



Accessibility of Kahoot! And Quizizz

Utilizing educational games with Elderly Students

Mirkka Forssell

Faculty of Information Technology and Communication
Sciences/Computing Sciences, Tampere University
Tampere Finland
mirkka.forssell@tuni.fi

Markku Turunen

Faculty of Information Technology and, Communication
Sciences /Computing Sciences, Tampere University,
Tampere Finland
markku.turunen@tuni.fi

Lobna Hassan

LUT School of Engineering, LUT University, Lahti Finland,
lobna.hassan@lut.fi

Isabella Aura

Faculty of Information Technology and Communication
Sciences /Computing Sciences, Tampere University,
Tampere Finland
isabella.aura@tuni.fi

ABSTRACT

Learning is a lifelong process and the ways of learning and teaching have been changing in recent years, reform traditional classroom teaching to interactive, entertaining, and engaging teaching. Recent years have shown the popularity of educational games as a pedagogical method for children and youth in particular. Games are often employed to engage, inspire and motivate learners, as well as to support teachers in delivering various pedagogical content. Learning and teaching methods are in the transition phase. However, only scarce literature exists on the utilization of educational games with older adults and the elderly. Additionally, the understanding of how accessible educational games are for the senior citizens is still limited. Educational games are often utilized in classrooms, next to traditional teaching methods. In such situations, the accessibility of a whole gaming session must be taken into consideration to ensure inclusion. It is thought that there are general barriers to their use of (game) technology such as psychological apprehension of technology, as well as physiological barriers, e.g., visual, hearing and other bodily impairments. Hence, this article examines the utilization of the educational games of Kahoot! and Quizizz, as well as their perceived accessibility with elderly students. Through surveys and observational data gathered from 27 participants in four different sessions, the results point to several issues in terms of accessibility, game tempo, as well as issues related to the classroom space design, such as lighting and size of the board on which the games are projected. However, similar to younger audiences, the elderly appears eager to engage with educational games, especially with appropriate game design and facilities.

CCS CONCEPTS

• Human-centered computing; • Accessibility; • Empirical studies in accessibility;



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KEYWORDS

Accessibility, Educational games, Usability, Elderly, Quizizz, Kahoot!, Lifelong learning

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1 INTRODUCTION

For the last decade, we have seen a notable increase of interest in game accessibility [1], and the number of games with accessibility features has grown massively [2]. Accessibility implementations have improved notably and a variety of strategies to cater towards different access needs are being utilized. However, not all games with accessibility are made equal [3], as some of them are more accessible than others and tend to differ in the groups they provide access for. Game accessibility is essential as it provides access to games for previously underserved groups of players, and it is estimated that a third of gamers worldwide experience a disability that hinders their game access [4]. At the same time, accessibility can improve the gaming experience to gamers at large as it would allow them to adjust the game to their personal needs and thus make the game more pleasurable and/or usable, a phenomenon known as the “curb cut” effect where investments in accessibility have been shown to benefit society at large [5]. This is especially important considering that games are not only the pinnacle of means of entertainment and culture, but they also have many other cognitive, social and emotional benefits to offer gamers [6].

One of the fields where games can offer several benefits to users is education [7]. Employing educational games with children and youth, with and without disabilities, has been popular already for decades [7, 8], whereas in adult education or with elderly students they are still rarely used [9]. Educational games could be of increased value to the elderly as they can keep them engaged with education, which, not only is basic right in most developed society, but can help them maintain their cognitive functions and independence through the cognitive challenge [10]. Moreover, research

has rarely investigated the accessibility of educational games, especially for elder adults who may experience hearing and/or vision impairment, as well as a lack of game literacy [9, 11]. The level of educational games' accessibility, in general, and specifically for the elderly, remains terrible [12]. On the other hand, there are also perceptions that the elderly has a negative disposition towards games, which may have unaffected their use in education or other contexts [13].

In this article we present a study which investigates the accessibility of the popular digital educational games of Kahoot! and Quizizz with elderly students. Educational games are used to support teaching in classrooms, the accessibility of the entire game session must be taken into account e.g., classroom lighting, screen size and acoustics. In the questionnaire conducted in the study, it was found that the elderly had previously played the following board games such as Mill, Checkers, and Mahjong, as well as the entertaining games Mario bros, Solitaire, and Angry Birds. Only one of the participants had previously played Kahoot, a digital educational game. Hence the digital educational games were novel to the participants it was well-founded to investigate the topic further. We examined the perceptions of the elderly students in classrooms, and what would be the accessibility needs for these games. We are also interested in discerning to what extent the elderly has the presumed negative disposition towards digital games, if at all. Hence, we investigate the attitudes and feelings of senior citizens towards digital gaming, gamification and accessibility of educational games overall. Towards that end, we conducted field experiments at three different community colleges in Finland through a surveys and observations. Our purpose was not to research students of retirement age in this context. The study participants were selected on the basis of the Community College learning groups, which were intended for elderly people. There was no minimum age limit in the groups, however the participants were older due to the nature of the courses. Such a study is essential to understand the possible advantages and pitfalls of using educational games with older students, and especially the potential accessibility issues distinctive for this age group.

2 BACKGROUND

As background information, three essential themes regarding the research in the upcoming section is presented. The topics of accessibility, educational games and also designing accessible games for elderly students are defined.

2.1 Accessibility

Accessibility can be seen as an aspect of design that creates usability for users with various capabilities. Within the context of digital games, same definitions exist conceptualizing it as the removal of barriers to participation in games and game cultures for people in general, especially those with disabilities [14]. Hence, accessibility means the possibility of being able to play the game as it is designed to be played. At the same time, it should be noted that games are not simply meant to be played but transfer different kinds of meanings, feelings, and purposes for players to experience. Overall, several groups in society have different access needs. These groups may share similar impairments that can be visual, motor, auditory or

cognitive, and many of these access needs often overlap [15]. Notable groups with access needs are people with disabilities and the elderly. They also need to engage with technology and gaming [16], as it is increasingly required in modern society for entertainment and serious purposes. In terms of digital games, accessibility issues arise when the game is unable to communicate feedback to users nor users can respond using conventional devices for a variety of reasons [15]. One person may experience more than one disability, and they can vary in their severity and the access attention they need when designing game accessibility.

2.2 Educational Games

Educational games are games designed for educational purposes or games that can be utilized for educational purposes by providing value for teaching and learning [17]. Educational games can also be referred to as serious games, game-based learning or gamification [7], which all aim for gamifying education, i.e., providing a way of motivating people to participate in a particular activity (education), or persist with it, using game-like elements, positive experiences, and incentives [18]. At best, gameful learning or gamification of education can enhance the learning experience through, for example, increasing motivation, facilitating sense-making processes, and encouraging curiosity [19, 20]. However, it may also be detrimental for long-term engagement [21] or promote antisocial behaviour, such as hyper-competitiveness [22]. These findings have been studied mostly with young adults, as they are the prominent target group in terms of gaming, but less research exists on the impact of educational games on the elderly in contrast. Hence, both the academic and educational field still lack a broad understanding of how educational games are experienced by older adults or elderly.

A recent systematic literature review by Koivisto and Malik [9] indeed states that more rigorous research on gamification utilized with older adults is needed. Their review analyzed 12 empirical studies in which a gameful intervention was implemented mostly in the health education and compliance domain, but also in the context of human-computer interaction. Results of the review report mainly positive outcomes; for example, enhanced engagement in training programs, clearer perceptions of self-efficacy and motivation, as well as increase in physical activity and positive emotions of social gameplay conditions. However, as Koivisto and Malik [9] point out, due to the limited sample size of the studies they analyzed and the studies' methodological shortcomings, these findings show mainly weak indications that older adults may benefit from gamification, thus further research is called for.

2.3 Designing accessible games for elderly learners.

When designing educational games as part of education for the elderly, key considerations are senior citizens' potentially deteriorating hearing, eyesight, memory, and hand dexterity [12]. According to Verma and Hätönen [23] people over the age of 65 have twice as many functional impairments as younger people. Furthermore, the ability of the elderly to function is often affected by various diseases and problems caused by sensory impairment, which should all be considered in designing accessible digital games for them. In addition to bodily limitations, cognitive challenges exist where many

seniors might find computers and the internet overwhelmingly difficult [24]. Today, however, information and communication technology, especially games, rely on sharp senses, reflexes and, specifically, the trinity of vision, dexterity, and memory, which are all often hindered by age. Overall, games' user interfaces are rarely suitable for elderly. As a person ages and the senses weaken, the elderly person may experience feelings of exclusion, and helplessness in the face of technology not designed for them, but simultaneously require its use in order to cope with modern society [25]. Game accessibility, hence, would ensure game access to the elderly through, for example, uncomplicated design and ease of use, as well as clear text under different conditions of use [12]. Hence, technology needs to be developed so that it is accessible to the elderly. The question then becomes: how do we design accessible educational games for the elderly? Or how can we adapt currently popular educational games to their needs to be adequately accessible?

3 METHODS

In the following paragraphs, topics related to the methods used in this research are discussed. Bringing out the implementation of the field experiments and introducing the educational games used, as the flow of the games and game mechanics. This section also presents how the research data was collected and introduces the research group.

3.1 Description of field experiments

In order to address the research questions presented, a series of user studies was conducted from fall of 2021 to spring of 2022 at community colleges in municipalities of Sastamala, Valkeakoski and Vanajavesi in Finland. The community colleges' aim is to develop new teaching methods and integrate gamification elements into existing courses for elderly students, to familiarize them with features of interactive technology and lower the threshold which inhibits elderly students from using new technology. The pedagogical approach used in this study was experiential learning. In this study, the target are adult and elderly learners. The methods that approach life-long learning and learning through one's personal work history are suitable for this research. Elderly people have acquired different skills during their life and work history, which is manifested in how they face a new kind of situation and relate to a new kind of technology. During the research, instructions are not given in advance at the start of the game, but the aim is to see how the elderly cope with solving the situation independently with the skills they have acquired through lifelong learning.

According to [26] experiential learning theory offers the foundation for an approach to education and learning as a lifelong process that is based in intellectual traditions of social psychology, philosophy and cognitive psychology. The model pursues the framework for examining and strengthening the critical linkages among education, work, and personal development. Experiential learning methods emphasize the critical linkages between classroom and the real world. Using these pedagogical approaches in this study helps to observe and guide the development of elderly and adult students' technological understanding.

In practice, a set of short lessons called "Threats on the Web: be safe in cyberspace" was developed for community colleges lectures, which aimed to teach elderly students about cybersecurity threats. The lessons were organized in two parts: in the first part, the students watched a short video tutorial on cyber security, at the beginning of the lecture. After that, the teaching continued with the discussion of the topics in the video presented as additional material. In the second part, the video contents were revised with the help of an educational game (Kahoot or Quizizz), which is the focus of this research. In total, four field experiments were conducted: two with Kahoot (at Sastamala and Valkeakoski), and two with Quizizz (at Valkeakoski and Vanajavesi). The purpose of the lessons and this research overall was to find out possible accessibility problems that can face the elderly, and how they react to and solve problems if they occurred during the gaming sessions. Field experiments were used to test the introduction of educational games to an actual classroom, rather than try that in an artificial setting that does not reflect reality. Surveys and interviews were used as they allow access to the inner thoughts and experiences of the participants. They were complemented with observations as people might not consciously reflect on all variables of interest.

3.2 Game flow and mechanics

Classrooms were selected from the classrooms where the education of the elderly in question would be organized normally. The students were not guided in choosing their seats as we wanted to observe if their seating or behavior would change after the game session started. And whether they would verbalize any problems in the overall natural environment and how they would try to resolve such problems as the study progresses.

The aim was not to explain too much about the rules of the games or how to use the mobile phone controls. Once the first question appeared on screen, some students reported confusion about how the game is to be played. Thus, the game was paused, and the researcher briefly recounted the course of the game and the rules of how to play it. The first question was intentionally intended as a training round. After the second question, the students got involved and seemingly caught on to the idea of the game. The purpose of this was to find out how intuitive the game mechanics were for the players and if they needed any advice to play the game. Intuitive in this context means how easily [26] the elderly knew how to directly use the game mechanics without instructions through their own previous life experiences. Although some of the players would have liked to play again and have a rematch, the educational game was played only once in all field test experiments.

The schedule of Kahoot! and Quizizz game sessions was structured in a slow pace, plenty of time was given for possible events or discussions during the games. Although the duration of the game was only four and a half minutes, the gaming session as a whole took approximately 30 to 40 minutes. Before starting the game, time was reserved for logging into the game. Possible problems with logging into the game were also taken into account in the schedule planning of the game sessions. There was also time at the end of the game for a free discussion (de-briefing) and for checking the results of the game. The questions answered in the game were related to the pre-game lecture.

In all Quizizz gaming sessions, the game had nine questions. Respondents had one right and one wrong option to choose from two options. The time to answer the question was 30 seconds. The total duration of the game was approximately eight to twelve minutes. The duration of the game was affected by the instructions given after the first round of questions. Sometimes, after the question, the students wanted to discuss the topic or celebrate their successful answer. In the Quizizz game, the question options appear both on the class board and on each game controller. Answer options are only visible on the game controller in Kahoot! (see Figure 1).

Kahoot game sessions had nine questions. There were four answer options. The game was structured so, that sometimes two of the options were correct and sometimes there was only one correct answer. The elderly had to notice the number of correct answers in the game. This was not instructed when the game started. However, instructions were given during the game if the students asked for advice on the number of correct answer options. In the Kahoot game, the students' question options are seen on the class board and the answer options are seen as four different colored symbols for the selected game controller, which can be a phone, computer or tablet (see Figure 1).

3.3 Kahoot! and Quizizz

Kahoot and Quizizz were selected for this study since the main author, who conducted the field experiments, has utilized them on a regular basis in teaching the elderly in community colleges and vocational education. The author has noted accessibility problems with said games, which was one of the reasons this research was initiated. Kahoot and Quizizz are internationally popular educational tools and are of similar design, yet, they have slight differences that can provide us insight on which design could be more accessible. As for research purposes, we perceived both to be sufficiently intuitive and simple enough to use so they would not increase technology anxiety within the elderly classrooms and could provide a smooth transition towards discussing their perceptions of educational games.

A game of Kahoot can be created and played on mobiles, tablets, computers, or any internet browser at www.kahoot.it free of charge, and paid licenses with additional features can be purchased. It resembles a traditional quiz with one question appearing at a time and four answer options to choose from. The question and the answer options are displayed on a shared screen, and students can select their answer using their personal device (see Figure 1.). Usually, Kahoot games involve a time limit and a live leader board that displays points earned and, eventually, the winner of the game. Quizizz is a similar software. A game of Quizizz can be created and played for free at www.quizizz.com with mobile, tablet or computer devices. Quizizz, however, provides more freedom in game types, features and interactive lessons. For example, Quizizz can be played as a live quiz at an “instructor-paced”, where participants progress together, or in a “classic” mode in which participants advance at their own pace. Both educational games, Kahoot and Quizizz, may be considered as a rather light employment of gamification of education. However, especially Kahoot is widely used and has shown various positive outcomes in recent research [27].

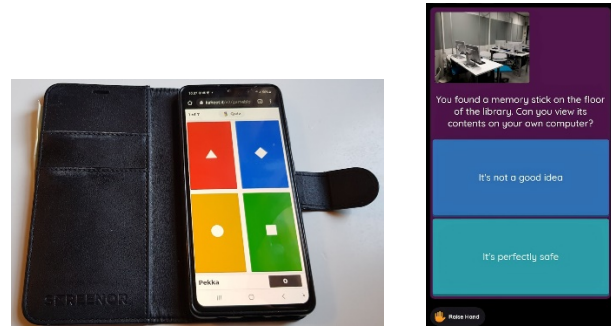


Figure 1: Kahoot! and Quizizz game interface on a smartphone

3.4 Participants

Participants were recruited from the three participating community colleges to participate in the “Threats on the Web: be safe in cyberspace” lecture as well as in research. Participation was voluntary and had no effect on the learning performance, or course evaluation. A written consent was collected from participants in which the research procedure and ethical principles were explained, and anonymity was ensured. In total, 27 students decided to take part in the research.

The age of the students varied between (41-50) - (81-90) years-old. Valkeakoski and Vanajavesi Community Colleges had 21 participants, who filled in the information on a survey, and their age distribution was 0% (31-40), 6% (41-50), 12% (51-60), 38% (61-70), 31% (71-80), 13% (81-90) 0% 91-. 82% of the students were over 61 years. The age of Sastamala college students was only asked verbally and in approximation was six students, aged 60 to 80 years old.

3.5 Data collection

Both observation and survey data were collected during the field experiments. Observation data [28] aimed to gather information on the accessibility of the physical learning environment settings and how it affects gameplay, such as the distance of the students from the blackboard, the lighting of the classroom, the glossiness of the screen/blackboard, the acoustics, as well as how the students behaved normally and especially when problems related to the classroom environment arose during gameplay.

Observations were recorded in diaries during and after the sessions. The employed survey was in Finnish, based on a modified and abbreviated version of the PLEX framework [29, 30], which aims to gather information on the experiences and feelings of players. Participants were asked to choose as many experiences as they wanted to describe their feelings and perceptions during the gameplay sessions of. The options in the survey, roughly translated to English, were accomplishment, challenge, communality, competition, concentration, different from normal teaching, empathy, excitement, frustration, humour, imaginative, inspiring, mastery, novelty, relaxation, rousing, self-expressive, unpleasantness. Students also had an open space to freely describe their experiences otherwise.



Figure 2: The white canvas, rolled up on the right side of the chalk board, used during the gaming session at Sastamala Community College

The students were given the following information security details of the game. The students were informed at the beginning of the game that playing the game does not require downloading the game to their phone or device. They were informed that playing does not require logging in or sharing personal information. They were also advised that they could use their first name, nickname or any other moniker of their choice in the game.

4 MAIN FINDINGS ON USING KAHOOT! WITH ELDERLY

The findings from two field experiments, one of which was conducted at Sastamala Community College and the other at Valkeakoski Community College, will be presented next. Introducing findings of utilizing Kahoot game to support teaching in an elderly students' group.

4.1 Sastamala Community College studies

At Sastamala community college six students, aged 60 to 80 years old, took part in the research. The students used their personal smartphones as a game controller for Kahoot (see Figure 1). At the beginning of the game session, participants were asked how many of them had previously played anything digitally, and only one student came forward. None had previously tried Kahoot. Once the game of Kahoot was initiated, a few students moved closer to the canvas on which the game was projected (see Figure 2). One of the students even said out loud that the questions were hard to see. Thus far, the canvas had been used in-class with no concerns, which perhaps indicates that the game had smaller than average fonts and/or low contrast. Once the first question appeared on the screen, the students reported confusion about how the game is to be played. Thus, the game was paused, and the game was briefly explained. The first question was intentionally intended as a training round. After the second question, the students got involved and seemingly caught on to the idea of the game. They appeared excited, enthusiastic and initiated competition with each other as well as encouraged each other to perform better.

After the session, the students received the survey. Four out of the six participants reported experiences of competition and novelty, whereas rousing, humour, and accomplishment were selected two times each. Finally, orientation, excitement, challenge and mastery were selected one times each. None of the participants selected

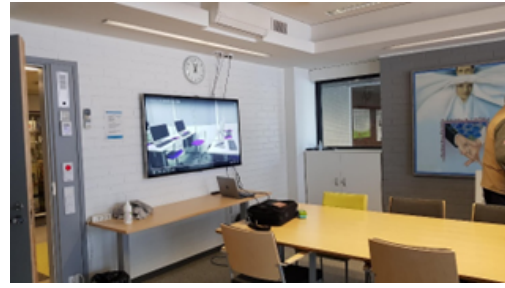


Figure 3: The screen utilized in Valkeakoski community college

unpleasantness, self-expressive, imaginative, relaxation, inspiring, frustration or sympathy. The open-ended answers show that the students perceived the learning situation as positive, motivating, pleasant and useful, and gave a sense of accomplishment. However, one of the participants stated that the game did not add much value to learning and resembled school pop quizzes. As the biggest accessibility shortcomings, almost all participants mentioned that the game was too fast, although we had set the response time to 30 seconds instead of the default 20 seconds.

4.2 Valkeakoski Community College studies

At Valkeakoski community college, seven students took part in the research, although only one of them filled out the survey. Four of the participants used their smartphones as a game controller and two shared a tablet. Once the game started, the students stated that they were not able to see the question-and-answer options on the screen, as the screen was too small (see Figure 2). The participants were urged to move closer, but no one wanted to change seats. As a result, the questions-and-answer options had to be read out loud so the game could continue. During the session, one of the players expressed difficulties understanding the game idea. Several players also had difficulties answering within the allocated time (30 seconds). However, they voiced out during the gaming session feelings of too fast game pace. They felt that the questions appeared too quickly, font sizes were too small, logging into the game was difficult as it was in a foreign language and the game rules were difficult to understand. However, one student commented during the game session in a positive tone that: "My heart rate rises while playing this game".

After the session, the students received the survey questionnaire. They chose the options of rousing, accomplishment, concentration, communality, competition, humour, relaxation, inspiring, empathy, different from normal teaching. In the open answers, they described the game session interesting, as fun and useful in terms of supporting the lesson.

5 MAIN FINDINGS ON USING QUIZZ WITH ELDERLY

The findings from two field experiments, one of which was conducted at Valkeakoski Community College and the other at Vanajavesi Community College, will be presented next. Revealing findings of utilizing Quizizz game to support teaching in an elderly students' group.

Table 1: Open answers related to accessibility and overall experiences of the teaching situation.

Open Answerers	Did you experience any problems while playing? For example, the game is in a foreign language, the rules are difficult to understand, or the font size is too small.	Write in your own words how you experienced the teaching situation
Student 1.		The teaching session was quite fast-paced and first I didn't think I learned anything. With the help of the game, I discovered that I had learned something about the subject after all, which was a nice and motivating feeling.
Student 2.	In the beginning, I didn't know how to be fast enough when a question came. Then it was no longer possible to select the right answer. Once I noticed this, everything went well.	
Student 3.		I want to learn more!
Student 4.	For that game, I would have liked clearer/more detailed instructions in advance. For example, that more than one option can be correct. This confused me a bit, thinking it could be this way or this way, but I figured there was only one to choose.	Otherwise, your visit was really pleasant and useful. It would be very nice and interesting to have you in our class again.
Student 5.		Competitive games in teaching are fun when implemented from time to time, but as a competitive person (bad loser) I would often find them stressful.
Student 6.		In my opinion, playing the game did not add value to learning the subject in class, I mainly remembered the school pop quizzes. Nice change though :).

Table 2: Open answers related to accessibility and overall experiences of the teaching situation

Open Answerers	Did you experience any problems while playing? For example, the game is in a foreign language, the rules are difficult to understand, or the font size is too small.	Write in your own words how you experienced the teaching situation
Student 1.	The questions came a little quickly.	Interesting and experience and fun. The topic of the lecture was conveyed well with the help of the game.

5.1 Valkeakoski Community College studies

At another session in Valkeakoski, Quizizz was utilized. To play the game, one student used their smartphone and the other seven used computers. Quizizz's instructor-paced mode was used in tall Quizizz sessions. Logging into the game caused problems for all students. as the game was in English, a foreign language to the students, and the website address was perceived as challenging to type without error. One of the participants even accidentally ended up on a fake hoax website that was made to resemble the original Quizizz game site. As the game session started, three students expressed excitement about revising what they had learned using a game. Students also voiced concerns such as: "Am I able to play this game, is it too hard?". As the game progressed, two students mentioned that the game's pace was too quick at a 30 second pace and that it was difficult to see the screen which had a lot of glare (see Figure 3.).

Hence, the lights were turned off, which improved the situation along with using Quizizz's dark mode (see Figure 3).

After the session, the students received the survey questionnaire. The questionnaire was edited based on the experiences gained from the Sastamala Community College by simplifying some words to increase understandability.

Five out of the eight participants reported experiences of novelty and concentration whereas the options of relaxation, different from normal teaching, and inspiring were selected four times each. Rousing, accomplishment, empathy were selected three times. Frustration, mastery and humour were selected two times, and finally, communality once.

None of the participants selected competition, excitement, challenge, imaginative, self-expressive, nor unpleasantness. In the open questions, students repeated that the experience was interesting,

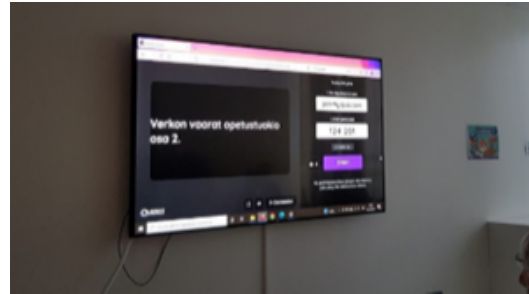
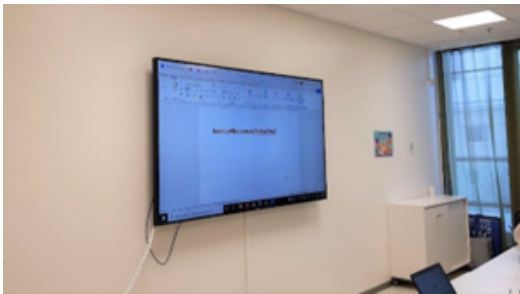


Figure 4: Canvas used at Valkeakoski Community College before and after light adjustments

Table 3: Open answers related to accessibility and overall experiences of the teaching situation

Open Answerers	Did you experience any problems while playing? For example, the game is in a foreign language, the rules are difficult to understand, or the font size is too small.	Write in your own words how you experienced the teaching situation
Student 1.	No problems	Pretty good It went a little fast Was interesting New experience Interesting, keeps motivation up, if the level is suitable: not too easy and not too difficult I'm old and slow Nice new experience
Student 2.	No	
Student 3.	I don't play	
Student 4.	The games have been easy, usually logging in is the hardest part	
Student 5.	I haven't played before this session	
Student 6.	Foreign language, rules	
Student 7.		
Student 8.		

nice and novel for them. However, they also expressed that the game's pace was too fast for them, and that the level of difficulty was appropriate, although logging into the game was the hardest part of the session.

More multiple-choice questions and open questions had also been added to the survey to get more information about accessibility and the participants' gaming background. Three out of eight had not played digital games before. Four had used computer, three phones, game console and board games for gaming, two had used tablet. The open-ended answers revealed that the respondents had not played much because they are not interested in games. In answer 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 stated: "games have been easy but, usually logging in is the hardest part". Another student had problems with foreign language and game rules.

5.2 Vanajavesi Community College studies

At the fourth and final session at Vanajavesi all six participating students used computers as the gaming device. Again, all students had difficulties logging into the Quizizz game (see section 5.1). Once the game started, similarly to previous reported sessions, all students expressed that the game questions appeared too quickly. It took a few questions for the students to get the game and get along with it. As the game progressed, the atmosphere was seemingly

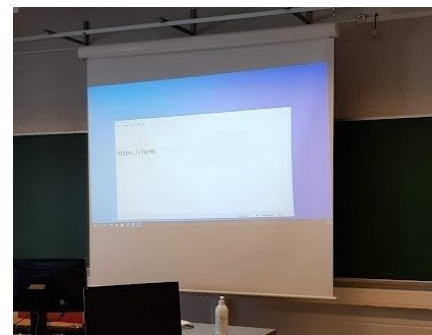


Figure 5: Canvas used at Vanajavesi Community College

positive, and the students cheered when they managed to get points in the game. The winner of the game cheered out spectacularly and the others clapped excitedly after the game ended. In terms of the physical space, the classroom was considered suitable for teaching the elderly: the screen was big, and the lighting was sufficient. Nobody had any problems seeing the canvas (see Figure 5.).

In the survey, two out of the six participants reported experiences of competition. Rousing, challenge, accomplishment, mastery, novelty, imaginative, excitement, concentration, inspiring, different from normal teaching were selected once. None of the participants selected unpleasantness, self-expressive, communality, humour,

relaxation, frustration, nor empathy. The background questions indicate that four out of six had not played digital games before, two had played on phones, tablets, computers and game consoles. Three had played board games. The survey revealed that they rarely played and did not like gaming so much due to their lack of experience. Overall, students stated that the gaming session was a good and pleasant experience for them, and that the teaching situation was a pleasant experience.

6 DISCUSSION

In this study, the intention was to find out how elderly students experienced digital games as a support for teaching, and to examine the accessibility of the popular educational games: Kahoot and Quizizz. Our findings indicate that educational games can be used to support teaching with older students when close attention is paid to the accessibility of the experience as a whole. Additionally, we observed that educational games may lower the threshold to try new technologies for the elderly as it allowed them to gain experience in using their own digital devices. Overall, the use of educational games as part of the classroom activities was a novel and a positive experience for the participants. The participants also noted aspects of excitement, novelty, fun, control, communality, and accomplishment that Kahoot and Quizizz provided.

In terms of accessibility, the central issues were the suitability of the learning environment for the game, logging into the games, game language, as well as the pace of the game. Participants also found the game too fast-paced and the size of the canvas presenting the gameplay was especially detrimental for their game experience. In the experiment, it was noticed that the mechanics of the game were not intuitive for all the elderly who were previously unfamiliar with games and playing. Some of the participants needed instructions as the game progressed, while others started without preconceptions by experimenting to get to know the mechanics of the game independently.

As our findings show, a key to utilizing games in education with the elderly, and people with disabilities by extension, is not only about creating new engaging games or gamified approaches for people with disabilities or the elderly, but allowing for an opportunity to participate, explore and learn. Through meaningful pedagogical methods, some modifications, when possible, patience and teacher involvement, the elderly were able to experience the possible educational benefits of games and gamification. Games and gamification ceased, at least temporarily, to be unusable or irrelevant to the elderly. This goes to show that a key to the perceived challenge elderly have with games is not merely cognitive or technology illiteracy. It is, above all, a design challenge where the elderly simply struggles to use technology not made for their needs, eyesight, dexterity, and so on. The first barriers to the games understudy, for example, were font sizes, time limits and matters of game accessibility, rather than the mechanics of the games.

This study of the needs and wishes of elderly informs future implementations of accessible games that can further improve the use of games with these groups. However, accessibility should not be implemented to a game as an afterthought, but an integrated part of it, preferably designed with the aid of a diverse group of

test players. This is to make sure accessibility is addressed meaningfully. In line with Aguado-Delgado et al. [3] we see accessibility as an essential part of future gaming as it creates opportunities and facilitates novel ways of meeting players' and users' complex needs. It's about fostering equality and providing a better game experience not only for the elderly or the disabled, but for all, which is why it should be taken into consideration with any technological, educational or gamified design.

Finally, it is important to consider the ongoing shift in today's gaming industry. The range of player demographics is expanding continuously, showing growing numbers of, for example, female gamers, and a broad range of ages and disabilities [31]. Hence, players are increasingly heterogeneous with various needs and abilities, which calls game developers for new kinds of actions and methods. Furthermore, modern society worldwide is undergoing a demographic shift in terms of population aging and people living increasingly healthier lives with longer life expectancy [32], which is why investing in diverse opportunities for technology usage and user experience is required.

6.1 Practical implications

The observed accessibility barriers indicate that the preparations of utilizing games with the elderly may differ greatly from planning education for, for example, younger adults. Physical classroom settings, lighting and the size of the utilized board play a significant role in facilitating the accessibility of the gaming sessions. By adjusting game settings in terms of pace, colors, and brightness, as well as classroom design in terms of seating, lighting, and distance (from gaming equipment, teacher or others), educational games may be integrated in a more accessible and comfortable way. Logging into the game could be made more accessible by having shorter web addresses, use of different languages in URLs, or using QR codes, which could be unfamiliar to elderly, but through instruction and guidance could be learned.

Overall, both psychological as well as physiological aspects need to be considered when designing accessible gaming sessions for older students, in order to facilitate positive experiences with digital devices to tackle possible prior fears and insecurities. When accessibility is ensured, as our findings indicate, gameful approaches can serve as educational tools to familiarize the elderly with new technologies, essential for modern life. Games encourage exploration, interactivity and experimentation [18]. Additionally, after failing or losing, games usually offer the player a new trial, providing them opportunities to learn from their mistakes and gain new insights and skills to proceed with the game [18]. These sorts of affordances provide an ideal environment to learn.

Furthermore, as our field experiments show, games might be a proper tool to lower the threshold of, for example, using new technologies, such as using phones for the first time (see section 5.1). Games of Kahoot and Quizizz were at first experienced as difficult and confusing, but through experimenting and following guidance, the games were seen as novel and fun. Additionally, even though only a few participants stated that they have played digital games before, it is probable that most of the participants were familiar, at least to some level, with traditional games, such as card games, board games, quizzes and crossword puzzles, which

largely utilize similar features as modern-day gamification. Tapping into this familiarity, rather than relying on novelty, can perhaps make game-based learning and gamification more approachable and comfortable for the elderly.

In addition to positive outcomes from the use of the games in the field experiments, students of our case study also stated feelings of competitiveness, which might not always facilitate learning or motivation [17]. Especially in educational contexts, competitiveness can be seen as harmful, which is why cooperative games are more often aimed to be employed in classrooms. However, with as small experiment as showcased in this study, competitiveness might have been an exciting and a new way for the participants to engage short term in classroom activities. Frustration was stated in the survey. The fast pace of the game can cause feelings of frustration in students, which can hinder learning.

6.2 Limitations

As with any research, this study has its limitations. Firstly, we employed a combination of observational and survey data, each with unique limitations. Observations are subjective and notable events could have been overseen by the researcher. Surveys are self-reported and subject to misunderstanding. Secondly, the participants of the studies were self-selected and hence, it is possible that they had a more favorable disposition towards technology and learning. Thirdly, the sample size of the studies is relatively small. This, however, is expected given the involved, qualitative research design utilized in this study and was compensated for through the conduct of four field experiments throughout three different municipalities in Finland.

6.3 Future research

In the future, we intend to continue this study by expanding the data collection and analysis. The aim is to provide more empirical data and insights from real-life examples with elderly students. This research highlights the need for more research on the accessibility of educational games, especially in emerging mediums, such as VR or AR. Based on our findings, we intend to collect further results, especially from older age groups aged 65 and older, in order to obtain unique information about the group of elderly people in a targeted manner. We additionally intend the outlined emerging technologies of VR, AR and their reception by the elderly. Such participants need more strategic purposeful sampling, and we advise researchers to widen the scope of participants they recruit and define as elderly, not just in terms of age, but also in terms of gender, educational level, disability, and other such personal factors.

It is possible that the accessibility challenges noted by the participants may be experienced in the population at large. We encourage future researcher to examine alternative designs of educational tools to find out what could be appropriate default font and contrasting settings as well as accessible design at large.

7 CONCLUSIONS

In this research we studied the accessibility of educational games of Quizizz and Kahoot! with elderly students. We conducted four field experiments at community colleges in Finland and collected data through observations and a survey questionnaire. Our findings

indicate that educational games can be used to support teaching with older students when close attention is paid to the accessibility of the gaming experience as a whole. Educational games were perceived positively as novel and fun.

In terms of accessibility, the central issues were logging into the game, game font, contrast, lack of voice over and use of a foreign language in game. We recommend practitioners to use QR-codes or shorten the game URLs, which might foster usability. Physical classroom settings, lighting and the size of the utilized board play a significant role in facilitating the accessibility of the gaming session. Overall, both psychological as well as physiological aspects need to be considered when designing accessible gaming sessions for older students, in order to facilitate positive experiences with digital devices to tackle possible prior fears and insecurities.

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