use to computerized systems. Although this technological shift has promoted technological literacy in older workers, it has also been perceived as threatening to the individual. Research on cognitive testing using computerized tasks indicated that computer anxiety is more common among older participants compared to younger adults (Laguna 1997) and negatively related to computer attitudes (Broady, Chan, and Caputi 2010). However, computer anxiety does not seem to have an impact on specific cognitive abilities but seems to generally reduce the speed of motor response of older adults (Broady, Chan, and Caputi 2010). Factors like previous experience to computers, self-efficacy, learning styles and computer attitudes contribute to the development of computer anxiety (Worthington & Zhao 1999.

Although computer anxiety has been identified as a potential barrier to computer-based learning in older adults, recent evidence suggests that technological acceptance is similar in younger and older users and that negative stereotypical views about older adults determine their attitudes towards computers (Broady, Chan, and Caputi 2010). Particularly relevant is the question of whether older adults are able to learn using computer interfaces. There is evidence that memory and speed of processing is decreased in older adults (Ypsilanti and Vivas 2011) and that there is a tradeoff in speed and accuracy in performance on computers in older adults (Botwinick 1967). In accordance, there is evidence that older individuals find it more challenging to learn how to use a computer because they tend to forget more and take longer to become proficient users (e.g., Dickinson, Arnott, & Prior, 2007).

Therefore, in order for learning using computer interfaces to be effective, particularly in novice users, it requires longer time requirements, extensive practice (repetition) (Charness, Kelley, Bosman, and Mottram 2001) and positive attitudes towards technology (Mahar, Henderson, and Deane 1997). On the contrary, lack of previous knowledge (Dickinson, Eisma, Gregor, Syme, and Milne 2005), lack of confidence (Marquie, Jourdan-Boddaert, and Huet 2002) and negative stereotypes against older adults using new technologies (Broady et al. 2010) reduce technological acceptance and performance.

1.5 Overview of serious games designed to facilitate IGL in Europe

Desk research was performed on peer-reviewed articles on serious games and IGL using Google Scholar. The search terms that were included were: intergenerational learning, web-based games and IGL, serious games, games for raising awareness, game-based learning. Results included published articles, conference proceedings, and research reports or agency reports by government and private research organizations. All material that referred to childhood recreational and educational games were filtered out. For relevancy purposes this paper reviews IGL game-based training and serious games for raising awareness.

The desk research on games and IGL yielded a few matches to the search terms described in the methodology. Examples of games that facilitate IGL are scarce, while there are no examples of IGL games in most EU countries (e.g., Romania, Finland). For the purposes of the present review, we adopted the CIMO logic (Context-Intervention-Mechanism and Outcome) to address the specific questions described above for presenting games that are being designed and used to facilitate IGL (see Table 1) and games used for raising awareness (see Table 2).

The desk research that was performed for this review on serious games and IGL yielded only a few matches with the search criteria (see the method described above). There are five games that have been developed to facilitate IGL, the toy generations game developed with the SILVER project (in six EU languages) the e-vita games (in six EU languages) and the Game Project e-treasure developed in the Netherlands (in Dutch and English). Both games have incorporated learning methods that facilitate knowledge-exchange between younger and older generations. For example, the e-vita games involve single players in role-playing, which facilitates experiential learning in realistic scenarios. The e-treasure game facilitates learning through four-player interactions and knowledge exchange but not in an organizational setting.

There are also numerous serious games in EU countries that have been developed to raise awareness on issues like health and environment (Table 2).

One of the key questions of this review was whether these games have proven to be effective and why. Based on our desk research, success indicators are scarce in serious game design and implementation. Although in some cases there is a brief questionnaire that assesses the player's learning, or the game's effectiveness, there are no reported results of these questionnaires that would provide some indication as to whether the games have short-term or long-term impact on the learner, the organization and on society. Naturally, this would be difficult to assess, particularly since there are numerous factors that affect learning and behavior modification. However, in this paper we support the need for further follow-up of serious games in terms of effectiveness and success indicators. As such, there is clearly a need to develop ways that determine measurable outcomes in game design and implementation and allow for generalization of findings to raising public awareness.

Real-life simulation has been challenging for game designers; however, in order to use serious games to facilitate learning in educational, organizational and social settings we need to develop success indicators to assess their effectiveness, compared to other traditional learning methods. Importance must also be placed on establishing the specific goals of each game, be it to raise awareness, to change attitudes, to alter behavior, or to educate. In this context, Shaffer (2006) proposes the concept of

Table 1 Summary of games designed to facilitate IGL in European countries

Name	Country of origin	Language	Context	Intervention	Mechanism	Outcome
Toy Genera-tions (Silver Project)	Netherlands Finland Greece Romania Germany Scotland	Dutch Finnish Greek Romanian German English	To experience IGL in the workplace environment through taking different roles as a younger worker with creativity and technology awareness and as an older worker that has more experience but less innovation	The player takes a role of a younger and an older worker in a factory of building toys	Web-based role-playing game in a workplace environment	Facilitates and raises awareness of IGL through experiencing working with different generations
East and West Block (e-vita)	Germany UK Greece Portugal Spain Poland	German English Greek Portuguese Spanish Polish	To create a learning experience that promotes self-reflection	The player is narrated through travelling abroad	Narrative-based game (story-telling)	Facilitates knowledge transfer and IGL and increases European cultural awareness
Tourism (e-vita)	Germany UK Greece Portugal Spain Poland	German English Greek Portuguese Spanish Polish	Hosting a tourist in your country	The player is transferred to a state, faced by a narrator and hosts a tourist	Experiential game	Increases European cultural awareness and knowledge on IGL
Working (e-vita)	Germany UK Greece Portugal Spain Poland	German English Greek Portuguese Spanish Polish	Working abroad	The player takes the role of a person working abroad	Puzzle-based game (problem solving	Facilitates knowledge transfer and IGL and makes the player confront him/herself in a different culture
Recreation (e-vita)	Germany UK Greece Portugal Spain Poland	German English Greek Portuguese Spanish Polish	Living in previous generations (50's and 60's)	The player is required to entertain other people without the use of	Exploratory game	Increases the zone of proximal development (Vygotsky) and awareness on IGL

Table 1 (continued)

Name	Country of origin	Language	Context	Intervention	Mechanism	Outcome
				technology (e.g., internet)		
'De Grote Teletijdsh-ow'	Netherlands	Dutch, English	Promote IGL and stimulate inclusion and learning. Also helps older people gain digital competence	Four-player game (grandparents-grandchildren)	Uses Wii control as a medium for knowledge exchange and knowledge development. Wii helps with motor development and familiarity with new technology	Raises awareness about IGL (between older/elderly persons and younger persons) but not in an organizational setting

Table 2 Summary of games used to raise awareness in European countries[1]

Name	Country of origin	Language	Context	Intervention	Mechanism	Outcome
Emergency 2012	Germany	German	Managing rescue efforts during an emergency situation	The player acts as the emergency dispatcher or officer	Role-taking in realistic scenarios	Raise awareness on how to act in emergency situations
Unknown name, used at naturschutzzentrum Karlsruhe	Germany	German	Used by visitors to the Naturschutzzentrum Karlsruhe	Using a joystick, the player controls the height of the flood	Simulation/ Role-taking	Raise awareness of the dangers of a flood disaster
FloodSim	UK	English	Dealing with random weather conditions across 3 years, developed for public use	The player takes the role of a flood policy strategist	Simulation	Raise awareness on issues related to flooding
FoodForce	Finland	Finnish	Humanitarian crisis in a fictional island driven by drought and war	Six virtual missions that reflect real-life obstacles in emergency situations around the world	Rehearse, thinking	Raise awareness about world disasters
Galactor game	Finland	Finnish	Security risks about internet and the mobile world	The player interacts with "friends" as they shop online	Problem solving	Raise awareness on internet shopping
Ilmastopeli (Climate Game)	Finland	Finnish	Climate change	Super-Mario 'Bros- Like' game	Thinking, problem solving	Raise awareness to climate change
Riskipeli	Finland	Finnish	Risk of chemicals	Card-game	Thinking	Raise awareness about the risk of chemical use
Eenrgiasummaaja	Finland	Finnish	Food/ healthy dieting	The player selects food to eat and sees how it affects him	Thinking	Raise awareness about healthy eating habits

Table 2 (continued)

Name	Country of origin	Language	Context	Intervention	Mechanism	Outcome
Petra's planet (by Ludocraft)	Finland	Finnish	Explore different cultures	The player understands how different cultures behave	Reflect, thinking	Raise awareness on cultural differences
The Great Flu	Netherlands	English	To educate the public about the dangers of and difficulty in containing flu pandemics	Single-player game acts as the head of the World Pandemic Control during the outbreak of an unknown flu	Thinking, problem solving	To raise awareness about flu pandemics
The World Water	Netherlands	English	To promote the importance of water management	Multiple players become World Water Managers	Thinking, problem-solving, role-playing, collaboration, attitude and behavioral changes take place	To raise awareness about the importance of water management in a complex environment. No success indicators available
Zorgcontinuiteit	Netherlands	Dutch	To promote workers' safety within the organization	Single player is trained by using different scenarios	Thinking in scenarios and real-life situations. Force decision making	To raise awareness and create a certain level of knowledge about safety in each employee in the institution

[1] Note that this is not an exhaustive list of all the existing games for raising awareness in European countries

"transfer" to discuss the ways students use the experience of games to deal with situations outside the learning environment (Shaffer 2006, p. 224). Griffiths and Guile (1999) propose that the "transferring issue" could be resolved by using an educational system based on reflection and debate to identify ways that facilitate and transfer learning to new settings.

2 Researching success indicators

Based on presented research on the cognitive demands of the aging population including research on technological anxiety (see above sections 1.1.1 & 1.1.2) we have developed a list of issues that should be considered when designing a serious game to facilitate IGL.

- Serious games are more effective when they are personally relevant since they enhance learning associations.
- Serious games with realistic context/situations facilitate learning.
- Engagement can be increased with the use of vivid graphics, and bottom-up features (e.g., pop-up features) to attract and maintain attention on relevant to aspects of the game.
- Care should be taken to ensure easy access, with minimal requirements for installation and play (not having many technical requirements).
- Basic instructions should be included (a tutorial if necessary).
- Serious games should entail knowledge transfer; therefore they should have an informative aspect.
- Specific goals and expected outcomes assist in the successful development and effective impact.
- Serious games should have clear and measurable success indicators (long-term and short-term).
- There is need to provide feedback to the player to adjust the level of difficulty (neither too hard nor too easy) to the player in order to increase motivation and maximize engagement.
- The attentional demands of the games may need to be adjusted to the age of the players.

2.1 Measuring the effectiveness on game-based learning in adults

In order to measure the effectiveness of game-based learning in younger and older adults, research indicates that usability, sustainability and user-satisfaction assess inner-state effectiveness of software (McNamara and Kirakowski 2008). In addition, affective evaluations of an object/person have repeatedly been reported to implicitly influence and even shape one's perception and attitudes regarding that object. According to consumer, cognitive and social psychology, research has shown that most existing measures of software usability lack the affective assessment element, which seems vital to its effectiveness (Fenske and Raymond 2006; Millar & Tesser 1990).

Measuring effectiveness from the perspective of the organization is central to the concept of training in the workplace. Since informal learning (such as IGL) constitutes a large part of work-based learning, it seems plausible to measure the effectiveness of game-based learning in organizations. The use of serious games in training in organizations is less common; however, if effective, it may provide an alternating means of on-the-job training in a more interesting and engaging manner compared to traditional learning methods. As such, examining the effectiveness of game-based learning in organizations may prove to be beneficial for the learner and the organization. A central issue for the effectiveness of game-based learning is whether it can increase productivity and task performance. Such indicators are scarce in the literature, although increasingly valuable for the adaptation of one learning technique over another (e.g., selecting traditional seminar-like training as opposed to game-based training). If effectiveness, efficiency and user satisfaction are positively related it makes sense to measure only one dimension (Vuolle et al. 2008). However, it has been suggested that there are subjective and objective productivity measures in the workplace that determine the impact of training on employees. Even the relevance of academic studies to the actual work environment has been difficult to evaluate (Griffiths and Guile 1999) let alone the impact of learning with serious games in organizations. These indicators include the perceived productivity impact of the employee (self-assessment) as well as quantitative indicators of the organization's productivity.

Ropes (2011) discussed the impact of 'communities of practice' at an individual and group level. A main success indicator at an individual level is critical reflective work behavior (Van Woerkom 2003) a concept that highlights the importance of self-reflection in learning. At a group level "group working climate" and "team orientation" are good indicators of effectiveness of learning in the workplace (Ropes 2011).

De Freitas and Oliver (2006) propose a model for evaluating the effectiveness of game-based learning in educational settings that is useful for the discussion purposes of this paper. The four-dimensional model includes evaluating the context (e.g., setting, available technical support) as a facilitator or barrier in learning, the attributes of the learners with reference to their age, previous experience and learning style. The third dimension involves the internal representational world highlighting the importance of briefing and debriefing and finally the fourth dimension involves the process of learning (e.g., experiential). In designing or selecting a serious game for learning IGL processes it would be beneficial to consider the above dimensions to enhance the learner's ability and transfer of learning.

3 Conclusions

In this paper we report the results of a desk search on serious games designed for IGL, and discussed what factors should be considered when using serious games as a means of informal learning in the workplace. Our desk research showed that there are only a few examples in Europe of serious games designed to facilitate IGL, and these have rarely been implemented in organizations. Given the increase of the aging population in the workplace, we suggest that learning using serious games may be a potential tool to decrease skills obsolesce, and loss of critical knowledge within an organization. Using

serious games that facilitate IGL, could be valuable to knowledge transfer between generations, which is useful for maintaining critical knowledge.

This form of learning has many similarities with more traditional learning methods (e.g., one-to-one teaching), but in addition has several advantages such as the exposure of older workers to new technologies that have some leisure component often limited in traditional learning methods. There is very limited research on the effectiveness on serious games as a learning method in the older ages particularly in work environments. In this paper we propose that some of the crucial factors to consider when using serious games with older adults are the cognitive demands and complexity of the games including factors that influence technology acceptance in older adults.

Finally, we recommend that future research should concentrate on success indicators that can certify that using serious games facilitates IGL. We suggest that some of these indicators should include the affective aspects of using games for learning, and objective measures of the impact on the organization. This is a particularly challenging task because the number of interrelated variables is numerous. We have attempted to disentangle some of these variables particularly relevant to the aging population in the work environment. Future research should focus on how transference of skills learned through serious games can be effectively used at work and how raising awareness can have an impact in the work environment. It is suggested that existing tools and models implemented in other educational settings can work as a starting point to create evaluative frameworks for older workers. These will help to determine successful design, development and implementation of serious games with major emphasis on specifying the goals and expected learning outcomes of the game.

References

Aldrich, C. (2005). *Learning by doing. A comprehensive guide to simulations, computer games, and pedagogy in e-learning and other educational experiences*. New York: Wiley.

Andrés, P., & Van der Linden, M. (2000). Age related differences in supervisory attentional system functions. *Journal of Gerontology: Psychological Sciences, 35*, 373–380.

Baily, C. (2007). Reverse intergenerational learning: A missed opportunity? *AI & SOCIETY, 23*(1), 111–115.

Bainbridge-Frymier, A., & Shulman, G. M. (1995). "What's in it for me?": Increasing content relevance to enhance students' motivation. *Communication Education, 44*, 40–50.

Basak, C., Boot, W. R., Voss, M. W., & Kramer, A. F. (2008). Can training in a real-time strategy videogame attenuate cognitive decline in older adults? *Psychology and Aging, 23*(4), 765–777.

Botwinick, J. (1967). *Cognitive processes in maturity and old age*. New York: Springer.

Broady, T., Chan, A., & Caputi, P. (2010). Comparison of older and younger adults' attitudes towards and abilities with computers: Implications for training and learning. *British Journal of Educational Technology, 41*, 473–485.

Charness, N. (2008). Technology as multiplier effect for an aging work force. In K. W. Schaie & R. Abeles (Eds.), *Social structures and aging individuals: Continuing challenges* (pp. 167–192). New York: Springer.

Charness, N., Kelley, C. L., Bosman, E. A., & Mottram, M. (2001). Word-processing training and retraining: Effects of adult age, experience, and interface. *Psychology and Aging, 16*, 110–127.

Corti, K. (2006). Game-based learning; a serious business application. Available at: http://www.pixelearning. com/docs/seriousgamesbusinessapplications.pdf

De Freitas, S., Levene, M. (2004). An investigation of the use of simulations and video gaming for supporting exploratory learning and developing higher-order cognitive skills. In *Proceedings of the IADIS Cognition and Exploratory Learning in the Digital Age Conference*, Lisbon, Portugal, 12–15 December

De Freitas, S., & Oliver, M. (2006). How can exploratory learning with games and simulations within the curriculum be most effectively evaluated? *Computers & Education, 46*, 249–264.

Dickinson, A., Arnott, J., & Prior, S. (2007). Methods for human-computer interaction research with older people. *Behaviour and Information Technology, 26*, 343–352.

Dickinson, A., Eisma, R., Gregor, P., Syme, A., & Milne, S. (2005). Strategies for teaching older people to use the World Wide Web. *Universal Access in the Information Society, 4*, 3–15.

Fenske, N. J., & Raymond, J. E. (2006). Affective influences of selective attention. *Current Directions in Psychological Science, 15*, 312–316.

Garavan, T., & McGuire, D. (2001). Competencies and workplace learning: some reflections on the rhetoric and the reality. *Journal of Workplace Learning, 13*(4), 144–163.

Gee, J. P. (2003). What video games have to teach us about learning and literacy. *ACM Computers in Entertainment, 1*(1), 1–4.

Grady, C. (2012). The cognitive neuroscience of ageing. *Nature Reviews Neuroscience, 13*, 491–505.

Griffiths, T., & Guile, D. (1999). Pedagogy in work-based contexts. In O. Mortimore (Ed.), *Understanding pedagogy and its impact on learning* (p. 18). London: Paul Chapman Publishing.

Hahn, S., & Kramer, A. F. (1995). Attentional flexibility and aging: You don't need to be 20 years of age to split the beam. *Psychology and Aging, 10*, 597–609.

Hetzner, S., Pannese, L. (2009). E-VITA, life simulations in an intergenerational setting. Available at: http://je-lks.maieutiche.economia.unitn.it/index.php/Je- LKS_EN/article/viewFile/320/302 http://e2012.deepsilver.com/en/emergency-2012/emergency

Hubert-Wallander, B., Green, C. H., & Bavelier, D. (2010). Stretching the limits of visual attention: the case of action video games. Wiley interdisciplinary reviews. *Cognitive Science, 2*, 222–230.

Kim, K., Collins Hagedorn, M., Williamson, J., & Chapman, C. (2004). *Participation in adult education and lifelong learning. U.S. Department of education, national center for education statistics*. Washington: GPO.

Kimble, G. A. (1961). *Hilgard and marquis conditioning and learning*. East Norwalk: Appleton Century Crofts.

Kolb, D. A. (1984). *Experiential learning: experience as a source of learning and development*. Englewood Cliffs: Prentice Hall.

Laguna, K. (1997). Computer anxiety in young and older adults: Implications for human-computer interactions in older populations. *Computers in Human Behavior, 13*, 317–326.

Mahar, D., Henderson, R., & Deane, F. (1997). The effects of computer anxiety, state anxiety, and computer experience on users' performance of computer based tasks. *Personality and Individual Differences, 22*, 683–692.

Marquie, J. C., Jourdan-Boddaert, L., & Huet, N. (2002). Do older adults underestimate their actual computer knowledge? *Behavior and Information Technology, 21*(4), 273–280.

McAuliffe, J., Chasteen, A. L., & Pratt, J. (2006). Object and location-based inhibition of return in younger and older adults. *Psychology and Aging, 21*, 406–410.

McNamara, N., & Kirakowski, J. (2008). Measuring the human element in complex technologies. *International Journal of Technology and Human Interaction, 4*, 1–14.

Millar, M. G., & Tesser, A. (1990). Attitudes and behavior: The cognitive-affective mismatch. *Advances in Consumer Research, 17*, 86–90.

Mitchell, A., Savill-Smith, C. (2004). The use of computer and video games for learning. Available at: http://dera.ioe.ac.uk/5270/1/041529.pdf

Ng, T. W. H., & Feldman, D. C. (2007). Organizational embeddedness and occupational embeddedness across career stages. *Journal of Vocational Behavior, 70*(2), 336–351.

Pannese, L., & Carlesi, M. (2007). Games and learning come together to maximize effectiveness: The challenge of bridging the gap. *British Journal of Educational Technology, 38*, 438–454.

Ravitz, J., Becker, H. J., & Wong, Y. T. (2000). *Constructivist-compatible beliefs and practices among U.S. teachers*. Irvine and University of Minnesota: Center for Research on Information Technology and Organizations University of California.

Ropes, D. (2011). Measuring the impact of communities of practice: a conceptual model. *International Journal of Intellectual Capital, 8*, 94–107.

Ropes, D. (2013). Intergenerational learning in organizations. *European Journal of Training and Development, 37*(8), 713–727.

Shaffer, D. W. (2006). Epistemic frames for epistemic games. *Computers & Education, 46*, 223–234.

Stewart, J., Bleumers, L., Looy, J., Mariën, I., All, A., Schurmans, D., Willaert, K., De Grove, F., Jacobs, A., Misuraca, G. (2013). *The potential of digital games for empowerment and social inclusion of groups at risk of social and economic exclusion: Evidence and opportunity for policy*. Available at: http://ftp.jrc.es/EURdoc/JRC78777.pdf

Susi, T., Johannesson, M., & Backlund, P. (2007). *Serious games – An overview, technical report*. Sweden: School of Humanities and Informatics University of Skoumlvde.

Van Woerkom, M. (2003). *Critical reflection at work: Bridging individual and organisational learning.* Enschede: The Netherlands, Print Partners.

Vuolle, M., Tiainen, M., Kallio, T., Vainio, T., Kulju, M., & Wigelius, H. (2008). Developing a questionnaire for measuring mobile business service experience. Amsterdam: 10th International Conference of human-Computer Interaction. doi:10.1145/1409240.1409247

Wright, P. M., McHanan, G. C., & McWilliams, A. (1994). Human resource and sustained competitive advantage: A resource based perspective. *International Journal of Human Resource Management, 5,* 301–326.

Worthington, V. L. Y., & Zhao, Y. (1999). Existential computer anxiety and changes in computer technology: What past research on computer anxiety has missed? *Journal of Educational Computing Research, 20,* 299–315.

Ypsilanti, A., & Vivas, A. B. (2011). Ognitive ageing in older workers and its impact on lifelong learning. In european centre for the development of vocational training. In *Working and ageing: Guidance and counseling for mature learners.* Thessaloniki: Cedefop.