

FOSTERING PLAYFUL LEARNING: ACCESSIBILITY IN EDUCATIONAL GAMES FOR OLDER ADULTS

Mirkka Forssell

*Faculty of Information Technology and
Communication Sciences/ Tampere University
Finland*

ORCID 0000-0001-9262-7684

Markku Turunen

*Faculty of Information Technology and
Communication Sciences/ Tampere University
Finland*

ORCID 0000-0001-7395-0769

Lobna Hassan

*LUT School of Engineering
LUT University
Lahti Finland*

ORCID 0000-0002-6201-9159

Isabella Aura

*Faculty of Information Technology and
Communication Sciences/ Tampere University
Finland*

ORCID 0000-0001-9540-710X

Abstract: *Educational games played on mobile devices can be utilized in teaching older adults to foster motivation, create a competitive spirit, and provide playful experiences within the classroom. There has been little previous research on the accessibility of educational games and the playful experiences of older adults. To identify which features facilitate or create potential barriers, this article offers insights into the educational games Kahoot! and Quizizz, focusing on their perceived accessibility and the playful experiences they provide for older adults. 27 participants participated in four distinct gaming sessions. Data was collected through surveys and observational methods. The results highlight issues related to accessibility, such as the pace of the game and classroom space design, including lighting and the size of the classroom display. While older adults found educational games enjoyable, interesting, and novel, the rapid pace of the games led to frustration.*

Keywords: *accessibility, games, gamification, playful experiences, older adults.*

©2025 Forssell, Turunen, Hassan & Aura, Tampere University, Faculty of Information Technology and Communication Sciences, Finland. LUT University, Lahti, Finland

DOI: <https://doi.org/10.14254/1795-6889.2025.21-2.1>



This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

INTRODUCTION

There has been a global recognition of the increasing population of older adults and the potential benefits of games in enhancing their well-being and cognitive functions. Various memory games played on tablets enhance short-term memory, while puzzle games improve visual and visuospatial abilities, as stated by Canapa, Paterno, and Santoro (2025). Sertel et al. (2025) explored the benefits of virtual intelligence games on cognitive skills, mood, and quality of life in older adults. The study found that playing smartphone-based games significantly enhanced cognitive functions, including memory, attention, numerical processing, and visuospatial skills. These activities also improved mood, alleviated depressive symptoms. Additionally, the findings revealed associations between sociodemographic factors, mental health, independence in daily activities, quality of life, and social participation.

The results highlight the value of incorporating socially engaging elements into geriatric rehabilitation to support older adults' overall well-being. The relationship between games and older adults' interactions and social relationships has been studied. Nakagomi et al. (2025) explored the impact of digital gaming on the health and well-being of older adults. The results indicated increased social interaction, with older adults' participation in hobby groups and meetings with friends showing an increase. However, the research found that games played on computers, mobile phones, smartphones, tablets, and consoles did not significantly enhance general well-being, including happiness, life satisfaction, and physical and mental health.

Educational mobile and VR games have been used to support older adults' learning, both in community college settings, as studied by Forssell et al. (2023), and in leisure activities for older adults, as described by Forssell, Hassan, and Turunen (2024). The significance of examining the accessibility and playful experiences of educational games among older adults is increasingly recognized, particularly as they engage with diverse platforms. The study by Forssell et al. (2023) and Forssell, Hassan, and Turunen (2024) identified both accessibility barriers and a spectrum of positive and negative playful experiences in this context. A systematic review by Liang and Kuo (2025) highlighted that game-based interventions can effectively motivate and engage older adults in the learning process. In order to fully benefit from educational games for older adults and promote their cognitive skills, social interaction, and learning by ensuring that they have enjoyable and accessible gaming experiences, research into the accessibility and playful experiences of educational games with this target group is essential.

Older adults' use of technology is associated with challenges due to aging. However, barriers can also include cultural background, limited IT skills, and fear or uncertainty about the technology being used, as Bahadori et al. (2025) found in their study. The Bahadori et al. (2025) research identified accessibility challenges that hindered older adults' ability to use technology effectively and consistently. Accessibility issues included small font sizes, bulky mobile devices, insufficient internal memory, and the complexity of using smartphones. According to Bahadori et al. (2025), cultural barriers included a lack of cyberspace culture, while societal barriers encompassed the digital divide and poverty. Older adults face insufficient technological knowledge, limited access to technology, and inadequate IT-education. Barriers due to aging included physical and cognitive limitations such as reduced hand dexterity, sensory impairments.

This article presents a study that examines the accessibility and playful experiences of the popular digital educational games Kahoot! and Quizizz among older adult students. Educational games are employed to support teaching in classrooms, and the accessibility of the entire game session must be considered, including factors such as classroom lighting, screen size, and acoustics.

The survey conducted in the study revealed that older adults had previously engaged with board games such as Mill, Checkers, and Mahjong, as well as entertaining games like Mario Bros, Solitaire, and Angry Birds. Only one participant had prior experience with Kahoot, a digital educational game. Given that digital educational games were novel to the participants, it was well-founded to investigate the topic further.

The study examined the perceptions of older students in classrooms and identified the accessibility needs for these games. Additionally, the research aimed to discern whether older adults have a presumed negative disposition towards digital games. Consequently, the study investigated the playful experiences of older adults with digital educational games. Hence, field experiments were conducted at three different community colleges in Finland through surveys and observations.

The aim was not to specifically study retirement-age students, rather, the participants were active older adults. The study participants were selected based on the community college learning groups intended for older students. Although there was no minimum age limit in the groups, the participants were older due to the nature of the courses. Such a study is essential to understand the potential playful advantages and pitfalls of using educational games with older students, and especially the potential accessibility issues distinctive to this age group.

Games Accessibility

Despite the increasing popularity of educational games, research on accessibility for older adults remains limited. Forssell, Hassan, and Turunen (2024) highlight that older adults often face barriers such as poor fit of VR headsets and difficulties with game controls, which can hinder their experience with educational games. Additionally, Forssell, Hassan, and Turunen (2024) found that older adults with more experience using smartphones and computers had fewer issues with game controls, suggesting that prior technological familiarity plays a significant role in ease of use.

Moreover, Forssell, Hassan, and Turunen (2024) observed that while educational games have the potential to enrich the lives of older adults, the accessibility of these games is often compromised by design issues that do not account for age-related physical and cognitive limitations. This aligns with the findings of Wang, Hou, and Tsai (2020), who discovered that digital games can improve older adults' cognitive skills and overall well-being, but accessibility remains a crucial factor. Hassan (2024) further emphasizes that the accessibility of games and game-based applications is essential for ensuring that older adults can fully benefit from educational opportunities. Therefore, it is critical to tackle these accessibility challenges to ensure that older adults can fully benefit from these educational games.

Prior research has shown that educational games can significantly enhance learning outcomes by providing immersive and interactive experiences. Forssell, Hassan, and Turunen (2024) emphasize that educational VR games can support teaching by creating engaging and realistic learning environments. These games allow older adults to practice skills in a safe and

controlled setting, which is particularly beneficial for learning complex subjects. The study by Forssell, Hassan, and Turunen (2024) also indicates that educational VR games can increase motivation and interest in learning, as they offer a novel and enjoyable way to engage with educational content.

Playful experiences

The experiences and feelings of users form the foundation for developing educational games. According to Lucero, Holopainen, Ollila, Suomela, and Karapanos (2013), studying players' experiences and feelings, as well as the elements of games, is essential for understanding why people play and what emotions educational games evoke in users. Examining playful experiences helps to identify which elements in a game are enjoyable for users and motivate them to continue playing. Different dimensions of the game provide motivation for users; for instance, some may find the element of competitiveness central, while others may require narrative features. However, these experiences are not necessarily static and may evolve over time. It is therefore essential to investigate factors that hinder gameplay, such as feelings of frustration. Lucero et al. (2013) also underscore the importance of examining such negative experiences that can act as barriers to engagement. Furthermore, Kiili, Siuko, Cloude, and Dindar (2023) suggest intrinsic integration can be linked to playful cognitive engagement and game-based content.

When studying playful experiences in older adults, these experiences may be negatively influenced by physiological differences compared to younger age groups. According to Anttila (2023), these differences can include slower hand-eye coordination, reaction ability, or deteriorated vision. Older adults' independent use of devices can be hindered by the decline of memory, fine motor skills, sensory muscle condition, and exercise ability. Consequently, this may lead to unsuccessful interactions with educational games on mobile devices or computers, eliciting negative emotional responses such as frustration. Forssell et al. (2023) highlight that older adults experienced a range of playful emotions during VR gaming sessions, including confusion, fear, thrill, excitement, interest, curiosity, and enjoyment. These playful experiences can enhance engagement and motivation, making educational games not only informative but also enjoyable for older adults.

Educational Games

According to Pereira et al. (2021), educational games, also known as serious games or game-based learning tools, are designed to fulfill pedagogical objectives by embedding educational content within interactive and engaging gameplay. These tools aim to foster motivation, engagement, and knowledge retention by transforming conventional learning experiences into dynamic and enjoyable ones. Pereira et al. (2021) demonstrated that integrating educational material into a citizen science game, particularly through gradual content access as a reward for progression, significantly enhanced player engagement, retention, and performance. However, the effectiveness of such games is not without challenges. According to Fernández Galeote et al. (2022), one of the central challenges in designing educational games is finding a balance between delivering structured learning content and allowing players the freedom to explore and make autonomous choices. If games are designed too rigidly or are overly focused

on instruction, they risk reducing player engagement and limiting the effectiveness of the learning experience. As Fernández Galeote et al. (2022) emphasize, meaningful game-based learning requires careful attention to player agency, allowing for playful interactions, divergence from prescribed paths, and emotional engagement. These findings by Fernández Galeote et al. (2022) underscore the importance of designing educational games that not only convey content effectively but also respect and support diverse player experiences and motivations. By Sailer and Homner (2019), although gamification has been shown to positively influence cognitive, motivational, and behavioral learning outcomes, its effectiveness depends heavily on design quality and contextual factors. Sailer and Homner (2019) highlight that while gamification can enhance motivation, it may also produce mixed results, particularly in terms of sustained engagement. Furthermore, most empirical studies included in their meta-analysis focus on younger learners, especially in higher education settings, indicating a lack of research on how older adults experience and benefit from gamified learning environments. A systematic review by Koivisto and Malik (2021) highlighted this gap, emphasizing the need for more studies on gamification among older adults. Their findings suggest that while gamified interventions in health education and human-computer interaction contexts show promise, such as increased physical activity and improved self-efficacy, the evidence remains preliminary due to small sample sizes and methodological limitations.

Educational Game Design for Digital Inclusion of Older Adults

Although educational games hold significant promise for enhancing the lives of active older adults, their design must be firmly grounded in accessibility principles and responsive to the distinct challenges associated with aging. In the absence of such considerations, digital learning environments risk perpetuating digital exclusion rather than fostering inclusive and engaging learning experiences. Hence, in designing educational games for older adults, it is essential to consider age-related changes in sensory, cognitive, and motor functions. As Forssell, Hassan, and Turunen (2024) note, older individuals often face challenges related to vision, hearing, and hand dexterity, which can significantly affect their ability to interact with digital interfaces. These limitations are further compounded by limited prior experience with digital technologies, making the learning curve steeper and potentially discouraging.

In addition to these physiological and experiential factors, research on older adults' use of digital health services in Finland highlights broader usability and accessibility challenges in the use of novel technology. According to Vehko, Ruotsalainen, and Hyppönen (2019), many older users report difficulties with unclear instructions, fear of making mistakes, and a lack of support when using digital services. These findings underscore the importance of designing educational games that are not only technically accessible but also cognitively and emotionally.

Games that rely on fast-paced interaction, complex navigation, or small interface elements may unintentionally exclude older adults, particularly those with reduced fine motor skills or slower reaction times. As Forssell, Hassan, and Turunen (2024) found, such design features in VR games can hinder accessibility and limit the enjoyment and learning potential for older users. In addition, Forssell, Hassan, and Turunen (2024) noted the absence of intuitive controls and insufficient visual or auditory feedback were identified as key barriers to engagement, emphasizing the need for inclusive design that supports diverse sensory and cognitive needs.

The Finnish digital inclusion strategy by Vehko, Ruotsalainen, and Hyppönen (2019), as reflected in the national eHealth survey, emphasizes that digital services must be perceivable, operable, understandable, and robust principles that are equally vital in designing educational games for older adults. The Vanhus- ja lähimmäispalvelun liitto VALLI ry. The (2023) report and the Digi arkeen -neuvottelukunta (2019) report both stress the need for simplicity, clarity, and adaptability in digital solutions for older adults. These principles translate into game design as well, such as interfaces should offer adjustable text sizes, voice guidance, and simplified navigation paths. Importantly, involving older adults directly in the co-design process can ensure that the resulting games reflect their needs, preferences, and lived experiences.

METHODS

To address the research questions, what accessibility challenges older adults encounter when using digital educational games, how they perceive and experience playfulness during gameplay, how intuitive these games are without prior instruction, and how physical classroom environments influence their experiences, a series of user studies were conducted from the fall of 2021 to the spring of 2022 at community colleges in the municipalities of Sastamala, Valkeakoski, and Vanajavesi in Finland. The participating community colleges aimed to develop innovative teaching methods by integrating gamification elements into existing courses for older students. This initiative sought to familiarize learners with interactive technologies and reduce the barriers that often hinder older adults from adopting new digital education technology.

The pedagogical framework employed in this study was grounded in experiential learning, with a focus on adult and older learners. Approaches that emphasize lifelong learning and draw upon individuals' personal and professional histories were particularly well-suited for this research context. Older students bring a diverse range of skills acquired over their lifetimes, which influence how they approach unfamiliar situations and engage with new technologies.

To explore this dynamic, participants were not provided with instructions at the outset of the game sessions. Instead, the study aimed to observe how they navigated the challenges independently, relying on their accumulated life experience. Kolb's (2014) theory of experiential learning, which conceptualizes education as a continuous, cyclical process involving concrete experience, reflective observation, abstract conceptualization, and active experimentation, served as a foundational model for this investigation.

As emphasized by Kleinheksel et al. (2023), the theory conceptualizes learning as a cyclical progression through concrete experience, reflective observation, abstract conceptualization, and active experimentation. This model highlights the integration of experience and reflection as essential to meaningful learning, reinforcing the connection between theoretical knowledge and practical application across educational and professional contexts. Using these pedagogical approaches in this study helps to observe and guide the development of older adults and adult students' technological understanding.

As a component of the teaching strategy, a series of short lessons titled "Threats on the Web: Be Safe in Cyberspace" was developed for community college lectures, aiming to educate older students about cybersecurity threats. The instructional design was structured in two parts. In the first part, students viewed a brief video tutorial on cybersecurity at the beginning of the lecture, followed by a guided discussion that expanded on the topics presented

in the video. In the second part, the content was revisited through the use of an educational game, either Kahoot! or Quizizz, which served as the focal point of this research.

A total of four field experiments were conducted: two utilizing Kahoot! (in Sastamala and Valkeakoski) and two utilizing Quizizz (in Valkeakoski and Vanajavesi). The overarching aim of both the instructional sessions and the research was to identify potential accessibility challenges encountered by older adults when engaging with educational games. Additionally, to examine how they respond to and resolve such challenges during gameplay. Field experiments were selected as the methodological approach to ensure that the introduction of educational games occurred within authentic classroom environments, thereby enhancing validity and avoiding the limitations of artificial settings. A mixed-methods approach was employed to capture a comprehensive understanding of participants' experiences. Surveys and interviews were used to access participants' subjective reflections and perceptions, while observational methods complemented these tools by capturing behavioral responses and contextual factors that participants might not have been able to articulate explicitly.

Game Mechanics and Flow

Data collection took place in classrooms that were regularly used for the education of older adult learners, ensuring that the study was conducted in familiar and authentic learning environments. Participants were not assigned specific seats, as the intention was to observe whether their seating choices or behaviors changed once the game sessions commenced. Additionally, the study aimed to capture whether participants would verbalize any difficulties related to the physical environment, such as visibility, acoustics, or spatial arrangement, and how they attempted to address or adapt to these challenges as the game session progressed.

The instructional approach deliberately minimized the explanation of game rules and mobile phone controls prior to gameplay. This was intended to assess the intuitiveness of the game mechanics and to observe how older adults navigated the experience using their existing knowledge and life skills. When the first question appeared on the screen, several participants expressed confusion regarding how to proceed in the game. In response, the game was temporarily paused, and the researcher provided a brief overview of the gameplay structure and rules. The first question functioned as a training round, designed to familiarize participants with the game format. By the second question, most students appeared to engage more confidently and demonstrated an understanding of the game's mechanics. This approach aimed to evaluate the extent to which the games were intuitive, defined, following Kolb (2014), as the ability to interact with new tools or environments without explicit instruction, drawing on prior experiences. Although some participants expressed interest in replaying the game or having a rematch, each educational game session was conducted only once during the field experiments.

The Kahoot! and Quizizz game sessions were deliberately structured at a slow and accommodating pace to allow for potential interruptions, discussions, and technical difficulties. Although the actual gameplay lasted approximately four and a half minutes, the entire session spanned 30 to 40 minutes. Time was allocated at the beginning of each session for participants to log into the game, with potential login difficulties anticipated and incorporated into the session planning. Additionally, time was reserved at the end of each session for a debriefing discussion and for reviewing the game results. The questions presented at the games were

directly related to the content of the preceding lecture, thereby reinforcing learning through interactive engagement.

Each Quizizz session consisted of nine questions, with older adults selecting between one correct and one incorrect answer option. A 30-second time limit was allocated for each question. While the core gameplay lasted approximately eight to twelve minutes, the overall duration varied depending on the need for additional instructions following the initial round of questions. In some instances, participants paused to discuss the content or to celebrate correct responses, which extended the session length. In Quizizz, both the questions and answer options were displayed on the classroom screen as well as on each participant's device. However, in Kahoot! the questions were presented on the shared classroom screen, while the answer options, represented by colored symbols, were visible only on the participants' individual devices (see Figure 1).

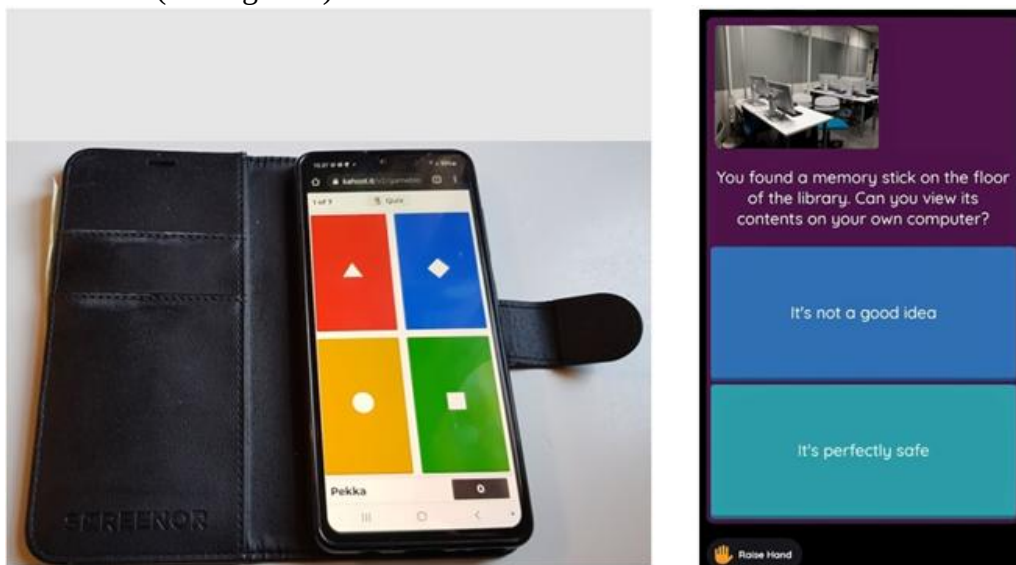


Figure 1. Kahoot! and Quizizz game interface on a smartphone. [Source: Forssell, Hassan, Turunen & Aura, 2023]

Each Kahoot! game session consisted of nine questions, with four answer options provided for each. The game was designed such that some questions had a single correct answer, while others included two correct options. This required participants to discern the number of correct responses without prior instruction, as this detail was not communicated at the outset. However, clarification was provided during the session if participants inquired about the number of correct answers. In Kahoot!, the questions were displayed on the classroom screen, while the answer options appeared as four distinct colored symbols on each participant's device, whether played with a smartphone, tablet, or computer (see Figure 1).

Kahoot! and Quizizz

Kahoot! and Quizizz was selected for this study due to the primary researcher's prior experience using these platforms in teaching older adults in community college and vocational education settings. Observed accessibility challenges in these contexts served as a motivating

factor for initiating the present research. Both Kahoot! and Quizizz are widely used, internationally recognized educational tools that share similar design principles, yet differ in specific features that may influence their accessibility. For the purposes of this study, both platforms were deemed sufficiently intuitive and user-friendly, minimizing the risk of inducing technology-related anxiety among older adult participants. Their simplicity also facilitated a smoother transition into discussions about participants' perceptions and experiences with educational games.

Kahoot! is a widely adopted game-based learning platform that can be accessed via mobile devices, tablets, computers, or any internet browser through www.kahoot.it. While the basic version is freely available, additional features can be accessed through paid licenses. The platform follows a quiz-style format, presenting one question at a time with four answer options. Questions are displayed on a shared screen, while participants respond using their personal devices (see Figure 1). Typically, Kahoot! game sessions include a time limit and a live leaderboard, which fosters competition and enhances engagement. Recent research has demonstrated Kahoot!'s effectiveness in educational contexts. A recent study by Navarro-Castillo, Pablo-Lerchundi, and Morales-Alonso (2025) demonstrated that the use of Kahoot! significantly enhanced learning outcomes for engineering students in economics and management courses. The study highlighted the platform's effectiveness in increasing student motivation, participation, and knowledge retention, reinforcing its value as a pedagogical tool in higher education.

Quizizz is a widely used game-based learning platform that allows educators to create and deliver interactive quizzes via mobile devices, tablets, or computers through www.quizizz.com. Unlike some other platforms, Quizizz offers greater flexibility in game formats and instructional features. For instance, it supports both "instructor-paced" mode, where participants progress together, and "classic" mode that allows learners to advance at their pace. These options make it adaptable to various teaching contexts and students' needs. Recent research by Hernanz et al. (2024) demonstrated that the use of Quizizz significantly enhanced students' self-efficacy, intrinsic motivation, satisfaction, and academic performance across multiple university programs. The research highlighted the platform's effectiveness in fostering active participation, and improving learning outcomes. Additionally, in educational settings that emphasize student engagement and interactivity. Both Kahoot! and Quizizz can be considered easy access platform for gamification in education, providing meaningful pedagogical value when thoughtfully integrated into instructional design.

Participants

Participants were recruited from three community colleges participating in the study to take part in both the "Threats on the Web: Be Safe in Cyberspace" lecture and the associated research activities. Participation was entirely voluntary and had no impact on students' performance or course evaluations. Informed written consent was obtained from all participants, outlining the research procedures, ethical considerations, and ensuring anonymity. A total of 27 students participated in the study. Of these, 21 were from Valkeakoski and Vanajavesi Community Colleges and completed a demographic survey. Their age distribution was as follows: 6% were aged 41–50, 12% were 51–60, 38% were 61–70, 31% were 71–80, and 13% were 81–90 years old. Notably, 82% of participants were over the age of 61. At

Sastamala Community College, age data were collected informally through verbal inquiry, with the six participants estimated to be between 60 and 80 years old.

Data collection

Both observational and survey data were collected during the field experiments (Vilkkä 2025). The purpose of the observational data was to assess the accessibility of the physical learning environment and its influence on gameplay. Specific factors examined included the students' distance from the blackboard, classroom lighting conditions, screen or board reflectivity, and acoustics. Observations also focused on how participants responded to environmental challenges during gameplay, including whether and how they verbalized difficulties and the strategies they employed to address them.

Observational data were recorded in field diaries during and immediately after each session. To complement these observations, a survey was administered in Finnish, based on a modified and abbreviated version of the Playful Experiences (PLEX) framework. Originally developed by Korhonen, Montola, and Arrasvuori (2009), the PLEX framework is designed to capture a broad spectrum of emotional and experiential responses to playful systems and has been widely applied in user experience and game-based learning research.

Participants were invited to select from a list of predefined experiential descriptors to characterize their feelings during gameplay. These included: accomplishment, challenge, communality, competition, concentration, deviation from traditional teaching, empathy, excitement, frustration, humor, imagination, inspiration, mastery, novelty, relaxation, stimulation, self-expression, and unpleasantness. To gain more profound insight into these experiences, participants were also asked to provide open-ended responses describing their gameplay experience in their words.

The qualitative responses were analyzed using the affinity diagram method, a technique used to externalize and organize unstructured qualitative data into meaningful thematic clusters by Lucero (2015). According to Schrader, (2022), this method is particularly effective for identifying emergent patterns in user experience research and has been validated in the context of serious games and game-based learning.

Older adults were provided with key information regarding the information security aspects of the game prior to participation, and privacy notices were presented. They were informed that accessing the game did not require downloading any applications onto their personal devices, nor did it necessitate logging in or sharing personal data. Additionally, participants were advised that they could use a first name, nickname, or any pseudonym of their choice when joining the game, thereby ensuring anonymity and minimizing privacy concerns.

RESULTS

The following sections present the results of the study. First, findings concerning the accessibility of Kahoot! are discussed. This is followed by an analysis of the accessibility of the educational game Quizizz. Subsequently, the results related to the playful experiences

associated with both platforms are examined. The section ends with the study's limitations and suggestions for future research.

Accessibility of Kahoot!

At Sastamala Community College, six students aged between 60 and 80 years participated in the study. The participants utilized their smartphones as controllers to engage with the educational game platform Kahoot (see Figure 1). At the outset of the session, participants were asked whether they had prior experience with digital games; only one individual indicated previous engagement. None of the participants had used Kahoot before. Upon initiation of the game, several students moved closer to the projection screen (see Figure 2), with one participant commenting aloud that the questions were difficult to read.



Figure 2. The white canvas, rolled up on the right side of the chalkboard, was used during the gaming session at Sastamala Community College. [Source: Forssell, Hassan, Turunen & Aura, 2023]

Although the same canvas had been used in previous classes without issue, this feedback suggests that the game interface may have featured smaller-than-average font sizes or insufficient contrast. When the first question appeared, the students expressed confusion regarding the gameplay mechanics. Consequently, the session was paused to provide a brief explanation. The initial question had been designed as a practice round. By the second question, participants began to understand the format and became actively engaged. They displayed enthusiasm, initiated friendly competition, and encouraged one another to improve their performance.

One of the most frequently identified accessibility challenges was the game's pace. Despite extending the response time to 30 seconds (from the default 20 seconds), nearly all participants reported that the game progressed too quickly. At Valkeakoski Community College, seven students participated in the study, although only one completed the post-session survey. Four participants used their smartphones as game controllers, while two others shared a tablet. Once the game commenced, students reported difficulty seeing the questions and answer options due to the small screen size (see Figure 3).

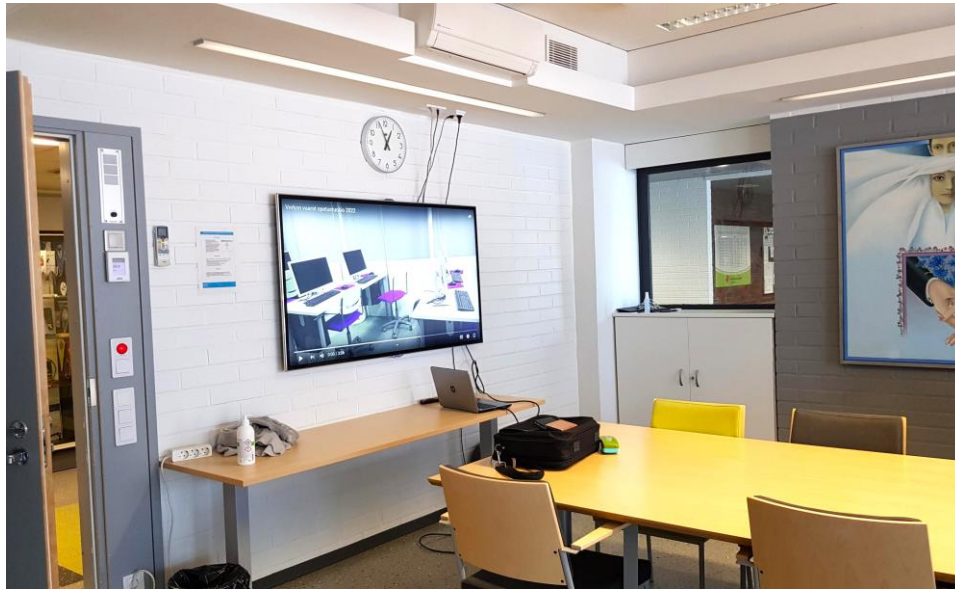


Figure 3. Classroom display used during a Kahoot! game session at Valkeakoski Community College.
[Source: Forssell, Hassan, Turunen & Aura, 2023]

Although they were encouraged to move closer, none opted to change seats. Consequently, the facilitator had to read the questions and answer choices aloud to ensure the session could proceed. During the game session, one participant expressed difficulty understanding the overall concept of the game. Several others struggled to respond within the allotted 30 seconds. Participants also noted that the game moved too quickly, the font size was too small, logging in was challenging due to the interface being in a foreign language, and the game rules were not easily comprehensible. Despite these accessibility barriers, the session was not without positive feedback. One student remarked enthusiastically during gameplay, “My heart rate rises while playing this game.” In the open-ended responses, participants described the session as interesting, enjoyable, and beneficial in supporting the lesson content.

Accessibility of Quizizz

In a subsequent session at Valkeakoski Community College, the educational game platform Quizizz was employed. One student participated using a smartphone, while the remaining seven used desktop computers. All Quizizz sessions were conducted in instructor-paced mode. Logging into the game posed challenges for all participants, primarily due to the platform being in English, a foreign language for the students, and the complexity of the web address, which was prone to typing errors. Notably, one participant inadvertently accessed a fraudulent website designed to mimic the official Quizizz platform.

At the start of the session, three students expressed enthusiasm about using a game to review previously learned material. However, some voiced concerns, asking questions such as, “Am I able to play this game? Is it too hard?” As the game progressed, two students reported that the 30-second response time felt too short, and that screen visibility was impaired due to glare. To address this, the classroom lights were turned off and Quizizz’s dark mode was enabled, which improved visibility (see Figure 4.).

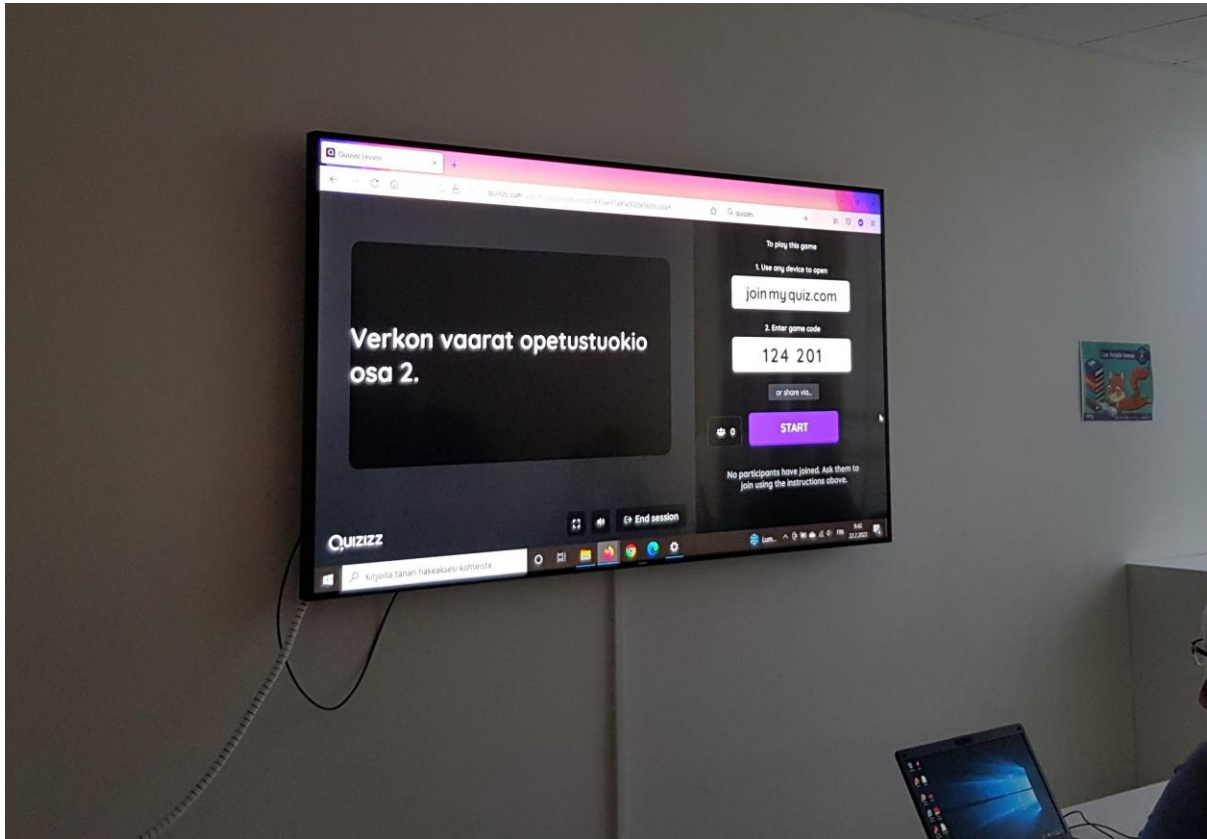


Figure 4. Classroom display used during a Quizizz game session at Valkeakoski Community College.
[Source: Forssell, Hassan, Turunen & Aura, 2023]

Following the game session, students were given a revised survey. This version was adapted based on insights from the earlier Sastamala session, with simplified language to enhance clarity, and additional multiple-choice and open-ended questions to gather more detailed feedback on accessibility and participants' gaming backgrounds. In the open-ended responses, students described the experience as interesting, enjoyable, and novel. Nevertheless, they reiterated that the game's pace was too fast. While the difficulty level was deemed appropriate, logging into the game remained the most challenging aspect.

Regarding prior gaming experience, three of the eight participants had never played digital games. Among the rest, four had used computers, three had used smartphones, game consoles, and board games, and two had experience with tablets. The limited gaming experience was largely attributed to a lack of interest. In response to the question, "Have you experienced any problems while gaming? For example, the game is in a foreign language, the rules are difficult to understand, or the font size is too small," one student noted, "Games have been easy, but usually logging in is the hardest part." Another reported difficulties with foreign language use and understanding game rules.

In the final session, held at Vanajavesi, six students participated, all using desktop computers. As in previous sessions, all participants encountered difficulties logging into the Quizizz platform. Once the game began, students again reported that the questions appeared too quickly. It took several questions for participants to become familiar with the gameplay.

As the session progressed, the atmosphere became increasingly positive. Students celebrated their successes, with the game winner expressing excitement and others applauding enthusiastically at the end. The physical classroom environment was considered well-suited for older adult learners. Hence, the screen was large, the lighting was adequate, and no issues with visibility were reported (see Figure 5.).



Figure 5. Classroom display used during a Quizizz game session at Vanajavesi Community College.
[Source: Forssell, Hassan, Turunen & Aura, 2023]

Survey responses indicated that four of the six participants had not previously played digital games. Two had experience with phones, tablets, computers, and game consoles, while three had played board games. Overall, participants reported that they rarely engaged in gaming and generally lacked interest due to limited prior experience. Despite this, they described the session as a pleasant and positive learning experience.

Accessibility Adaptations in Game Sessions

To accommodate the cognitive and perceptual needs of older adults, several accessibility adaptations were implemented during the game sessions. In both Kahoot! and Quizizz, the response time for each question was set to 30 seconds to reduce time pressure and allow participants more time to reflect. In Kahoot!, this meant extending the default time from 20 seconds. In Quizizz, although the default time was not explicitly stated, the 30-second limit was consistently applied across sessions. Additionally, in Quizizz, the classroom lights were turned off and dark mode was enabled to improve screen contrast and reduce glare (see Figures 6. and 7.).

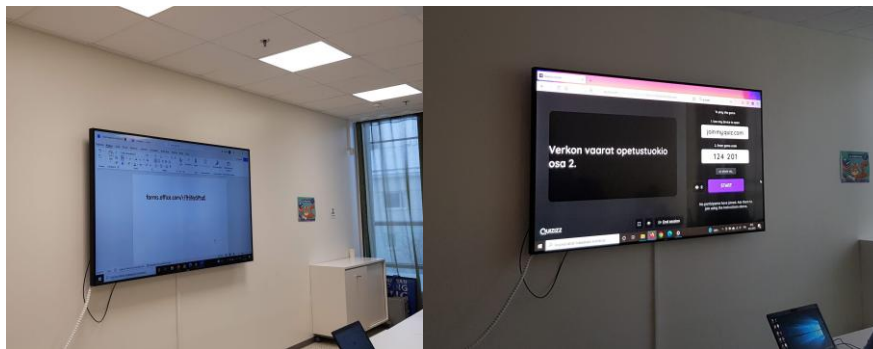


Figure 6. and 7. Classroom lights were turned off and dark mode was enabled to improve screen contrast and reduce glare during a Quizizz game session at Valkeakoski Community College. [Source: Forssell, Hassan, Turunen & Aura, 2023]

Questions in both games were designed to be directly related to the lecture content and kept simple to avoid unnecessary complexity. The first question in Kahoot! was used as a training round, and verbal instructions were provided to clarify the game mechanics. Despite these efforts, some participants still reported challenges with font size, screen visibility, and understanding the number of correct answers, indicating that further customization of game interfaces may be necessary to fully support accessibility for older users.

Playful Experiences

This study employed two complementary research methods to gain a comprehensive understanding of older adults' playful experiences during educational game sessions designed to support teaching and learning. Open-ended responses were analyzed using the Affinity Diagram method (Lucero 2015), which revealed six distinct categories of playful experience: enjoyment, interest, novelty, frustration, confusion, and anxiety. Enjoyment was the most frequently reported experience, with seven participants expressing positive sentiments toward the educational game. Interest was articulated by five participants. Both novelty and frustration were mentioned three times. Frustration was primarily associated with the fast pace of the game, which several participants found challenging. Confusion and anxiety were each mentioned twice. Confusion stemmed from difficulties in understanding the game mechanics and rules, while anxiety was linked to the competitive nature of the game. One participant, for

example, reported feeling anxious because the game reminded them of a school pop quiz. A summary of the frequency of each reported experience is presented below (see Table 1.).

Table 1. Emotions from open answers using an affinity diagram.

Type	Emotions
Enjoyment	7
Interest	5
Novelty	3
Frustration	3
Confusion	2
Anxiety	2

The results, analyzed using the PLEX (Playful Experiences) Framework, revealed a diverse range of playful experiences reported by older adult participants. According to ten respondents, the gaming experience differed notably from traditional classroom instruction, with novelty being selected eight times. Participants most frequently reported experiences of excitement, concentration, accomplishment, and competition, each mentioned seven times. Relaxation and inspiration were each selected five times, while mastery, communality, and humor were each chosen four times. Empathy was reported three times, and frustration, rousing, and challenge were each selected twice. Imagination was mentioned once. Notably, none of the participants selected self-expression or unpleasantness as part of their experience. A detailed breakdown of the frequency of each playful experience is presented in (see Table 2).

Table 2. PLEX framework.

Type	Emotions
Different from normal teaching	10
Novelty	8
Excitement	7
Concentration	7
Accomplishment	7
Competition	7
Relaxation	5
Inspiring	5
Mastery	4
Communality	4
Humour	4
Empathy	3
Frustration	2
Rousing	2
Challenge	2
Imaginative	1
Self-expressive	0
Unpleasantness	0

Limitations

As with any research, this study has certain limitations. First, it employed a combination of observational and survey data, each with inherent methodological constraints. Observations are subject to the researcher's interpretation, and significant events may be inadvertently overlooked. Surveys, on the other hand, rely on self-reported data, which can be prone to misunderstanding or bias. As Vilkkä (2025) notes, observational data can be influenced by the subjectivity of the observer, and the reliability of survey responses may be affected by the participants' interpretations of the questions.

Second, the participants were self-selected, which may have introduced a bias toward individuals with a more favorable disposition toward technology and learning. Third, the sample size (N=27) was modest and limits generalizability, the study was designed as an exploratory field experiment to uncover accessibility and experiential patterns among older adults in authentic learning environments. The diversity in participants' technological backgrounds and attitudes reflects the heterogeneity of the older adult population, which is essential for understanding the range of accessibility challenges and playful responses. However, this is consistent with the qualitative research design employed in the study and was mitigated by conducting four field experiments across three different municipalities in Finland. Fourth, although the study did not measure learning outcomes quantitatively, the educational process was implemented through a structured pedagogical framework. Each game session was preceded by a cybersecurity-themed lecture and followed by gameplay that reinforced the lecture content. Participants' reflections were collected via surveys and open-ended responses, which captured both emotional and cognitive engagement.

Future research

In addition to the positive outcomes observed in recent studies on gamified learning (e.g., Liang & Kuo, 2025), participants in this study also demonstrated feelings of competitiveness during gameplay. While competition is frequently associated with increased motivation and engagement, its role in educational contexts, particularly among older adults, remains unclear. Educational environments have traditionally favored cooperative approaches, as competition may induce stress or reduce inclusivity. However, a meta-analysis by Sailer and Homner (2020) found that combining competition with collaboration in gamified learning environments can positively influence behavioral and motivational learning outcomes. The emergence of competitiveness as a motivating factor among older adults in this study highlights its potential as a design element in short-term educational game activities. Observational data and participant comments revealed that features such as live leaderboards in Kahoot! and score-based feedback in Quizizz introduced competition that elicited excitement and motivation, but also anxiety in some cases, particularly when the gameplay pace was perceived as too fast or reminiscent of formal testing environments. These findings suggest that competition can serve as a meaningful design element in educational games for older adults, provided it is implemented with careful attention to pacing, emotional comfort, and inclusivity. Moreover, the findings indicate that the fast pace of gameplay can lead to frustration, which may hinder learning. This underscores the importance of designing games that are sensitive to the cognitive and perceptual needs of older users. Future research should aim to deepen the understanding

of older adults' playful experiences by employing larger and more diverse participant samples and incorporating comprehensive emotional and physiological assessment methods. Additionally, further investigation is needed to explore how different game mechanics, such as competition and pacing, affect engagement, emotional response, and learning outcomes among older adults. Such research would contribute to the development of inclusive and age-sensitive game-based learning environments that support both enjoyment and educational outcomes.

DISCUSSION

This study aimed to explore how older students experience digital games as a pedagogical tool and to examine the accessibility and playful dimensions of two widely used educational platforms: *Kahoot!* and *Quizizz*. The findings suggest that educational games can effectively support teaching among older learners, provided that careful attention is given to the overall accessibility of the experience. Furthermore, the use of such games appears to lower the barrier for older adults to engage with new technologies, as it offers them opportunities to interact with their own digital devices in a familiar and low-pressure environment. Overall, incorporating educational games into classroom activities was perceived as a novel and positive experience by the participants. They reported a range of playful experiences, including excitement, novelty, enjoyment, a sense of control, social connectedness, and accomplishment—attributes that were particularly associated with the use of *Kahoot!* and *Quizizz*.

From an accessibility perspective, several key challenges emerged, including the suitability of the learning environment for gameplay, difficulties logging into the platforms, the use of non-native language in the games, and the overall pace of gameplay. Participants frequently reported that the games progressed too quickly, and the size of the projected display (canvas or display) negatively affected their ability to engage with the content. These issues significantly hindered the overall playful experience. It was also observed that the game mechanics were not intuitive for all older adults, particularly those with limited prior exposure to digital games. While some participants required ongoing guidance throughout the session, others approached the games with curiosity, experimenting independently to understand the mechanics.

The findings suggest that effectively integrating games into educational settings for older adults, and by extension, for individuals with disabilities, requires more than simply designing engaging or gamified content. It necessitates creating inclusive opportunities for participation, exploration, and learning. Through the use of thoughtful pedagogical strategies, minor design modifications, patience, and active instructor support, older adults were able to experience the educational potential of games in a meaningful way. Importantly, the study challenges the assumption that older adults' difficulties with games stem primarily from cognitive limitations or technological illiteracy. The barriers encountered by participants, such as small font sizes, strict time limits, and general accessibility shortcomings, were more significant than the complexity of the game mechanics themselves.

This study contributes to a more profound understanding of the needs and preferences of older adults in the context of educational gaming, offering valuable insights for the development of more accessible and inclusive game designs. Accessibility should not be treated as an afterthought, but must be integrated into the design process from the outset.

Ideally, this process should involve a diverse group of users, including older adults and individuals with varying abilities, to ensure that accessibility considerations are grounded in real-world needs and experiences.

Accessibility in game design is increasingly recognized not merely as a technical requirement, but as a foundational design principle that ensures equitable participation and usability for a diverse range of users. As Aguado-Delgado et al. (2020) emphasize, accessibility in video games remains underdeveloped despite growing awareness. They argue for the adoption of integrated methodologies that embed accessibility throughout the software development lifecycle. Their systematic review highlights a persistent gap between accessibility guidelines and their practical implementation, particularly in games designed for older adults and individuals with disabilities. This perspective aligns with broader trends in inclusive design, which advocate for user-centered approaches that extend beyond regulatory compliance to foster meaningful and empowering user experiences. In this context, accessibility is not an afterthought but a core design ethos that benefits all users, especially those with age-related or sensory limitations.

To contextualize these findings and acknowledge the limitations of the study, it is important to note that this research presents promising insights into the use of educational games with older adults, it is important to acknowledge the exploratory nature of the research. The statements regarding the pedagogical value of educational games, their potential to lower the threshold for engaging with new technologies, and the positive and novel experiences reported by participants are supported by qualitative data, including survey responses and open-ended feedback. Notably, enjoyment was the most frequently reported emotion, and novelty was highlighted both in open responses and through the PLEX framework, indicating that participants perceived the activities as distinctly different from traditional classroom instruction. These findings suggest that educational games can offer meaningful and engaging experiences for older adults. However, the results are based on a limited sample size and do not include quantitative measures of learning outcomes. Therefore, the conclusions should be interpreted as indicative rather than definitive. Further research with larger and more diverse participant groups is needed to validate and generalize these observations.

Finally, it is essential to acknowledge the ongoing transformation within the contemporary gaming industry. As noted by Kinnunen, Taskinen, and Mäyrä (2020), the demographic composition of players is becoming increasingly diverse, with notable growth among female gamers and individuals across a wide spectrum of ages and abilities. This expanding heterogeneity underscores the need for game developers to adopt innovative design strategies and inclusive development practices that address the varied needs, preferences, and capabilities of a broader user base.

CONCLUSIONS

This study examined the accessibility of educational games, specifically Quizizz and Kahoot!, among older adult learners. The research involved four field experiments conducted at community colleges in Finland, with data collected through structured observations and survey questionnaires. The findings indicate that educational games can effectively support instructional practices for older students, provided that the accessibility of the gaming

experience is carefully considered. Older adults generally perceived the games as enjoyable, engaging, novel, and stimulating. However, a fast-paced gameplay environment was identified as a significant barrier, often leading to frustration and reduced enjoyment.

Key accessibility challenges included difficulties with logging into the game, insufficient font size and contrast, the absence of voice-over features, and the use of non-native languages in the game interface. To improve usability, the study recommends the use of QR codes or shortened URLs to simplify the login process. Additionally, physical classroom conditions, such as lighting, screen size, and the visibility of the display board, were found to play a crucial role in facilitating accessible gaming sessions. Overall, the study emphasizes the importance of addressing both psychological and physiological factors when designing educational gaming experiences for older adults. Addressing these factors can help foster positive learning experiences with digital tools and mitigate potential anxieties or insecurities associated with technology use.

IMPLICATIONS FOR APPLICATION

The findings of this study suggest that digital games can serve as effective tools for lowering the threshold to adopting new technologies, such as mobile devices, among older adults. To maximize the potential of such interventions, both psychological and physiological factors must be considered in the design of accessible game-based learning environments. These considerations are essential for fostering positive user experiences and addressing common fears or insecurities associated with digital technology use. When accessibility is prioritized and game content is structured to elicit positive emotional responses while minimizing frustration, gamified approaches can function as valuable educational tools. They can support older adults in becoming more comfortable with digital technologies that are increasingly integral to everyday life. Looking ahead, it is imperative to ensure that all individuals remain active participants in an increasingly digitized society. This requires the development of inclusive pedagogical strategies that not only familiarize older adults with emerging technologies but also promote lifelong learning and digital confidence.

REFERENCES

- Aguado-Delgado, J., Gutiérrez-Martínez, J.-M., Hilera, J. R., de-Marcos, L., & Otón, S. (2020). Accessibility in video games: a systematic review. *Universal Access in the Information Society*, 19(1), 169–193. <https://doi.org/10.1007/s10209-018-0628-2>
- Anttila, H. (2023). (toim.). Ikätekniologian kansallinen koordinaatio: kohti jatkuvuutta ja yhteistyötä. Ehdotus ikätekniologian kansalliseksi koordinaatiomalliksi ja toimenpiteiksi vuosille 2023–2027. Terveysten ja hyvinvoinnin laitos (THL). Työpaperi 7/2023. 62 sivua. Helsinki 2023. ISBN 978-952-408-039-2. https://www.julkari.fi/bitstream/handle/10024/146136/URN_ISBN_978-952-408-039-2.pdf?sequence=1&isAllowed=y
- Bahadori, F., Abolfathi Momtaz, Y., Mohammadi Shahboulaghi, F., & Zandieh, Z. (2025). Evaluating the barriers to information and communication technology adoption among older adults in Iran. *Educational Gerontology*, 51(4), 438–454. <https://doi.org/10.1080/03601277.2024.2397575>

- Chaudhry, B. M., Islam, M. U., Chawla, N. V., Fritsch, J., Le Dantec, C. A., Vallgård, A., Jönsson, L., & Alaoui, S. F. (2024). Longitudinal Evaluation of Casual Puzzle Tablet Games by Older Adults. *Proceedings of the 2024 ACM Designing Interactive Systems Conference*, 2073–2087. <https://doi.org/10.1145/3643834.3661528>
- Canapa, G., Paterno, F., & Santoro, C. (2025). Interactive Serious Games for Cognitive Training of Older Adults: A Systematic Review. *IEEE Transactions on Computational Social Systems*, 1–24. <https://doi.org/10.1109/TCSS.2025.3532307>
- De Leon Pereira, R., Tan, A., Bunt, A., Tremblay-Savard, O., Harteveld, C., Pirker, J., Fowler, A., Canossa, A. A., & Arya, A. A. (2021). Increasing player engagement, retention and performance through the inclusion of educational content in a citizen science game. *Proceedings of the 16th International Conference on the Foundations of Digital Games*, 1–12. <https://doi.org/10.1145/3472538.3472554>
- Digi arkeen -neuvottelukunta. (2019). Digitaalinen Suomi – Yhdenvertainen kaikille: Digi arkeen -neuvottelukunnan toimintakertomus (Valtiovainministeriön julkaisu 2019:23). Helsinki: Valtiovainministeriö. <https://julkaisut.valtioneuvosto.fi/handle/10024/161486>
- Gill, A. S., Irwin, D., Long, P., Sun, L., Towey, D., Yu, W., Zhang, Y., & Zheng, Y. (2025). Enhancing learning in design for manufacturing and assembly: the effects of augmented reality and game-based learning on student's intrinsic motivation. *Interactive Technology and Smart Education*, 22(1), 61–80. <https://doi.org/10.1108/ITSE-11-2023-0221>
- Fernández Galeote, D., Zeko, C., Volkovs, K., Diamant, M., Thibault, M., Legaki, N.-Z., Rajanen, D., Rajanen, M., & Hamari, J. (2022). The Good, the Bad, and the Divergent in Game-based Learning: Player Experiences of a Serious Game for Climate Change Engagement. *Proceedings of the 25th International Academic Mindtrek Conference*, 256–267. <https://doi.org/10.1145/3569219.3569414>
- Forssell, M., Hassan, L., & Turunen, M. (2024). Inclusive VR gaming with older adults: Accessibility of entertainment and educational VR games. *Proceedings of the 27th International Academic Mindtrek Conference*, Tampere, Finland. ACM. <https://doi.org/10.1145/3681716.3681736>
- Forssell, M., Paavilainen, J., Hassan, L., Turunen, M. (2024). Older adults' playful experiences of VR gaming. *IMX 2024 - Proceedings of the 2024 ACM International Conference on Interactive Media Experiences*, 182–191. <https://doi.org/10.1145/3639701.3656309>
- Hassan, L. (2024). [Rev. of Accessibility of games and game-based applications: A systematic literature review and mapping of future directions]. *New Media & Society*, 26(4), 2336–2384. <https://doi.org/10.1177/14614448231204020>
- Hernanz, V., Latorre-Coscolluela, C., Suárez, C., & Lanchares-Sancho, E. (2024). Revitalising learning in three university contexts: Unleashing the power of the Quizizz app to increase self-efficacy, intrinsic motivation, satisfaction and performance. *Education and Information Technologies*, 29(17), 23917–23935. <https://doi.org/10.1007/s10639-024-12779-9>
- Kiili, K., Juho, S., Cloude, E., & Dindar, M. (2023). Demystifying the Relations of Motivation and Emotions in Game-Based Learning: Insights from Co-Occurrence Network Analysis. *International Journal of Serious Games*, 10(4), 93–112. <https://doi.org/10.17083/ijsg.v10i4.629>
- Kinnunen, J., Taskinen, M., Mäyrä. (2020). *Pelaajabarometri 2020: Pelaamista koronan aikaan*. Tampereen yliopisto, Informaatioteknologian ja viestinnän tiedekunta - Faculty of Information Technology and Communication Sciences; Tampere University.
- Kleinheksel, A.J., Chen, W., Rudd, M.J. et al. (2023). Putting reflection back into practice: Kolb's theory of experiential learning as a theoretical framework for just-in-time faculty development. *SN Soc Sci* 3, 59 (2023). <https://doi.org/10.1007/s43545-023-00649-z>
- Koivisto, J., and Malik, A. (2021). Gamification for Older Adults: A Systematic Literature Review. *The Gerontologist*. 61, 7, 360-372. <https://doi.org/10.1093/geront/gnaa047>
- Kolb D., (2014.) *Experiential Learning: Experience as the Source of Learning and Development*. Second Edition. Pearson Publishing. Retrieved August 5, 2022, from *Experiential Learning: Experience as the Source of Learning and Development*, Second Edition (oreilly.com)

- Korhonen, H., Montola, M., and Arrasvuori, J. (2009). Understanding playful user experience through digital games. In International Conference on Designing Pleasurable Products and Interfaces, (Vol. 2009). Retrieved February 26, 2024 from https://www.researchgate.net/publication/242084991_Understanding_playful_user_experiences_through_digital_games
- Liang, Ming-Hao, and Shu-Hsin Kuo. (2025). Systematic Review on Health Literacy through Game-Based Educational Interventions in Older Adults. *Educational Gerontology*, 2025, 1–14, <https://doi.org/10.1080/03601277.2025.2470273>.
- Lucero, A., (2015). Using Affinity Diagrams to Evaluate Interactive Prototypes. In: Abascal, J., Barbosa, S., Fetter, M., Gross, T., Palanque, P., Winckler, M. (eds) Human-Computer Interaction – INTERACT 2015. INTERACT 2015. Lecture Notes in Computer Science(), vol 9297. Springer, Cham. https://doi.org/10.1007/978-3-319-22668-2_19
- Lucero, A., Holopainen, J., Ollila, E., Suomela, R., and Karapanos, E. (2013). The playful experiences (PLEX) framework as a guide for expert evaluation. In Proceedings of the 6th International Conference on Designing Pleasurable Products and Interfaces (DPPI '13). Association for Computing Machinery, New York, NY, USA, 221–230. <https://doi.org/10.1145/2513506.2513530>
- Nakagomi, A., Ide, K., Kondo, K., & Shiba, K. (2025). Digital Gaming and Subsequent Health and Well-Being Among Older Adults: Longitudinal Outcome-Wide Analysis. *Journal of Medical Internet Research*, 27(12), e69080-. <https://doi.org/10.2196/69080>
- Navarro-Castillo, Y., Pablo-Lerchundi, I., & Morales-Alonso, G. (2025). Kahoot! as a tool to enhance learning for engineering students in economics & management courses. *The International Journal of Management Education*, 23(2), 101173-. <https://doi.org/10.1016/j.ijme.2025.101173>
- Schrader, C. (2022). Serious Games and Game-Based Learning. In: Handbook of Open, Distance and Digital Education. Springer, Singapore. https://doi.org/10.1007/978-981-19-0351-9_74-1
- Sailer, M., & Homner, L. (2020). The Gamification of Learning: a Meta-analysis. *Educational Psychology Review*, 32(1), 77–112. <https://doi.org/10.1007/s10648-019-09498-w>
- Sertel, M., Gündoğan, M., Bostanoğlu, B., & Çolak, M. (2025). The Effect of Virtual Intelligence Games Applied to Older Adults on Cognitive Skills. *Topics in Geriatric Rehabilitation*, 41(1), 65–76. <https://doi.org/10.1097/TGR.0000000000000463>
- Vanhus- ja lähimmäispalvelun liitto VALLI ry. (2023). Älyä ja iloa teknologiasta – Teknologia ja laitteet ikääntyneiden arjen tukena. Ikäteknologiakeskus. Helsinki. <https://www.valli.fi/wp-content/uploads/2023/01/Älyä-ja-iloa-teknologiasta-2023.pdf>
- Vehko, T., Ruotsalainen, S., & Hyppönen, H. (Eds.). (2019). E-health and e-welfare of Finland: Checkpoint 2018 (Report 7/2019). National Institute for Health and Welfare (THL). https://www.julkari.fi/bitstream/handle/10024/138244/RAP2019_7_e-health_and_e-welfare_web_4.pdf
- Vilkka, H., & Santalahti-kustannus, kustantaja. (2025). Tutki ja kehitä (6., uudistettu painos.). Santalahti-kustannus.
- Wang, Y.-L., Hou, H.-T., & Tsai, C.-C. (2020). A systematic literature review of the impacts of digital games designed for older adults. *Educational Gerontology*, 46(1), 1–17. <https://doi.org/10.1080/03601277.2019.1694448>
- Westin, T., Brusk, J., Palmquist, A. (2025). Accessibility and Inclusion in the Game Industry: A position paper. In Proceedings of the 20th International Conference on the Foundations of Digital Games (FDG '25). Association for Computing Machinery, New York, NY, USA, Article 14, 1–6. <https://doi.org/10.1145/3723498.3723803>

Authors' Note

This research paper is an extended version of the paper by Forssell, Hassan, Turunen, and Aura (2023). Accessibility of Kahoot! And Quizizz: Utilizing educational games with Elderly Students. In Proceedings of the 11th International Conference on Communities and Technologies (C&T '23). Association for Computing Machinery, New York, NY, USA, 75–84. <https://doi.org/10.1145/3593743.3593760> and it is intended for an issue in the journal Human Technology (ISSN 1795-6889, <https://ht.csr-pub.eu/index.php/ht/index>) with the topic "Humanization of Digital Technologies " In this extended partly rewritten version, the research results have been analyzed from a new perspective and the playful experiences of older adults have been added to the research. No funding has been received for the research.

All correspondence should be addressed to
Mirkka Forssell
Faculty of Information Technology and
Communication Sciences/ Tampere University
Arvo Ylpön katu 34. PL 100 33014
Tampereen yliopisto, Finland
mirkka.forssell@tuni.fi

Human Technology
ISSN 1795-6889
<https://ht.csr-pub.eu>