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SERIOUS GAMES PER PROMUOVERE L'INVECCHIAMENTO SANO E ATTIVO E MONITORARE LA FRAGILITÀ DELL'ANZIANO

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ABSTRACT In our ageing society, game-based learning can play an important role. Ageing turns us into "lifelong learners" and serious games could provide valuable support to improve health, enhance and rehabilitate cognition, promote new skills and promote social inclusion. To date, serious games are promising and accessible tools suitable for promoting healthy and active ageing. The role of developers and trainers is crucial in achieving the set goals. When the target population is elderly there are functional, pedagogical, psychological, and ergonomic aspects to be considered when implementing new games and new technologies. Despite the many difficulties, serious games can and "should" complement existing neuropsychological interventions, offering a more engaging, standardized, and personalized context for training or rehabilitation. The objective of this contribution is to provide a framework for understanding and developing ICT-IoT products for the elderly population so that process pipelines and effectiveness measures can be optimized.

KEYWORDS Serious games; Ageing; Frailty; Prevention; Health.

SOMMARIO Nella nostra società che invecchia, l'apprendimento "game-based" può assumere un ruolo importante. Invecchiare ci trasforma in "studenti a vita" i serious games potrebbero fornire un valido supporto per migliorare la salute, potenziare e riabilitare la cognizione, promuovere nuovi sapere/saper fare e favorire l'inclusione sociale. Ad oggi, i serious games sono strumenti promettenti ed accessibili, adatti a promuovere un invecchiamento sano e attivo. Il ruolo degli sviluppatori e dei formatori è cruciale per il raggiungimento degli

obiettivi prefissati. Quando la popolazione target è quella anziana, infatti, vi sono aspetti funzionali, pedagogici, psicologici ed ergonomici da considerare in fase di implementazione di nuovi giochi e nella realizzazione delle nuove tecnologie. Nonostante le molte difficoltà, i serious games possono e "dovrebbero" integrare gli interventi neuropsicologici già esistenti, offrendo un contesto più coinvolgente, standardizzato e personalizzato per l'allenamento o la riabilitazione. Si propone in questo contributo una cornice di riferimento per la comprensione e lo sviluppo di prodotti ICT-IoT nella popolazione anziana così da ottimizzare le pipeline di processo e le misure di efficacia di questi utili strumenti.

PAROLE CHIAVE Serious Games; Invecchiamento; Fragilità; Prevenzione; Salute.

1. INTRODUCTION

In ageing societies, *learning* plays a crucial role in addressing many of the critical challenges and opportunities, such as upgrading and updating skills in the knowledge-based information society, encouraging the intergenerational exchange of knowledge and experience, increased social and health care expenditures, and older people's participation and contribution to the economy (Ogg, 2021; Ahmad et al., 2022).

Within this context, it is increasingly important to consider learning more broadly and not just to look at formal learning institutions. Indeed, there are also non-formal ways of learning, on your own or in collaboration with other people (Villar & Celdrán, 2013). Precisely, a non-formal learning program is the result of a planned, organized, and systematic effort to improve skills and abilities. The activities are not usually interconnected systematically and age-graded, and they are not often held outside of recognized educational institutions (Villar & Celdrán, 2013). Non-formal learning becomes more prominent in ageing societies, while at the same time information and communications technology (ICT) has an expanding impact. Both in its own right and as an educational method in an era of knowledge, ICT plays a big role in developing learning opportunities for older people.

ICT has an important role to play in developing learning opportunities for older people both as a subject in its own right and as a means of learning in the knowledge society. By using ICT, individualised learning can be provided, disabilities can be compensated for, and new opportunities can be opened for information and services. While it can be beneficial, ICT is not always user-friendly for older users who may have physical limitations and low ICT literacy, depending on the tools and approaches used (Marston, Genoe, Freeman, Kulczycki, & Musselwhite, 2019).

Playing brings in crucial elements to learn new things (Corbeil, 1999; Anolli & Mantovani, 2011; Antonacci, 2012; Cera, 2009). *Game-Based Learning* refers to learning achieved through the use of games or video games, which may sometimes start as entertainment tools but are then used, with or without modification, to achieve an educational goal. The word “empathy” is perhaps the key to it all.

To support these processes, *gamification* comes into play, i.e. the set of game mechanics and dynamics whose primary objective is to maintain the user's interest and, therefore, involvement. In essence, certain game mechanics are applied for which the player feels motivated to continue.

Serious Games are digital games in which learning, in its various forms (expanding knowledge/skills, promoting physical activity, fostering social interaction, simulating real-life contexts), is the main objective. and not just entertainment. They are digital tools intentionally conceived, designed and developed for training on specific skills.

Generally, serious games are training tools, and ideally, the serious and playful aspects are balanced. The focus is on creating an effective and enjoyable learning experience, while the genre, technology, medium and audience vary.

The fundamental aim is to develop skills and competencies that can be applied in the real world, through practice in a simulated and protected environment. Their effectiveness in promoting active learning of essential 21st-century skills is widely acknowledged at a scientific level (Romero, Usart, & Ott, 2014; Zhang et al., 2021).

The role of the player within a serious game is that of an active player, able to interact with the surrounding environment thanks to interactivity, a typical feature of educational games. The game allows the user to learn from his/her experiences and modify his/her way of acting accordingly (learn to know, learn, how, learn to do). Feedback and motivation are two crucial elements in the design. Serious games are therefore engaging, effective and suitable tools for promoting guided learning and training processes (Trinchero, 2014). Through virtual simulation, they enable participants to have precise and accurate experiences. The challenge is to convert the learning needs of the elderly into strong demand for age-recognising serious games (Trinchero, 2014).

Serious Games could also be useful for the maintenance and/or development of social interactions, using interactive gaming activities. This is especially true in cases where an increasingly precarious mobility condition exacerbates the person's social isolation. As is well known, games are an extraordinary means of expression and socialisation. Games provide a unique outlet for expression and socialization, as is well known (Bertolo & Mariani, 2014). Although the play has considerable value, scientific studies in the educational and medical fields have focused largely on it as a childhood activity, ignoring the fact that it can characterize an individual's life at any stage of development (Caillois, 1981; Huizinga, 1946). This reflects the popular conception of the game and the poor dissemination of scientific literature on Game Studies (Juul, 2005; Mäyrä, 2008; McGonigal, 2013). Indeed, play is especially relevant for seniors. It's no secret that active play and fun can have many benefits for older adults, as they can help improve brain function, prevent memory loss, and help relieve stress and depression (Kletzel et al., 2021).

In this article, the reader will be guided through an initial definition of aging and the main theoretical models, paying special attention to the concept of physical and cognitive frailty. A section devoted to learning in old age as a tool for promoting healthy and active aging follows. The proposal primarily focuses on the conformity of ICT to the third age, the key role of Serious gaming as a catalyst for interventions aimed at psychological well-being and health promotion according to a biopsychosocial model (Borrell-Carrió, Suchman, & Epstein, 2004; Pinheiro et al., 2019), as well as fostering social inclusion and relationships among individuals. The final section discusses the growing importance of Serious Games as diagnostic, monitoring, and rehabilitation tools in clinical settings.

2. ACTIVE AND HEALTHY AGEING VERSUS FRAILTY IN THE ELDERLY

The population of the European region has the highest average age in the world, and the population of many European countries enjoys one of the highest life expectancies in the world (Liotta et al., 2018; Palermo, 2020). With the increased life expectancy, more people are living beyond the age of 65 and into very old age, increasing the number of older people considerably. By 2050, it is expected that more than a quarter (27%) of the population will be 65 or older (United Nations, 2019; Eurostat, 2020). However, the increase in longevity is uneven, and the gaps within - and between countries - in the European Region continue to increase.

There is great uncertainty regarding the future development of the health and functional status of older populations, even though many people are living longer and healthier lives. The situation calls for public health policies that

will enable more people to remain active and participate fully in society. Also, chronically ill or frail individuals require appropriate support and protection (Morese, Palermo, Defedele, Nervo, & Borraccino, 2019; Palermo, 2021).

There are many dimensions to the individual, including physical, cognitive, biological, psychological, economic, spiritual and social. Age brings a reduction (sometimes physiological, sometimes not) in the functional reserves of organs and apparatuses, which exposes the individual to a higher risk of disease and functional loss. "Frailty" occurs when an organism is exposed to an unstable balance when exposed to negative events (Palermo, 2021). As a result of multiple variables that increase the likelihood of adverse health outcomes, frailty is a dynamic state where an individual loses function in one or more domains (Gobbens, van Assen, Luijkx, Wijnen-Sponselee, & Schols, 2010). In this syndrome, functional reserves and resistance to stress are diminished, resulting from the gradual decline of multiple physiological systems resulting in multiple morbidities, disabilities, risk of institutionalization, and mortality (Fried, Ferrucci, Darer, Williamson, & Anderson, 2004).

Detecting the global ageing trend, the WHO in the late 1990s called for a paradigm shift and presented "*healthy and active ageing"* as a process whereby people age and mature while realizing their potential for physical, social, mental well-being and participating fully in society while receiving appropriate care when they need it (World Health Organization, 2002). Essentially, "*healthy and active ageing"* is about optimizing opportunities for health, participation, and security to improve the quality of life as people age. All individuals and population groups are involved and the program aims to extend healthy life expectancy and quality of life for all ageing persons, including frail, disabled and care-dependent elderly (Liotta et al., 2018; Palermo et al., 2020, Palermo, 2021).

In this scenario, lifelong learning in late adulthood deserves more attention in the current discourse of active ageing policies (Narushima, Lui, & Diestelkamp, 2018), while game-based learning can play a major role here, especially in cases where primary caregivers are not able to provide proper and constant care, or when the need arises for people who are not yet frail and dependent but are at risk of becoming frail (Smarr et al., 2014).

As a means to enhance learning and social interaction, serious games could also provide valuable support for the cognitive abilities of older people, improving their learning and social interactions, and fostering inclusion of the elderly increasingly at risk of social exclusion (Villani, Serino, Triberti, & Riva, 2017; Morese et al., 2019).

3. LEARNING AND AGEING WELL

3.1. ICT for elderly learners

As people age, they become *lifelong learners* as a means of keeping their minds active and entertained (Ahmad et al., 2022). Lifelong learning plays an important role in helping older people to remain mentally active and to practice healthy lifestyles (Ahmad et al., 2022).

The knowledge society is marked by the need to utilize ICT to the fullest. Both formal and informal education can be enhanced with the use of ICT, providing effective methods and means for improving knowledge and skills. Moreover, social computing (Pascu, Osimo, Turlea, Ulbrich, Punie, & Burgelman, 2008) and other networked technologies make it possible to share information and collaborate with others in a new way.

The use of ICT can cover different aspects of older people's learning (learn to know, learn how, learn to do), integrating itself well into all dimensions of older people's lives. In its different forms, ICT allows new ways to access and use learning resources, compensating for disabilities and facilitating flexible learning models that

integrate self-directed learning with organized learning in ways that allow the elderly to reflect and process their lives in their way.

The adult learning theory shows that older learners prefer to learn about topics they can apply to their daily lives (Kaufman, 2017; Seah, Kaufman, Sauvé, & Zhang, 2018; Knowles, 1980), and they are willing to use technology when its advantages outweigh the effort and time required to master it (Chang, Kaufman, & Ireland, 2015; Kaufman, 2017; McLaughlin, Gandy, Allaire, & Whitlock, 2012). Moreover, they value games that provide learning objectives and cognitive exercise, as well as the learning experience itself (Nap, de Kort, & IJsselsteijn, 2009; Wang, Lockee & Burton, 2011).

Serious games can be incorporated with personalised learning content to provide older people with an engaging way of learning about the topics they are interested in. Using repetition, positive reinforcement, feedback, and breaking up the content into smaller chunks, these games structure the content to be learned and reinforce learning (Kaufman, Sauvé, Renaud, Sixsmith, & Mortenson, 2016). Furthermore, the serious game can also empower older players, boost their self-esteem, and provide a satisfying "flow" experience (Kaufman et al., 2016).

For this to happen, the educational model for digital literacy of the elderly must be based on a few, but fundamental, considerations. A recent systematic literature review focuses on several effective digital literacy strategies for older adults (Ahmad et al., 2022). In particular, the Authors emphasize the importance of creating instructional designs that cater to the needs and preferences of older adult learners; as well as providing an overview of the factors that influence learning digital technologies among the elderly. Towards this goal, the educational model for digital literacy in the elderly should be based on the following principles (Martinez-Alcalá et al., 2018):

1) *usefulness of learning* (ICT provided knowledge must be truly useful, and therefore it must meet their personal and social needs;
2) *co-operation and collaboration* (for proactive learning, the ICT curriculum must be centred on teamwork, support, cohesion, and interaction);
3) *social inclusion* (knowledge of the internet should allow older adults to use the web to expand communication channels with their loved ones and friends);
4) *autonomy* (the content should be designed considering the learning styles, interests and expectations of the elderly individual, who must be considered the protagonist and not the passive user of learning

3.2. Serious games for promoting health

Older people generally do not perceive current healthcare interventions as motivating because they often consist of repetitive tasks (Marin, Navarro, & Lawrence, 2011). An opportunity to increase motivation is e-Health, which refers to "*all forms of electronic health care provided over the Internet, ranging from informational, educational and commercial 'products' to direct services offered by professionals, non-professionals, companies or consumers themselves*" (Maheu, Whitten & Allen, 2001, pp. 3-4). E-Health interventions can be highly motivating for older people because they enable them to exercise greater control over their health (Timmer, 2010).

As part of the rehabilitation process, Researchers in the medical field have explored the possibilities of applying different alternative treatments, among which are Serious Games (Bonnechère, 2018; Ortiz-Vigon Uriarte, Garcia-Zapirain, & Garcia-Chimeno, 2015; Rikkers, Lawrence, Hafekost, & Zubrick, 2016). Since computer technology has made impressive leaps in development over the past two decades, which have expanded the capabilities of modern computer equipment and made it easier for people to obtain it. In addition to representing almost every

real process in a virtual simulation, modern game creation technology does so with a high level of graphic and visual representation (Shapoval, García Zapirain, Mendez Zorrilla, & Mugueta-Aguinaga, 2021).

Unquestionably, serious games contribute to a healthier lifestyle and its determinants, especially when it comes to the person's knowledge of health determinants with long-term effects (DeSmet et al., 2014). However, the effects on behaviour are less long-lasting in the absence of effective conditioning (DeSmet et al., 2014; European Commission, 2007). Studies on the effects of serious games on physical performance have likewise been conducted (Lee, Kim J., & Kim K., 2015). The Authors determined that although too little time had passed for measurable physical changes to take place, it still yielded highly positive effects on perceptions of health beliefs, health concerns, reliability, ease of use, and perceived behavioural control (Lee, Kim J., & Kim K., 2015, p.181). Furthermore, it has previously been proven that playing sports games on the Nintendo Wii console can be beneficial for the well-being of older people, especially in lowering loneliness and improving mood (Chesler, McLaren, Klein, & Watson, 2015; Kahlbaugh, Sperandio, Carlson, & Hauselt,2011).

Even though the practices prescribed by the treating physician are mandatory and irrefragable in the field of rehabilitation, they can sometimes be perceived as prescriptive-imposition ("*they told me, I did it because it's necessary*"). With the introduction of interactive gaming features, the recovery process can become more meaningful for the patient. While true, it does not always work with certain populations, such as children and the elderly. In both cases, it is important to engage, and the activation process is equally important (Janhunen et al., 2021; Nguyen et al., 2017). Indeed, the more attractive and interesting rehabilitation activities are to a person, the more motivated he or she is to perform them (Howard, 2017). According to these studies, video game-based interventions can assist the elderly in preventing secondary ageing and promoting active ageing. They seem to improve some physical health variables in older adults, for whom ageing-related progressive degeneration in muscle strength and balance control system can lead to motor impairment, disability and falls (Cayley, 2008; Nikolić, Vranid, Arbanas, Cvijanović, & Bajek, 2010).

Despite a lack of research on video game-based interventions as a tool for promoting active ageing, to date, they are promising and accessible.

3.3. Serious games for promoting cognitive enhancement and neurorehabilitation

How can serious games be the present and future of cognitive rehabilitation? For neurorehabilitation to succeed, motivation must be cultivated; it is essential to promote active participation that makes the most of the immense resource that neural plasticity represents for the brain (Taub, Uswatte & Elbert, 2002).

Psychologists and neuropsychologists are increasingly using serious games for rehabilitation because of how they are structured. The appeal of serious games lies in the fact that they are a natural method of learning; they are usually used to promote motivation, involvement, and to monitor online the progress of cognitive training exercises. Nowadays serious games are used in clinical contexts to cope with mild cognitive impairment or with subjects with a high risk of conversion to Alzheimer's disease, major neurodegeneration, acquired brain injuries or vascular cognitive dysfunction, as well as to promote tolerance and resilience in patients with specific tasks (Kwok, Clark, & Pua, 2015; Soanclat Aguilar, Lamoth, Maurits, & Roerdink, 2018; Zhang & Kaufman, 2016).

Serious games can be implemented in the screening phase in place of the classic "paper-pencil neuropsychological tests" because the latter are time-consuming, expensive and require the involvement of many trained professionals.

New technologies, therefore, allow for the development of faster, easier to use measurements. By providing controlled testing conditions, they can also reduce data processing time (Zucchella et al., 2014).

There is also strong empirical evidence that serious games have beneficial effects on cognitive functioning in neurorehabilitation contexts, in particular, acting directly and specifically on selective attention, language, memory and decision-making skills. Functional use also allows the maintenance of healthy brain function by limiting the decline of cognitive function necessary to perform everyday activities in elderly adults with dementia or neuropsychological issues, providing possibilities for continuous monitoring and expanding the possibilities in "telerehab" and "telemedicine" (Tziraki, Berenbaum, Gross, Abikhzer, & Ben-David, 2017).

It is not uncommon to see serious games also as protagonists in those contexts where cognitive enhancement training is required, or even specifically for the elderly to promote active and healthy ageing in non-clinical contexts. Among all serious games, "brain training" games are particularly important in this case. There is widespread consensus that such games are appropriate tools for supporting the cognitive functions and activities in the elderly, including attention, concentration, memory, preparedness, and problem solving (Nouchi et al, 2012). These games' popularity stems from the notion that mental exercise stimulates the brain and can have long-lasting benefits in terms of thinking and reasoning skills, memory, attention and processing speed (Nouchi et al, 2012). However, in most cases, brain training improves performance on the training itself, rather than everyday application (Owen et al., 2010), except for training of working memory (Klingberg, 2010), which supports reasoning and fosters learning. Some differences were related to personal preferences and attitudes (some gamers were more likely to perform repetitive tasks and others more challenging activities), but most of these games were very well received by the target population.

An important aspect to consider is that many different games are listed under the umbrella term "brain training games"; the definition is overly generalized (Parson, 2017).

The games it includes are very diverse not only in the choices of interface and tasks to be solved, but also in the type of learning goals to be achieved, pedagogical paradigms, and underlying mechanics. This makes brain training games range from simple question-and-answer tasks to more complex strategy games, in which the development of an appropriate strategy is the key to achieving the solution.

According to the revised Taxonomy of Educational Objectives (Anderson & Krathwohl, 2001), there are six different levels for cognitive processes (remember, understand, apply, analyse, evaluate, create) and four different types of knowledge (factual, conceptual, procedural and metacognitive). Often brain training games stimulate only remembering, understanding, and applying, while mostly reaching the domains of factual and conceptual knowledge. Other types of serious games (different from brain-training games) instead cover a wider range of cognitive processes and dimensions of knowledge. Therefore, are more suitable to reach higher-order cognitive goals that can be easily transferred to everyday life. The role of trainers is crucial to the achievement of the goals set, and careful customization of educational pathways is essential to also make the most of the potential of games with older people (Al-Mubaid, 2008).

3.4. Serious games for promoting social inclusion

As seen in the previous section, research has addressed the topic of digital and interactive games as tools for rehabilitation or prevention of physical and cognitive decline (Kwok, Clark & Pua, 2015; Soancatl Aguilar, et al., 2018; Zhang & Kaufman, 2016). Enjoyment and usability of non-online digital games have been assessed

(Marston, Greenlay, & van Hoof, 2013), as well as the effects of these types of games on physical activity, sense of loneliness, and mood in the elderly (Kahlbaugh et al., 2011).

The number of older adults using digital games has steadily increased since 2004 (Villani et al., 2017). Studies on online socialization of older adults can be found, although not related to online gaming (Blit-Cohen & Litwin, 2004; Kanayama, 2003; Pfeil, Zaphiris & Wilson, 2009; Xie, 2008). Digital games promote socialization primary because the elderly have more topics of conversation and opportunities to experience a relationship albeit remotely. Moreover, digital games can implement social networking of knowledge and intergenerational communication (when seniors play with grandchildren or young people) (Villani et al., 2017).

There is a call from the research community to create serious games that address well-being and fun needs in older adults (Villani et al., 2017).

As well as supporting access and methods for organised learning, ICT can also facilitate communities for ICT users to participate, collaborate and share ideas. As a result of all these avenues, the elderly have the opportunity to act both as learners and as teachers in areas of their interest, and to form informal networks of older and younger people with similar interests. ICT users are also able to participate in and create communities and develop innovative new connections through social computing applications (Pascu et al., 2008).

As depression and social isolation are risk factors that double the risk of dementia (Ownby, Crocco, Acevedo, John, & Loewenstein, 2006) and death (Holt-Lunstad, Smith, & Layton, 2010) in older adults, the positive effects of video games on negative affect and social health are of particular importance. Playing video games has been shown to enhance social interaction, reduce loneliness, improve mood, and promote a sense of accomplishment (Kahlbaugh et al., 2011; Vázquez et al., 2018). Nevertheless, it is unknown if playing video games has the same mood enhancement and social participation benefits as non-virtual social participation. Future research into social health would greatly benefit the field.

4. SERIOUS GAMES AS CLINICAL ASSESSMENT TOOLS

In clinical practice and research, functional, BioMed, and neuropsychological assessments are essential for: assessing the global profile of patients, making differential diagnoses, monitoring the progression of diseases, and verifying the beneficial impact of interventions.

In this panorama, the first challenge of the experts was to find a set of methodologies and tools able to evaluate the learning obtained through serious games, considering both the playful dimension and the educational impact. To design more effective and efficient serious games, one has to:

1) evaluate the learning results obtained through playing;
2) identify which of them is most appropriate for a given objective (learn, learn how, learn how to do) or domain (functional, behavioural, cognitive);
3) provide feedback or customize the game in a manner that is tailored to the player's performance, to ensure motivation and learning.

There has been an increase in interest in this area in recent years, leading to an increasing number of software applications to assess, screen, and monitor the elderly to measure their performance in an automated and real-time manner. In recent years, serious games have been focused on assessment methods implemented within the game itself, which provide objective measures of players' performance considering the various phases of training and gameplay, allowing the customization of activities performed according to the performance measured, and providing real-time feedback. Some of the first experiments in this field are represented by CancerSpace (Swarz

et al., 2010), an interactive e-learning tool developed for the healthcare sector and PIXELearning Enterprice game, for the business environment.

In neuropsychology, serious gaming offers the additional advantage of being used and managed independently by players as a cognitive exercise. Therefore, they can be used as a stimulus supplement and continuous evaluation of the older adult players (that it means, training and monitoring), offering valuable information for follow-up by professionals involved in inpatient care (Neto, Cerejeira, & Roquea, 2018).

5. CONCLUSIONS

Working on motivation is fundamental to active and healthy ageing; active participation must be promoted to make the most of the incredible resource that neural plasticity represents for the ageing brain. In this scenario, lifelong learning is gaining recognition as an important means for enhancing personal development and reducing socioeconomic inequalities, which will promote the original aims of the movement for lifelong learning (Villar & Celdrán, 2013). Additionally, promoting practical, application-oriented skills in later life education would enable older people to make a greater contribution to their communities and families (Villar & Celdrán, 2013). Because of the way they are structured, serious games are increasingly used by psychologists and neuropsychologists for functional, behavioural and cognitive enhancement and/or rehabilitation purposes. Their attractiveness lies in the fact that the game is a natural learning method. Indeed, serious games are often used to promote motivation, involvement and allow instant monitoring of the training carried out.

It is increasingly common to use serious games in situations where cognitive training is required, or specifically for the elderly to promote active ageing in daily-living contexts. Serious games are increasingly used in clinical settings to address neurodegenerative disorders, acquired brain injury, functional deficits and cognitive neurodevelopment issues, as well as to foster tolerance and resilience in patients, as well as to foster social relationships, alleviating feelings of isolation and loneliness.

A careful choice among serious games is necessary and should be made both with the specific goals to be met and the specific needs/attitudes of the target population of older adults in mind (Lin, Mao, Tsai, & Chou, 2018).

Considering the needs of older learners is essential in the development of Serious game learning in terms of tools, contents, and methods. Learning content, interactions, and related motivational and emotional factors should be studied. It is beneficial to involve the elderly in the planning of *Game-Based Learning* approaches since they can provide significant insights and also encourage them to participate in these learning opportunities. Using their knowledge and experience in the development of serious games is another way to demonstrate their importance and role in the ICT society (Lin et al., 2018). The future sustainability of ageing societies will likely depend on the view of older people as a resource rather than a burden.

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