Older Adults and Games from a perspective of Playability, Game Experience and Pervasive Environments: A Systematics Literature Review

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Abstract. Games have had a growth and have been applied in different areas other than fun or entertainment. In the case of older adults, they are used as a mechanism to increase physical activity or improve cognitive training. Traditionally, games generate entertainment through consoles with motion sensors, traditional digital games or mobile devices. These initiatives can be improved when used in older adults considering the particularities of these people. Improvements can focus on both the gameplay and the design of the experience offered to the player as well as their subsequent evaluation. For this reason, we conducted a systematic review of the literature to identify the actual advances in these areas. Also, through the review it was possible to identify that games have been used to generate deeper and more complete experiences such as those offered by pervasivity in a variety of contexts.

Keywords: Pervasive experiences, Playability, Older Adults, Game Experience, Player Experience.

1 Introduction

Traditionally, digital games have been associated with young people as a means of entertainment and enjoyment since their launch in the decade of the 70 [1]. These digital games have been directly affected by the current technological development, allowing it to evolve rapidly by offering new and varied entertainment systems, including computers, video game consoles, mobile devices such as smartphones and tablets, virtual reality (VR), augmented reality (AR) and virtual assistants.

The evolution of games has allowed them to be used as a means different from entertainment, where areas such as education, business and health have made use of them for teaching and rehabilitation purposes through serious games. In the health area, they are used by people of all ages to promote physical activity and cognitive training. In addition, games are not only used by young people, but also by adults (30 to 59 years old) and older adults (60 years and older), the latter represent 21% of the total number of players and are the second largest population group [2].

Currently, there are evaluation mechanisms to measure the players' experience and its impact during the game, considering the game design and the elements that compose the game. However, depending on the target audience you want to evaluate, the environment may change drastically and you may need to add new elements or adjust existing ones in order to measure objectively. For example, the particularities of older adults such as response times or possible cognitive impairment make it necessary to adjust these assessment methods for this particular population.

Among the different theories and tools used for the evaluation of these elements, the following stand out: Game Experience Questionnaire (GEQ) [3], Player Satisfaction Need Experience (PENS) [4], System Usability Scale (SUS) [5], among others.

For this reason, the following section will address the background of older adults and games, definitions of pervasive games, mechanics and dynamics game, playability and game experience. Section 3 describes the planning of the systematic literature review. Section 4 shows the data extraction activities performed on the relevant articles found and the results obtained with ratios and figures. Finally, section 5 discusses conclusions and future work.

2 Background

A related work previously done is the one executed by Rienzo and Cubillos [6], which analyzes digital games for older adults but not of the pervasive type. To better understand what is proposed in this paper, issues related to gaming and older adults, the concept of pervasiveness, game dynamics and mechanics, and the differentiation between Playability, Player Experience and Game Experience have been studied in depth.

2.1 Older Adults and Games

The first record of the application of digital games in older adults dates back to 1987, which was aimed at evaluating the cognitive improvement that could be achieved by playing video games, specifically in response times for decision making [7]. From that research to date, the landscape has not changed much, being cognitive processing, physical activity and social interaction the main focus of research, making use of different devices such as PC, consoles, sensors such as Kinect, Nintendo Wii Controllers and others.

2.2 Pervasive Games

The pervasive games represent a gaming feature that allows virtual game experiences are transferred to the physical world, making use of technology to achieve this as motion sensors, VR, AR, geolocated, among others. In this type of games, the dynamics evolves from the information provided by the context where the game is played, breaking the limits of the magic circle by not being limited to a specific place, for a limited time and with determined people [8].

2.3 Dynamics and Mechanics

These terms are related and used synonymously, but they are different properties that work together. The dynamics in a game generally establish how the mechanics and the player interact in real time. The mechanics are the various actions, behaviors and control mechanisms, defining how the game-based system will work. [9]. In short, the dynamics establish what you want to achieve with the game, while the mechanics establish how you achieve it.

2.4 Playability, Player Experience and Game Experience

The concept of playability, also defined as "Gamefulness" or "Gameplay" can be interpreted in different ways when measuring a game's quality. Playability is normally used to evaluate the game as a software product that must be analyzed in detail to determine its quality and characteristics according to the game-based system to be evaluated. Player Experience (PX) is the measurement of the quality of the player's experience, being this directly related to the user experience (UX). Game Experience is oriented to evaluate the experience provided by the game in general to all players, that is, what all players perceive as a group, even those who are not playing directly during the game sessions and live it from a much more social point of view [6].

3 Systematic Review

Systematic literature review is a method focused on analyzing, evaluating and interpreting all important studies related to a research question, area or phenomenon of interest. This type of processes originated in medicine due to the increasing amount of research in each area. Some proposals have been defined for the application of these protocols in the field of software engineering, and of these proposals the established by Kitchenham and Charters [10] stand out, which define a series of steps or phases for the application of these protocols in the software field. These phases are used in this paper and the process is described below.

The main objective of this systematic review was to determine the current status of games oriented to older adults from a playability perspective, game experiences and pervasivity, in order to identify the existence of metrics or indicators of enjoyment, adjusted to the specific characteristics of this particular population. In addition, we

wanted to find trends concerning the focus of attention on pervasive games, or otherwise on non-pervasive games oriented to localization in closed spaces (motion sensors) or traditional digital games in which one interacts through a controller or keyboard, and the process of acceptance by older adults to this type of technologies. Finally, we looked for the most used dynamics and mechanics in this context of application of games, all oriented to support active aging. To achieve the above, the following research questions were established to guide the systematic literature review process:

- **RQ1:** Are there metrics or indicators of fun or entertainment in pervasive games oriented to the specific characteristics of older adults?
- **RQ2:** What are the different focuses of pervasive games currently applied to older adults?
- **RQ3:** How has the process of acceptance of older adults to the use of games through technology?
  RQ4: What are the main dynamics and mechanics used in the game processes applied to older adults?

3.1 Search Terms

According to the protocol of the chosen methodology the related concepts are the following:

— Pervasive games	— Playability	— Game experiences
— Older adults	— Older people	— Games and fun
— Active Aging		

3.2 Search Process

For the exploration of documents and related studies, a query string was defined using logical operators and relevant words to efficiently filter the results to be obtained. The process was limited to relevant studies from the last 5 years, being this process carried out on July 1, 2021. Based on these identified elements, the following query string was established:

- ("elderly" OR "older adult" OR "older people") AND ("gam*") AND ("experience" OR "pervasive" OR "playability")

3.3 Inclusion Criteria

- Papers published between 2017 to current date (Last 5 years).
- Papers published as a result of conferences, congresses or journals.
- Papers presented in English.
- Papers included in the databases Science Direct, IEEE xplore digital library, ACM digital library, Scopus, Web of science and Springer link

3.4 Exclusion Criteria

- Papers not related to the subject of the systematic literature review.

- Paper only with table of contents or curriculum vitae, which did not exceed 2 pages.
- Papers with a playability / game theme, evaluation of experiences or pervasive experiences not applied to an older adult context or intergenerational practices.

3.5 Extracting Information

Running the query string in each database without filters (only the string without the inclusion criteria) returned a total of 50,663 documents. In each database the inclusion criteria were applied and the documents were reduced to a total of 358. Table 1 shows in detail the results obtained:

Table 1. Queries results. Matrix of results of each databases and query strings

String database	Results without inclusion criteria	Results with inclusion criteria	%
Science Direct	24	12	3.3%
IEEE xplore digital library	51	19	5.3%
ACM digital library	11	4	1.1%
Scopus	950	129	36%
Web of science	177	85	23.7%
Springer link	49.450	109	30.4%
Total	50.663	358	

4 Data Analysis and Results

Each of the papers identified, applying the inclusion criteria indicated in Table 1, were analyzed in detail by reading their title, abstract and finally their content, validating that each one was related to the research topic. The results obtained are presented in Table 2, where the accepted (A), rejected (R) and duplicate (D) papers are shown.

Table 2. Results of the analysis of titles and abstracts

Databases	Total	D	%D	A	%A	R	%R
Science Direct	12	0	0	2	16,6	10	83,4
IEEE xplore digital library	19	0	0	11	57,8	8	42,2
ACM digital library	4	0	0	1	25	3	75
Scopus	129	26	20,1	56	43,4	73	56,5
Web of science	85	5	5,8	20	23,5	65	76,4
Springer link	109	3	2,7	14	12,8	95	87,1
Total	358	34	9,4	104	29	254	70,9

4.1   Process Description

Initially, the query string established in each database was executed by applying the inclusion criteria, obtaining a total of 358 papers. In addition, one article obtained from a source other than the chosen databases was included because it was relevant to the research topic and its high citation in other related works, this one satisfies all the other inclusion criteria. The next step consisted of applying the exclusion criteria based on the title, reducing the total number of papers to 223. Subsequently, the exclusion criteria based on the abstract were applied and the total number of papers was reduced to 137.

From the process applied, a 29% acceptance rate was obtained from the total number of papers obtained from the application of the inclusion criteria, corresponding to 358 papers and 1 obtained from other sources. Subsequently, each of these was classified into different topics of interest, according to the main objective of each paper. For the complete list of papers, their classification and required codes, see Appendix A.

4.2   Results

Some of the questions established in this review are specifically oriented to pervasive experiences and others to play experiences in general. Table 3 shows the total number of game types used in each of the papers identified. It should be noted that the categories corresponding to "Does not apply" are related to papers such as systematic reviews or methodological definitions of game applications in older adults, where it was not possible to establish a specific type of game. In addition, the "Not specified" category refers to game experiences in which it was not possible to identify the type of game due to the ambiguity of the description of the game applied. With this information obtained, the research questions previously posed are answered:

Table 3. Results by game type

Game type	Total	Game type	Total
Motion sensors in enclosed space	35	Motion sensors in open space	4
Classic games	32	Not specified	3
Pervasive	15	Classic games and motion sensors in closed spaces	2
Does not apply	13	Classic and pervasive games	1

- **RQ1 Are there metrics or indicators of fun or entertainment in pervasive games oriented to the specific characteristics of older adults?** Of the 15 games specifically oriented to pervasive experiences, and of the initiative that uses pervasiveness in conjunction with traditional digital games, there is no model fully adjusted to the particularities of older adults that evaluates fun and entertainment. The application of existing models such as the GEQ and PENS was found in 3 of the works with superficial adjustments in order to evaluate particular elements of the participants. Of these initiatives applying pervasiveness, only 6 were focused on documenting

elements of fun or playability [11–13]. 12 papers presented comments and recommendations on particular elements that should be taken into account in the design of pervasive experiences applied to older adults, examples of these are A. Mol [14] and R. Tahmosybayat [15]. Finally, as can be seen in Fig. 1, only 1 paper presented a total of 13 open-ended interview questions [16], which was an attempt to evaluate the general experience of older adults, but without exploring the particularities of this population.
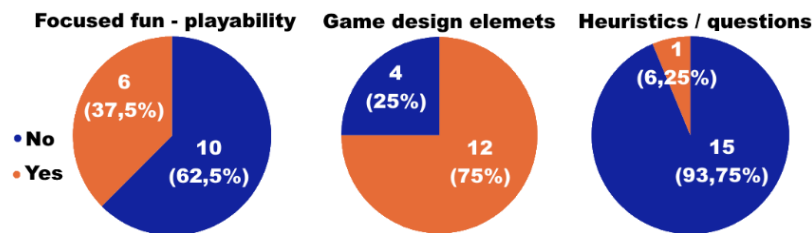

Fig. 1 Results by game elements oriented to the characteristics of older adults.

- **RQ2 What are the different focuses of pervasive games currently applied to older adults?** It was identified that initiatives to implement pervasive experiences in older adults have been found to focus primarily on the generation of social and emotional well-being for example, the research E. Cerezo [17], followed by physical activity [18]. Some research has tried to implement more than one simultaneous approach, such as physical activity and the generation of well-being [14, 16]. In the findings identified, the absence of pervasive experiences for cognitive training stands out, being this applied only on one occasion and not as the main research objective [19]. As shown in Fig. 2, the implementation of pervasiveness for entertainment, fun and active aging is still incipient, with few efforts in this field and with the possibility of extensive research in this area of study.

Fig. 2 Focus on pervasive games

- **RQ3 How has the process of acceptance of older adults to the use of games through technology?** In the different papers identified, for pervasive and non-pervasive experiences, the acceptance processes of older adults were positive as long as a previous process of training and accompaniment was carried out for example as reported by S. Subramanian [20], to achieve a basic control of the technology and

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thus achieve a pleasant experience in the applied games. In addition, it was identified that older adults have a greater acceptance of the technology and the applied games when there is a perceived possibility of improvement in health as a result of a constant execution of this, such as physical activity and cognitive training, as demonstrated for example in the work of S. Merilampi [21]. As can be seen in Table 4, such motivation in older adults is reflected in 69% of the total accepted research, being this a focus of interest in the application of games in general.

Table 4. Active aging results

	Physical activity	**Cognitive training**	**Active aging**
Yes	47 (44,76%)	33 (31,43%)	69 (65,71%)
No	46 (43,81%)	58 (55,24%)	25 (23,81%)
Does not apply	12 (11,43%)	14 (13,33%)	11 (10,48%)

- **RQ4 What are the main dynamics and mechanics used in the game processes applied to older adults?** As can be seen in Table 5, a variety of dynamics applied in the research focused on older adults were identified, highlighting those oriented to physical activity, cognitive training and the application of immersive and non-immersive experiences, example of this is the research of S. Merilampi [21]. Regarding the mechanics implemented, a high percentage of application is found in the use of challenges, the experiences offered, the obtaining of points to evaluate the performance of the participants, the findings and the thematic application to improve the experience lived by the older adults.

Table 5. Results of the applied games dynamics / mechanics

Game dynamics	**Total**	**Game mechanics**	**Total**
Physical activity	25	Challenges	31
Does not apply	22	Does not apply	21
Cognitive training	14	Experience	12
Others	44	Others	41

5 Conclusion and Future Work

The main objective of this systematic literature review was to determine the current status of games oriented to older adults from a playability approach, the play experiences offered and the current state of pervasiveness applied to this population. This was done, in order to identify the existence of metrics, indicators or heuristics of fun oriented to the older adult population and adjusted to their particularities.

Different applications of games in older adults make use of games that are not oriented to the particularities of this population, only commercial games focused on a younger segment and with different needs are applied, which does not allow providing

a totally satisfactory experience. However, there are some research initiatives that adjust some elements to the needs of older adults, but the evaluation systems applied to measure the game experience and the quality of the game itself as a product are still traditionally applied. These evaluation systems, although scientifically validated and offering good results, could be improved if they were fully adjusted to the preferences, needs and particularities of people over 60 years of age.

The implementation of pervasiveness oriented to older adults is still in an incipient state, due to the fact that no efforts have been focused on this specific field of research, oriented to offer deeper experiences to the participants, taking the game from the virtual world to the real one, with a comfortable theme, a deep narrative and allowing social interaction between the different participants. In this aspect, we cannot confuse the application of devices such as Kinect or Nintendo Wii, which, although they are controlled with physical movements in the real world, are missing the integration of more elements to be considered pervasive experiences.

As future work, indicators, metrics and evaluation systems adjusted should be established to measure the game experiences lived by older adults, in order to carry out deeper and more objective analyses. In addition, game design processes should be established that focus on the motivations and expectations of the participants, from a socio-cultural approach, applying new forms of experience such as pervasiveness, promoting active aging at the physical, cognitive and emotional levels.

Appendix A

This information is available in: https://tinyurl.com/ReviewOlderAdultsGames2

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