Article

Assessing Older Adults' Perspectives on Digital Game-Related Strategies to Foster Active and Healthy Ageing

Francisco Regalado, Cláudia Pedro Ortet, Liliana Vale Costa, Carlos Santos, and Ana Isabel Veloso *

DigiMedia, University of Aveiro, Portugal

* Corresponding author (aiv@ua.pt)

Abstract

The growing use of digital platforms among older adults has brought increased challenges to the design and development process, thus requiring considering age-related needs and changes. Nonetheless, a growing body of research suggests that different types of applications of digital platforms, i.e., digital games, can foster new opportunities to encourage active and healthy ageing (AHA) by promoting knowledge acquisition, developing competences, fostering well-being, and deepening social connections. Therefore, this study aims to assess older adults' perspectives and participation in digital game-related strategies and how these can foster AHA. A mixed-methods approach was applied, resorting to field notes and a questionnaire, involving 18 participants aged between 63 and 81, at the Ageing Lab (Laboratório do Envelhecimento). Through 10 exploratory digital gaming-related sessions over approximately two months, participants were introduced to game-related strategies and online communities. Overall, this study sustained previous research about the influence of digital games and online communities in the promotion of AHA, by encouraging participation in society, acquisition of new digital competences in the dimensions of information and data literacy, communication and collaboration, and safety; and maintaining one's health and well-being. Moreover, findings suggest that continued contact with information and communication technologies stimulates digital proficiency, thus further fostering inclusion in an increasingly digital society.

Issue

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1. Introduction

Information and Communication Technologies (ICT) are essential for disseminating research information and promoting its shareability and socialization. Indeed, ICT can facilitate different generations with information consumption and daily activities, and older age cohorts are no exception. For example, older adults may benefit from learning new competences, cognitive development (Llorente-Barroso et al., 2022; Quan-Haase et al., 2018), and increasing possibilities of keeping in touch with family and friends, including their social relationships using ICT (Urbina et al., 2022)—thus mitigating the negative effects of social isolation (Llorente-Barroso et al., 2021), and promoting active and healthy ageing (AHA; Bousquet et al., 2015).

According to Köttl and Mannheim (2021), the age definition of an older adult when considering the relationship with digital technology varies between 50+ and 70+. The WHO (2015) considers 60 to be the minimum age for this classification, whereas other researchers (e.g., Koivisto & Malik, 2021; Nimrod, 2014; Sharma et al., 2021) refer to older adults as people aged 55 and older. It should be noted that at the age of 50, some of the age-related impairments may start to emerge (Landi et al., 2017; Sengoku, 2020).

Nonetheless, the enormous heterogeneity of older adults and context are often overlooked (Köttl & Mannheim, 2021). Whereas younger older adults (50+) are already starting to use digital technology and close the age gap, older ones (70+) show high percentages of use combined with a great willingness to sustain this behaviour (Kakulla, 2020). Therefore, developing inclusive digital platforms is crucial.

Digital inclusion emerges as a way of mitigating the disparities between those who master ICT (i.e., digital literacy) and those who do not, as happens with a significant part of older adults (Han & Nam, 2021; Reneland-Forsman, 2018). This concept requires equal opportunities for learning about digital technology, not just in terms of skills and qualifications, but also understanding its significance and purpose. In fact, the wide availability and access to digital media do not guarantee an increase in use per se (Loos & Ivan, 2022)—their learning must be guaranteed. This new info-communication period characterized by interconnections, flows, and networks (Castells, 2004), highlights that digital inclusion or exclusion in the social appropriation of ICT tends to affect the emancipation of individuals, social inclusion, and informational competences for learning.

In a digital society, ageing audiences are doubly excluded in terms of access and appropriation. They are often associated with the inability to adapt to new contexts and learning; however, the design of digital artefacts tends to be neither accessible nor suitable for older adults (Zheng et al., 2013). Learning to use the computer and/or the internet is a cognitive competence (Le Deist & Winterton, 2005) and can present further challenges when dealing with age-related cognitive impairments (Steinberg et al., 2013). Nevertheless, older adults having difficulties does not make their educational process unfeasible and it is not a condition for digital exclusion. By encouraging them to use ICT, their cognitive skills, autonomy, involvement in interpersonal relationships, and performance of daily tasks can be stimulated (Zheng et al., 2013), preferably through guided and modular learning (Schlomann et al., 2022).

In the same vein, digital games can foster one's mental capacities, which can make it beneficial to promote older adults' AHA, and in the prevention and treatment of diseases (Rose et al., 2015). In fact, playing digital games may present a way for older adults to increase social connectedness by sustaining networks to current social ties and assisting novel social interactions with online communities (Sauvé et al., 2017; Schell et al., 2015). Specifically, this article gives insights into how game-related sessions (i.e., the use of digital games as a primary instructional tool) can foster AHA and older adults' digital competences (as an integral and consequent part of the cognitive stimulation and well-being).

In the context of this research, a series of 10 exploratory game-related sessions are designed to provide an engaging and immersive learning experience that leverages the motivational and interactive features of games to promote learning and competence development. The researchers recruited a sample of 18 older adults to engage with digital technologies in a computer-based setting—in particular, digital games and online communities. It is expected to have additional knowledge for conceptualizing, designing, and implementing digital games in senior online communities. To do so, a thematic analysis was performed, based on a narrative synthesis, resulting in three major themes to be explored: (1) digital knowledge and competences, (2) player versus player versus bots, and (3) technological peripherals: helpful or a threat?

2. Older Adults in a Digital Society

2.1. Digital Games in Late Adulthood

Playing can be an approach to support older adults to deal with and engage with new digital ICT (Oppl & Stary, 2020). Beyond being an incentive for older adults' participation in exercising, it may also offer therapeutic effects—i.e., older adults start demonstrating changes in behaviour, satisfaction, and interaction, which may provide physical (González-Bernal et al., 2021) and psychological well-being (Rienzo & Cubillos, 2020)—by using technology-assisted learning (Llorente-Barroso et al., 2022), as well as improvement in autonomy (Jahouh et al., 2021).

Digital games are often regarded as attractive and interactive environments that capture players' attention and motivate them by offering challenges that require increasing levels of dexterity and skills (Isbister, 2017). Numerous benefits are potentially brought by digital games, such as motivation for using ICT—e.g., to engage in new gaming and learning activities (Zelinski & Reyes, 2009), and practice healthy behaviours for increased well-being (IJsselsteijn et al., 2007)—ease of learning, development of cognitive competences, stimulation of discovery, the opportunity for experiences, stimulation of socialization—when players are working in teams (i.e., cooperation), or even during the battle between players (i.e., competition)—promotion of motor skills, concentration and reasoning, stimulation of the development of representation and visual attention, critical thinking, and observation (Loos, 2017). In fact, digital games are able to cope with some of the effects of ageing, and to improve the cognitive competences (e.g., memory) of older adults (Damayanti & Ali, 2022; Schell & Kaufman, 2016; Udeozor et al., 2023).

Moreover, digital games tend to assume therapeutic purposes (e.g., cognitive, physical, psychological, and emotional), helping to alleviate pain and providing a sense of well-being, pleasure, and productivity (Allaire et al., 2013)—i.e., it contributes to AHA. Nonetheless, Xu et al. (2020) point out the need for further research on the impact of digital games on social inclusion, interaction, and health in older adults, despite the

existing evidence of their potential for active learning experiences and establishing connections between rules, reward systems, and good practices.

Furthermore, a model for attributing meaning to the game by older adults must present a purpose/value, cultural or educational benefits (e.g., promotion of personal growth and learning), and contribution to society (Nimrod, 2011). Considering that wisdom and experience are part of integrity—according to Erikson's psychosocial development—in adulthood (Malone et al., 2016), digital games should promote activities that reinforce integrity while fostering themes of memory, narrative, and sharing of experiences to allow a retrospection of the lived past.

Games tend to reflect a player's identity since these promote the transition to the outside world and confer expectations of social relations to the virtual scenario (Salen & Zimmerman, 2010), giving rise to senior online communities. Online communities in a game environment have the potential for (Moffatt et al., 2016; Preece, 2000): (a) uniting geographically distributed groups; (b) minimizing the effects of social isolation; (c) establishing relationships in multiplayer games with family and friends; (d) building learning networks; and (e) enhancing the value of social life, identity, and cultural heritage (e.g., language, traditions).

In this context, using digital games in a community can promote and contribute to a better quality of life and well-being. At the same time, the fact that older adults can play with/against other people introduces the aspect of socialization and increases their interpersonal relationships. New relationships can be formed through playing digital games, often perceived by players as a social gathering in an online social environment (Domahidi et al., 2018). The interactions and shared experiences in digital games can create a sense of connection with the community and nurture informational and emotional interactions that promote social connectedness.

2.2. Bridging Senior Online Communities and Digital Games

The evolution of media communication is visible through the creation of online communities, intending to constitute spontaneous social events in electronic networks around common interests, leading to the construction of a complex network of interpersonal relationships. Older adults' digital participation has the potential to minimize social exclusion by reducing loneliness and depression (Koss et al., 2014; Nedeljko et al., 2021). Social connectedness has been defined as the relationship between the self and society, as described by Lee et al. (2001, p. 310):

> People with high connectedness tend to feel very close with other people, easily identify with others, perceive others as friendly and approachable, and participate in social groups and activities….People

with low connectedness tend to feel interpersonally distant from other people and from the world at large.

Additionally, the main motivations of individuals aged over 50 for the use of online social communities are (Kamalpour et al., 2020; Pan, 2018; Vosner et al., 2016): (a) feeling pleasure; (b) interacting with other people and reducing of loneliness; and (c) receiving social support, which consequently reduces anxiety.

When combining senior online communities with digital games, a new hybrid medium emerges (i.e., social digital games). According to Juul (2010), it can be defined as a game where social connections have an additional dimension, by enabling an understanding of other players' goals, prioritizing social interactions, and sharing a common intentionality that gives a new social meaning to actions. In addition to complementarily sharing all the benefits of the media that are at its origin and being able to promote AHA—by deeply strengthening social ties, fostering participation, and promoting one's well-being—multiple studies (e.g., Lin & Chuang, 2019; Wang et al., 2011) have shown that competence acquisition is something that can be highly stimulated in these contexts.

3. Context and Methodology

This research study was developed and conducted with the main purpose of engaging older adults and assessing their perspectives on the multiple media assumed by ICT—specifically, digital game-related strategies, and senior online communities to foster AHA. It occurred between 3 October 2022 and 5 December 2022, over 10 exploratory digital game-related sessions, at the Ageing Lab (Laboratório do Envelhecimento).

A mixed methods approach was followed, enabling us to explore more complex phenomena in detail. This approach allows for an in-depth exploration of findings, starting from qualitative information that is complemented by quantitative data. The following sections describe a demographic characterization of the participants, the privacy and data protection measures taken, the data collection instruments, the design and research aims of the sessions, followed by its analysis strategy.

3.1. Recruitment and Privacy Matters

Participants were recruited voluntarily from the Ageing Lab, through a partnership with the University of Aveiro. Although the number of participants in all sessions was not uniform (Table 1)—as unforeseen events could occur to them—the same group of participants attended every session throughout the two months, with an average of 18 participants per session, and a total of 27 individual participants. The average age is 74 (Minimum = 63; Maximum = 81; SD = 5,15), and 83% (n = 15) are women. Moreover, all participants have

shown great difficulties and low familiarity with using digital technologies—including using computers, smartphones, and digital games.

Before starting the sessions, all participants signed an informed consent form stating that their participation was voluntary, agreeing to the collection of data through anonymized field notes, questionnaires, and photographs. Additionally, the possibility of withdrawing from the study at any time was reinforced, as well as their rights based on the General Data Protection Regulation (EU) 2016/679, and the Portuguese National Law 58/2019. Internally, to ensure this anonymity, information that could identify a user was not collected through the field notes and the questionnaire, limiting it to the strictly necessary, thus following a principle of data minimization; and photographs were captured without identifying the participants or anonymization techniques were applied and the original files were deleted.

3.2. Data Collection Instruments

Field notes were used to collect data, without requiring input from participants—which often causes biases—during the observation moment, or in a post-session reflection moment. These notes focused on difficulties, feedback, and observations during interaction, as well as the number of participants, and recorded quotes to illustrate interactions.

At the last session, and to complement the data from the researchers' diary, a self-administered questionnaire based on the technology acceptance model (Davis, 1989) and three key areas of the *DigComp 2.2* framework (Vuorikari et al., 2022; i.e., information and data literacy, communication and collaboration, and safety), was applied. The following is the set of questions posed, measured on a 5-point Likert-scale (ranging from *strongly disagree* to *strongly agree*):

Q1: Being able to use digital technologies and games is very useful, as it enables new learning moments (example: new places, people, news, knowledge, etc.).

Q2: Digital technologies and games help me research and obtain information daily.

Q3: Digital technologies and games contribute to improve my quality of life.

Q4: I started using more digital technologies and games to interact with friends, family, etc.

Q5: Digital games help me use the keyboard more easily (e.g., it is easier for me to find the letters, or I type faster).

Q6: Digital games help me to use the mouse more easily.

Q7: Playing digital games helps lessen my fear of damaging the technology or causing harm.

Q8: I gained curiosity to try new digital technologies and games in the future.

In the end, an open field for additional comments was provided, allowing more personal and complete views and opinions to be shared.

More specifically, regarding the questions based on the *DigComp 2.2* framework, Q1 and Q2 are included within the area of information and data literacy since it includes searching and processing information; Q3 is related to the area of security, focusing on protecting health and well-being; and Q4 is in the area communication and collaboration, as it assesses interpersonal interaction through digital technologies. The remaining questions are designed based on the technology acceptance model questionnaire. In the end, an open field for additional comments was provided, allowing more personal and complete views and opinions to be shared.

3.3. Designing Digital Game-Related Sessions

For two months—between 3 October 2022 and 5 December 2022—a set of 10 game-related sessions were iteratively designed and conducted in a computer-based setting, at the Ageing Lab. The rationale for only using computers during the sessions is that most participants did not have other digital devices, thus researchers provided them with equipment—a computer is still one of the most commonly owned digital devices (e.g., Salmon et al., 2017). Every week, two groups of older adults were divided into sessions of one hour each, encouraging the use of ICT through the computer and its peripherals (i.e., mouse, keyboard, and monitor), and familiarization with game-related strategies and online communities. In the context of this study, game-based sessions refer to the use of digital games as a tool to engage and immerse participants in activities and experiences to further promote the acquisition of knowledge and skills. The hardware used consisted of three Mac Mini (running MacOS), one Lenovo laptop (running Windows), four mice, and three keyboards. It is important to note that since these sessions are designed with web-based games, the operating system of the computers does not influence the interaction. Moreover, two researchers were always present, ensuring their correct operation. Table 1 presents the activities and research aims carried out in the aforementioned sessions.

3.4. Data Analysis

The analysis of quantitative data was performed using IBM SPSS Statistics (version 29.0.0.0), dividing the questionnaire responses into variables. Field notes were analyzed iteratively, allowing the design and development of the game-related sessions to be based on the feedback

Table 1. Description and research aims of the 10 game-related sessions carried out at the Ageing Lab between 3 October 2022 and 5 December 2022.

Session	Description	Research aims
(1) Research introduction and onboarding 3 October Number of participants: 19	Brief presentation of the participants and involved researchers. Introduction to game-related sessions. Participants were given complete freedom to play any game they wished.	The goal of this session was to introduce participants to the sessions' model and assess their game preferences regarding types, mechanics, and genres.
(2) Charades: Analog and digital platforms 10 October Number of participants: 15	A charades session was designed based on the *DigComp 2.2* framework and familiar games for older adults. Participants played in groups, with one person guessing a word based on descriptions provided by the others. The guesser was placed behind a screen.	The goal of this session was to assess participants' familiarity with the concepts discussed and their strategies for describing them.
(3) Player versus player 17 October Number of participants: 23	Based on the selections made in the first session, and the available online games, this session intended to have an online competition. For this, Tic Tac Toe and 4-in-a-row were used.	The goal of this session was to familiarize participants with the possibility of playing against each other online and help them realize that this could occur between them.
(4) Player versus player 2.0 24 October Number of participants: 15	This session was intended to engage players competing against each other online. However, this time the Naval Battle game was selected.	This session, although similar to the previous one, featured different game mechanics and interactions. It aimed to understand the acceptance of a strategic game.
(5) Tetris 28 October Number of participants: 9	In this session, the goal was to introduce a specific game that was very popular in the 1980s: Tetris.	This session aimed to enhance participants' keyboard skills while also evaluating their spatial orientation ability.
(6) Co-designing a quiz game 7 November Number of participants: 18	In a co-design approach, participants collaborated to design a quiz game. They worked in groups and registered questions and answer options in word-processing software.	This session aimed to familiarize participants with word-processing software and information searching, while also encouraging the use of a wider range of keyboard keys.
(7) Testing the co-designed quiz game 14 November Number of participants: 23	Based on the results of the previous session, this one intended to answer the quiz. Therefore, participants had to access/join the miOne online community (http://mione.altice.pt), access the games group, and reply as a comment to the different questions.	The aim was to encourage keyboard use and understand how participants searched for answers while exploring the social aspect of the online community.
(8) and (9) Drawing paths 21 November and 28 November Number of participants: 21 and 16	These sessions focused on playing Node, a game that involves using the mouse to connect dots and form multiple geometric shapes.	These sessions aimed to improve participants' mouse skills and cognitive abilities by providing activities that required precise mouse movements and fine motor skills.
(10) Player versus bots 5 December Number of participants: 16	Revisiting the games played in sessions (3) and (4), participants engaged in new versions that enabled them to compete against bots.	This session aimed to understand the relationship that players establish with an unknown entity that challenges them.

Note: At the end of the sessions, the questionnaire presented in the previous Section 3.2 was applied.

and needs identified. Thematic analysis was performed, based on a narrative synthesis, to better cross-reference all sources of information, and get a deeper and more realistic perspective on the lessons learned from older adults' participation and perspectives.

4. Results

After performing data analysis, and based on the literature that supports this research, the thematic analysis identified three major themes: (a) digital knowledge and competences, (b) player versus player versus bots, and (c) technological peripherals: helpful or a threat? The following sections describe these themes and main findings, while reporting the results of the field notes and applied questionnaire.

4.1. Digital Knowledge and Competences

Digital concepts are not usually part of this sample of older adults' daily vocabulary. Session (2), dedicated to charades on games and digital platforms, informed the thinking and knowledge within the digital world. Older adults showed analogical thinking towards concepts like database and file. Moreover, participants were reluctant to identify "computer virus," "internet," "password," and "social network." The following statements illustrate the aforementioned examples: "file room where all the information is," or "cover where you put the information"; "it erases everything, and it happens on mobile phones too," "we use something to communicate, but

sometimes we don't have it," "we can't give it to anyone and we must remember it," and "a lot of people come together in a space, in a network that is about people—we all live in a group," respectively. Additionally, considering the questionnaire responses (cf. Figure 1), Q1 shows a positive feeling towards learning more about digital technologies (15 totally agree and 3 agree); and most of them use it as a way to obtain information daily (Q2; 10 totally agree, 7 agree, and 1 neutral).

During sessions (6) and (7), participants reported the ease of word processing and editing while co-designing and testing a quiz game. Participants searched for information to support their own questions or answer those of others, leading to positive feedback on stimulating memory and creative thinking. These results are corroborated by Q3, where respondents stated that digital technologies and games contribute to improving their quality of life (16 totally agree and 2 agree).

4.2. Player Versus Player Versus Bots

The possibility to compete in online games was familiar to most participants. Although not all had experienced it, many had seen their grandchildren doing it. Sessions (3) and (4) changed that by challenging peer confrontation and placing participants in control of the interaction. Resorting to the used games, positive feedback was received, namely: (a) participants who claimed they wouldn't be able to use a computer, learned how to successfully handle the mouse; (b) by mixing elements from previously established groups, active participation
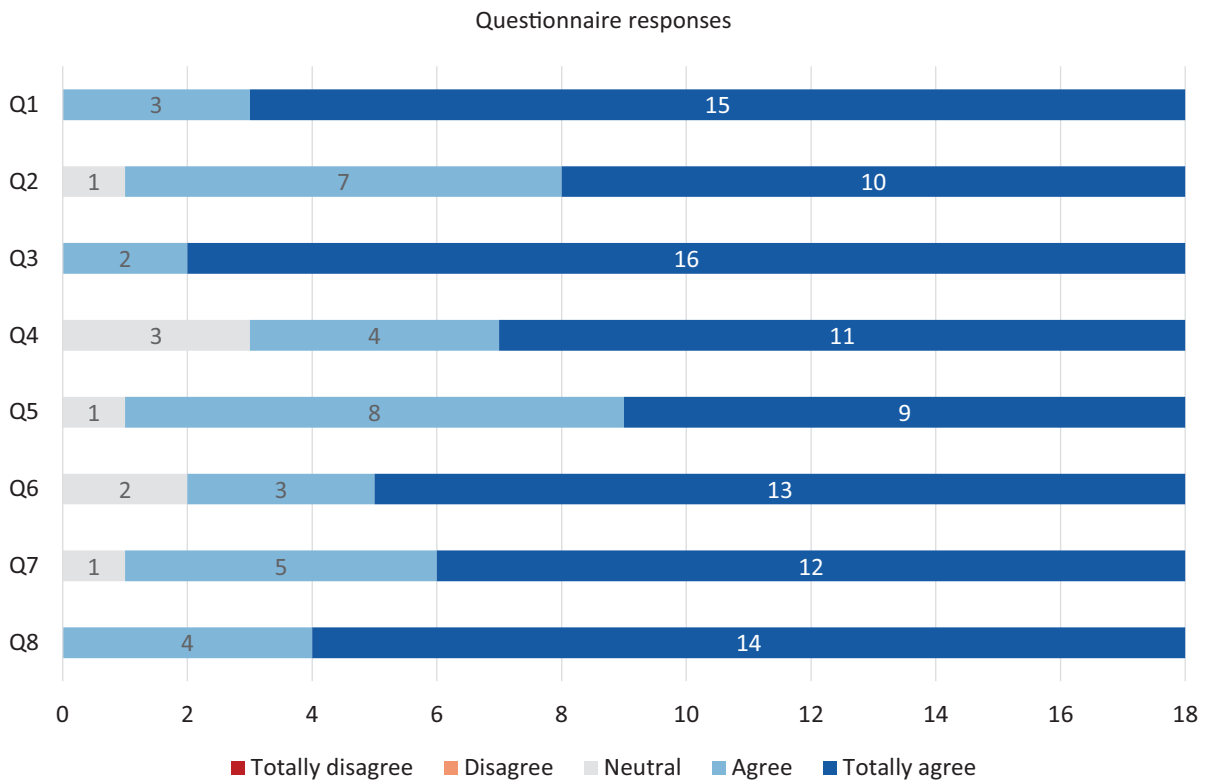
Figure 1. Stacked graph of questionnaire responses (*n* = 18). Note: cf. Section 3.2 for the complete questions.

was encouraged by all participants, increasing the feeling of confidence in digital technologies; and (c) healthy competitiveness emerged, where the different players competed with each other while recognizing it was mentally stimulating.

Moreover, due to the heterogeneity characteristic of older adults—which is also reflected in their relationship with ICT—some participants found the game mechanics and interaction too simple in session (3). Therefore, Naval Battle was introduced in session (4), giving more freedom to explore their abilities, without the frustration of losing a confrontation to another player, as demonstrated in the following quotes: "Look how cool it is, that is gone!" when one of their ships was defeated (Participant 1) and "It's funny, isn't it? It gives you excitement and adrenaline!" (Participant 4, reinforced by Participants 2, 3, 9, 10, 11).

Additionally, the social side related to using digital technologies and games was verified with the questionnaire's Q4, where most participants mentioned they started using more digital platforms to interact with friends and family (11 totally agree, 4 agree, and 3 neutral)

Nonetheless, as mentioned in session (3), a stable internet connection and available players are not always guaranteed. Thus, during session (10), the same games were used, but with bots as the opponent. This provided varying difficulties, making previously simple games (since the game mechanics were already familiar) more challenging. Tic Tac Toe, on the medium level, was not considered challenging enough, whereas four-in-a-row, even at the medium level, proved difficult—participants mentioned: "this game is very difficult" (Participant 9) and another "we are being completely trounced" (Participant 17, reinforced by Participants 4 and 11).

4.3. Technological Peripherals: Helpful or a Threat?

During the 10 planned game-related sessions, participants had the opportunity to interact with some peripherals from the digital world. In session (1) all participants chose games based on mouse interaction—e.g., domino, alphabet soup, solitaire, and checkers—such as clicking and dragging. Given this pattern, some participants believed that every time they had to move the cursor, it was required to keep clicking—which limited movement. Nevertheless, in the following sessions and with the help of their peers, the ease of use of the mouse increased exponentially—cf. Figure 2.

Moreover, with the Node game, sessions (8) and (9) were dedicated to training mouse use, while stimulating cognition through pattern drawing. The following observations were made: (a) participants who in the first session preferred to draw patterns on paper, then gained the confidence to do it directly on the computer; (b) at times participants realized they were doing the wrong path, continued until the end to practice using the mouse; and (c) strategies linked to their daily reality were created (e.g., by assigning street and bridge names to the path lines). Such was confirmed by the noted quotes: "We like those who put up a fight" (Participant 3), "I was saying I didn't know, and now we are already experts" (Participant 9), and "this is really nice" (Participants 4, 7, and 12). These observations are supported by Q6, stating that digital games helped them to use the mouse more easily (13 totally agree, 3 agree, and 2 neutral).

Although participants mentioned that digital games helped them to use the keyboard more easily (Q5; 9 totally agree, 8 agree, and 1 neutral), this was the question that had the least consensual answers. In fact, one participant stated that "I just haven't understood much yet. I'm still learning how to use the keyboard, but I'm on a good track." In addition to sessions (6) and (7), where frequent difficulty was shown in finding letters while writing or in following what was already written, session (5) involved the use of only four keys maximum for playing Tetris. It is worth mentioning that this session is a visible outlier regarding the number of participants ($n = 9$), and therefore the analysis of the results should

Figure 2. Examples of peer-to-peer support during sessions at the Ageing Lab.

be performed with extra caution. However, it can be pointed out that some participants forgot what the keys were for and had to (re)think through the process again while mentioning "this is moving very fast" or "I don't like any of this." Also, a minority of participants were familiar with the keyboard layout and with the spatial dimension of the Tetris pieces after a short time.

These sessions demystified the threat of digital peripherals and improved participants' quality of life through digital technologies and games (Q3; 16 totally agree, 2 agree). Participants also felt less fear of damaging technology (Q7; 12 totally agree, 5 agree, 1 neutral). Moreover, the questionnaire reflected positive feedback, such as "attending these sessions is very enriching. The relationship with peers is very good and the increase in technological knowledge is favourable to our minds," "I really like the new technologies. It helps me to live," and "new technologies help you enter new worlds and diverse areas." Additionally, they expressed an increased curiosity about experimenting with new digital technologies and games in the future (14 totally agree, 4 agree).

5. Discussion

The research conducted within the scope of the game-related sessions at the Ageing Lab allowed further insights into older adults' needs and preferences relative to game-related activities for AHA. It also has paved the way for a broader discussion on designing and developing social digital games for senior online communities, and its ability to impact AHA and digital competences. In particular, the social side was deeply stimulated and encouraged (Domahidi et al., 2018; Llorente-Barroso et al., 2021; Quan-Haase et al., 2018; Schell & Kaufman, 2016; Urbina et al., 2022), as the interaction between participants was highly valued. In fact, the majority reported Allaire et al. (2013) having started to use more digital technologies and games to interact with friends and family. Additionally, some strategies had an impact on or sustained the participants' perception of their health, and quality of life improved with the use of digital technologies and games. These results are in line with previous studies, e.g., Allaire et al. (2013), Martin et al. (2016), and Vosner et al. (2016) that show that digital technologies and games play an important role in increasing individual participation in society and improving one's security—although disparities in the perception of security and in the trust placed in operations related to online commerce and government are still registered (Llorente-Barroso et al., 2023). It is also worth emphasizing that new learning moments were encouraged, and information searching was stimulated—providing individuals with the necessary background knowledge and competences to enable them to participate proactively and safely in their (online) communities.

In fact, from a digital competences perspective, results show that the dimensions of information and data literacy, communication and collaboration, and safety

can be enhanced by game-related technologies. As highlighted by multiple researchers (Caroppo et al., 2017; Pyae et al., 2016; Watters et al., 2006), digital technologies and games, in a seemingly antagonistic way, can help acquire digital competences and mitigate some entry barriers posed by their design or preconceived ideas. In fact, it was possible to observe that older adults use strategies related to their daily lives and from other contexts to describe a reality that is not yet completely familiar to them. Participants showed interest in continuing to use digital media in the future. Through the quiz-building sessions, they improved their information and data literacy by exploring information search and fact-checking when trying to answer questions. This also raised awareness of digital technologies for social well-being and social inclusion, improving safety competence. Additionally, digital technologies and games fostered social interaction among friends and family, as well as close collaboration among peers, promoting communication and collaboration competence. Again, and in a complementarily bilateral approach, a set of digital competences was promoted which is increasingly relevant in today's World while fostering AHA—thus increasing older adults' digital inclusion (Han & Nam, 2021).

Simultaneously, the exploration of collaborative and informed design with older adults was quite well received, showing great involvement from participants, and reinforcing the importance of their involvement in applied research. This strategy has been widely used in several studies with older adults (e.g., da Silva et al., 2021; Kort et al., 2019), allowing them to achieve results that inform the development of digital products that are close to the preferences and needs of the target audience. In addition, close observation of older adults' interaction with digital platforms has allowed the formulation of the following design and development recommendations (complementing previous studies, e.g., Gerling et al., 2012; Machado et al., 2018; Marston, 2012): (a) allow players to play without an internet connection, as the internet can be unstable; (b) have clear instructions on which peripheral to use; (c) present explanatory guiding tutorials before each level—and accessible at any time (e.g., Schlomann et al., 2022); (d) do not use time-sensitive challenges, as it can cause frustration; and (e) allow social contact within and outside games, since it is highly valued by older adults.

Lastly, adding to previous studies (Ferreira & Veloso, 2015; Pappas et al., 2019), although not explicit in *DigComp 2.2*, older adults' ability to use technological devices and their peripherals was also assessed. Without this prior knowledge, reaching more advanced levels of digital competences would be challenging. Thus, despite the observed impairments in fine motor skills, mouse and keyboard usage showed significant improvements throughout sessions. Therefore, continued contact and stimulation of its use proved to be important for greater proficiency and ease of use.

6. Conclusions

This research further extended current knowledge on the relationship between older adults and digital media—in particular, online communities and digital games. Results show the preponderant role of these media in AHA and in stimulating digital competences, which was understood and reaffirmed. Specifically, (a) digital media have the ability to foster AHA in its dimensions of participation, social interaction, and psychological, and social well-being; (b) participants' digital competences in information and data literacy, communication and collaboration, and safety were fostered through engagement in social, research and sharing activities; and (c) continued contact with technological peripherals, such as mouse and keyboard, stimulates digital proficiency for navigating a digital world.

Nonetheless, some limitations should be considered. First, the applied questionnaire has a positive bias in its questions. However, when referring to some examples from *DigComp 2.2* (Lucas et al., 2022) or an example of the *Attitudes Towards Technology Questionnaire* (Zambianchi & Carelli, 2013), it was possible to conclude that it is a cross-sectional practice. In fact, after years of contacting and developing research with the target audience, it was observed that complex sentence structures—which often resort to double negations—were not easily understood, leading to a simplification of the language used. Second, the questionnaire should be applied transversally across the research. Even though great difficulties and unfamiliarity with digital technologies were recorded at the beginning of the study, and the questions were asked to lead to a reflection of the pre- and post-experience, it may lead to a positive bias in the questionnaire results. And third, a convenience sample was used. Thus, caution must be applied when extrapolating these results to other contexts.

Future research should use a larger and more diverse sample of older adults for a confirmatory approach. Additionally, more game-related sessions could be planned, incorporating a wider range of dimensions from *DigComp 2.2* and different strategies to promote AHA, leading to more accurate longitudinal results. Furthermore, due to one of the aforementioned limitations, the developed questionnaire can be applied to several moments of the research. Lastly, and since this study was useful in understanding how digital games may foster older adults' AHA, there is the prospect of integrating these mechanics into the context of senior online communities and potentially expanding the possibility of creating further impact within the physical context.

Conflict of Interests

The authors declare no conflict of interest.

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About the Authors

Francisco Regalado holds a MA in multimedia communication (interactive multimedia) from the University of Aveiro (2021), and a BsC degree in new technologies of communication from the same University (2018). Currently, he is a PhD student in information and communication in digital platforms at the University of Aveiro and the University of Porto, holding a Fundação para a Ciência e Tecnologia PhD scholarship; and research of the IC Senior X project, funded by DigiMedia. His research interests are digital platforms, human-computer interaction, computer-mediated communication, digital games, gamification, and ageing studies.

Cláudia Pedro Ortet is a PhD student of information and communication in digital platforms at the University of Aveiro and the University of Porto with a PhD Research Scholarship from the Fundação para a Ciência e Tecnologia. Holds a MA degree in multimedia communication (interactive multimedia field) and a BsC degree in languages and business relations (Portuguese, English, French, and Chinese). She is currently a researcher of IC Senior X and PLAYMUTATION projects. Her research interests are methodologies, gamification, digital games, digital inclusion, ageing studies, cyclotourism research, gerontechnology, e-Health, and human-computer interaction.

Liliana Vale Costa is equivalent to an assistant researcher at the DigiMedia Research Centre and the University of Aveiro. She holds a European PhD in information and communication in digital platforms at the University of Aveiro and the University of Porto (with an internship at the Disruptive Media Learning Lab, Coventry University). She holds a MA degree in multimedia communication and a BsC in new technologies of communication, both at the University of Aveiro. She is the coordinator of PLAYMUTATION project and researcher of IC Senior X. Her research interests are digital games, intergenerational interactions, transmedia storytelling, and e-Health.

Carlos Santos is an assistant professor at the University of Aveiro, and holds a PhD in information and communication in digital platforms. Since 2016 he is the director of the MA in communication and web technologies at the University of Aveiro. From 2008 to 2015, he was the executive coordinator and lead researcher of the SAPO Labs at the University of Aveiro R&D initiative. Since 2009, he is the coordinator of the Campus by Fundação Altice R&D project (https://campus.altice.pt).

Ana Isabel Veloso is an associated professor at the Department of Communication and Art of the University of Aveiro, in communication sciences and technologies, and a member of the DigiMedia Research Center. She holds a PhD in communication sciences and technologies from the University of Aveiro. Ana has been supervising many MA and PhD students. She has also been the coordinator of several research projects, such as IC Senior X, SEDUCE 2.0, SEDUCE, EYES ON GAMES, and IMP.cubed. Her research interests are video games, gerontechnology, and new media applications for different contexts and publics.