

Casual mobile games for the elderly: a usability study

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Abstract — The elderly population is increasing in Brazil. According to the Brazilian Institute of Geography and Statistics (IBGE), in the last ten years the elderly population increased 47,8% while the increasing proportion in the overall population was 21,6%. This fact raises the need for new forms of leisure and entertainment for this audience. Casual games on smartphones constitute an option for them. This paper presents the results of a usability evaluation of casual games for smartphones, considering the elderly. Each elderly who participated in the evaluation was asked to play five casual games installed on a smartphone and also to answer questionnaires. The contents of these questionnaires were based on a set of heuristics, obtained by the analysis and organization of guidelines collected from the literature, as well as other issues proposed by the authors. This study aimed to evaluate whether the set of used heuristics is valid to assess the usability of casual games on mobile device, focusing on the elderly. The results point to the need of interface adjustments on mobile casual games for the use by the elderly and also the need of exploring more this topic.

Keywords — *casual mobile game; usability; older users*

I. INTRODUCTION

In Brazil the elderly population grows continuously. According to the Brazilian Institute of Geography and Statistics (IBGE)¹, in 2010, people in this group accounted for 10.5% of the Brazilian population, corresponding to more than 20 million people. In the last decade the elderly population grew 47.8% while the total population growth in the country reached 21.6%.

The corresponding age group for the elderly is defined according to the level of development of each country. In developed countries, the World Health Organization (WHO) considers elderly, a person aged 65 or more. However, in developing countries, like Brazil, it is considered elderly a person aged from 60 years, inclusive.

To provide quality of life for elderly people it is necessary to identify forms of leisure and entertainment for them [2, 4, 22]. In this context, digital games are a promise to improve the lives of the elderly, as games can promote physical well-being and mental health, besides offering fun to spend time [19, 30].

The advancement of technology has provided people the opportunity to communicate with each other very easily, especially through devices such as mobile phones. In particular, the use of this type of device is growing, even by the elderly. As presented by the research TIC Domicílios 2011², 52% of people aged over 60 years have a mobile device; in 2006, they accounted for only 18.9%.

Despite the growing use of technological devices, users may be averse to the adoption of innovations. The elderly adopt a technological innovation when they identify any use to their life; they do not adopt something just because of being new [34]. Some factors may influence the decision whether to adopt an innovation, for example, the functional barriers which are related to the use of innovation and technical components such as the developed interface [25]. One barrier for the use of mobile devices by the elderly is that, in general, applications available for these devices were not designed for them. The interface of these applications, in general, does not consider the physical and cognitive limitations due to the natural aging process and, therefore, for example, presents content with small components [1, 4, 8, 9, 23].

The usability of mobile applications is of great importance, because it minimizes the difficulty of user interaction [4, 6]. Usability is considered by ISO/IEC 9126 one of the characteristics of software quality, and it is defined as the capability of the software product to be understood, learned and used, and also its ability to please the user, when used under specified conditions [6].

Given this definition and the current context, it is necessary to understand how the components of the interface of a mobile game influence the old user experience [27]. In particular, in this work we address casual games, because they “are considered to be something easy and quick to pick up and drop” [32]. Besides that, they are inclusive, non-punishing, “tend to speak to a player’s desire for fun and relaxation, rather than the desire for adrenaline or sensual stimulation” and, in general, they do not “overt violence” [33].

This paper presents the results of an evaluation of the use of casual games on smartphones by elderly users, checking their preferences and difficulties restricted to the tested games.

This paper is organized as follows: Section 2 presents the theoretical background, Section 3 presents the methodology

¹ http://www.ibge.gov.br/home/estatistica/populacao/censo2010/sinopse/sinopse_tab_brasil_pdf.shtm

² <http://www.cetic.br/usuarios/tic/2011-total-brasil/rel-semfio-02.htm>

used in the research, Section 4 presents the results and data analysis, and Section 5 provides the conclusions of this work.

II. RELATED WORK

We used the method of Systematic Literature Review (SLR) [7], to collect and analyze the results of literature review, efficiently identifying the major existing studies about usability for mobile devices, usability of digital games and usability of applications focused on old users.

Studies on the use of mobile games for the elderly have been conducted intensively over the last decade. However, no papers were found that addressed directly the focus of this work: usability for mobile casual games focused on old users. Some studies verify the benefits arising from the use of mobile games and compare the effectiveness of evaluation methods for these games. Figure 1 presents the chronology of studies on usability heuristics and mobile games.

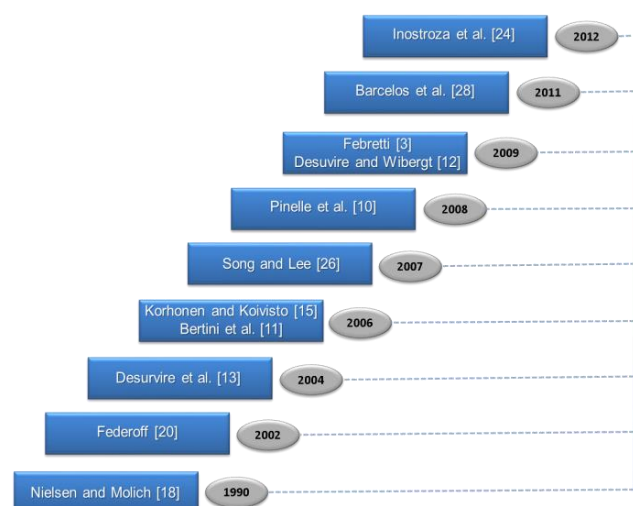


Fig. 1. Chronology of Studies on Usability Heuristics and Mobile Games

Reference [5] compared the use of three different evaluation methods, showing that each method has advantages that justify its use: Heuristic Evaluation (HE), Cognitive Walkthrough (CW) and Web Design Perspectives-based Usability Evaluation (WDP). According to [18], Heuristic Evaluation is a method of inspection used to evaluate usability of interfaces. It is performed by usability experts by means of the use of heuristics and aims to make the interfaces easier to use by its users. It is considered a faster, cheaper and simpler method than CW and WDP.

Reference [14] presents the results of tests conducted with the participation of users and experts, concluding that regardless of the participants, assessments provide benefits in the development process. However, for these benefits to be transferred to the domain of games, it is necessary to define a suitable set of heuristics [28].

Reference [18] presented usability heuristics to evaluate user interfaces. Reference [20] created a list of heuristics based on three areas of computer games: interface, game mechanics and gameplay. To evaluate playability, [13] defined specific heuristics called Heuristics Evaluation for Playability (HEP),

which emerged as a result of a literature review and subsequent expert review. These heuristics were organized by [16], in four areas: gameplay, game story, mechanics and usability.

Since there had not been defined heuristics for evaluating mobile games, [15] proposed a set of heuristics which consisted of three integrated modules: usability, mobility and playability. In the same year, [11] proposed a revision of these principles for usability evaluation, analyzing how these principles apply to mobile computing.

In turn, [26] explored the main factors of heuristics for evaluation of games. The initial goal was to continue the study of [13] and develop heuristics enhancing positive issues and minimizing negative ones. Surveys were conducted using Massively Multi-player Online Role-playing Games (MMORPG). In the following year, [10] defined game usability as something that the player is able to learn, to control and to understand. The existing games heuristic were used to evaluate some aspects of games; however, usability was not the focus.

Reference [3] used several existent heuristics to verify the relevance of usability and usability factors, analyzing commercial games. In other studies, [14] used two specific set of heuristics for evaluating games: one to check the usability and the other to check the gameplay. Reference [28] proposed a new set of heuristics based on analysis of previous work by [10, 12, 20]. They analyzed the main idea of each heuristic and grouped the ones with equivalent meaning. From this grouping, they proposed a new set of heuristics, with a uniform level of specificity in the description of heuristics [28]. Studies performed by [29] resulted in a set of guidelines aimed at the elderly and their use of web applications.

Reference [24] conducted a study to evaluate through the use of heuristics the usability of touchscreen mobile devices. A set of eleven heuristics was proposed and evaluated, and the authors concluded that if the heuristics are very specific they are likely to be difficult to understand and apply.

III. METHODS

This section presents the detailed steps adopted in the case study and data collection, after the completion of the literature review.

After the organization of the set of usability heuristics specific to evaluate casual mobile games for the elderly, we conducted an initial validation of these heuristics with old people. These heuristics were evaluated using five (5) free casual mobile games which outstand by the number of downloads on mobile devices³. Besides analyzing the effectiveness of existing heuristics, the goal of the case study was to identify if there is the need of new heuristics specific to the audience of this research. Data was collected through the use of questionnaires, interviews and notes made by observing the participants while playing the games. All participants signed an informed consent form with information about the tests that would be performed.

³ <https://play.google.com/store/apps/category/GAME> provides statistics on applications

A. Organization of Heuristics

The heuristics identified in the literature review were organized and used as a basis for developing a set of specific heuristics to casual mobile games geared for the elderly (Table I). Duplications were disregarded and heuristics on features that do not apply to the specific needs of this study were eliminated, such as heuristics to evaluate game story, personalization and characterization of characters/avatars.

TABLE I. HEURISTICS FOR THE USABILITY EVALUATION OF MOBILE GAMES FOR THE ELDERLY

Heuristics	References
H1: The controls should be clear, customizable and physically comfortable; their respective response actions must be immediate	[10] [11] [12] [15] [20]
H2: The player should find a tutorial / help to get familiar with the game	[28]
H3: The player should be able to customize the audio and the video of the game, according to his/her needs	[10] [11] [28]
H4: The player should be able to easily obtain information about everything around him/her, including his score	[10] [12] [20] [28]
H5: All visual representations should be easily understood by the player	[10] [11] [12] [24] [28]
H6: The layout and menus should be intuitive and organized so that the player can keep his/her focus on the game	[10] [15] [20] [28]
H7: The aesthetics of the screen should be good, with a visible content, enabling the identification and understanding of its components	[3] [11] [15] [24]
H8: Game sessions/matches should allow quick start	[15]
H9: The player should be able to save the current state to resume the game later	[12] [13] [15] [20] [28]
H10: The main objective of the game must be presented to the player since the beginning of the game	[12] [20] [28]
H11: Graphics and soundtrack should catch the interest of the player	
H12: The player should be rewarded for his/her achievements in a clear and immediately way	
H13: The challenge of the game can be adjusted according to the player's skill, and it should not be repetitive and boring	
H14: The game should allow the player to develop skills that will be needed in the future	

B. Development of Questionnaires

We developed three (3) questionnaires to collect the data and the opinion of the participants. The first questionnaire aimed to provide information to guide the other stages of the research. It included questions on the specific profile of the participants, like demographic information, as age and gender, and relevant details about their previous experience with the use of technologies [31].

The second questionnaire was developed to assess each of the five selected games. In the questionnaire it was used an adaptation of a Likert scale [36] to assess usability heuristics. The participant should choose one of the following options: 0 - Not applicable, 1 - Strongly disagree, 2 - Partially disagree, 3 - Neither agree nor disagree, 4 - Partially agree, 5 - Strongly agree or 6 - Don't know. Besides that, the questionnaire also

asked what the participants liked most and least in the game just tested. These questions make it possible to collect features that participants associated to the game. The questionnaire was completed for each game just after it was played.

The third questionnaire aimed to assess the degree of importance that the participants assign to each of the game's features according to the scale: 1 - Worthless 2 - Not very important, 3 - Important, 4 - Very important or 5- Don't know. These characteristics were defined based on the heuristics collected and previous studies [4, 22, 30]. The questionnaire also asked which of the games the participant most liked and least liked, and the reason for his/her choice. This questionnaire was completed after the participant played all five (5) games.

The developed questionnaires are available at <https://www.dropbox.com/sh/ksjxnm8drffs0e/iVzR6aKwqB?m>.

C. Game selection

There is a wide variety of games, classified in genres, according to their objectives and characteristics. Genres facilitate game development so that existing components can be reused and evolved [10]. In the present study we used three of the genres defined in AppData and GooglePlay: "arcade and action", "cards and casino", "brain and puzzle". For each genre it was identified the free games most installed on mobile devices, besides games related to the preferences of the elderly, like card games [19, 22, 30].

TABLE II. SELECTED CASUAL GAMES

Genre	Game	# Installations	# Evaluations
Arcade and action	Fruit Ninja Free	100.000.000 – 500.000.000	578.772
Arcade and action	aTilt 3D Labyrinth Free	10.000.00 – 50.000.000	53.218
Cards and casino	UNO Free	10.000.00 – 50.000.000	74.330
Brain and puzzle	Cut the ropes: Full Free	10.000.00 – 50.000.000	122.908
Brain and puzzle	Palavras Cruzadas – Passatempo	1.000.000 – 5.000.000	2.050

Source: <https://play.google.com/store/apps/category/GAME>

Access on: 19th May 2013

For the genre "arcade and action" it was selected two different games, because despite being of the same genre, they have very different characteristics: the first, *Fruit Ninja Free* is the most installed game and exercises quick mental responses; the second, *aTilt 3D Labyrinth Free*, exercises motor coordination. For the genre "cards and casino", the game that is most installed is *Pool Master Pro*, however, due to the fact that its interface is composed of smaller components that hinder the use by the elderly, it was not used in the case study. So we used the second most installed game, *Uno Free*. For the genre "brain and puzzle" it was also selected two games: the first, *Cut the ropes: Full Free* is the most installed and the second, *Palavras Cruzadas – Passatempo*, is a traditional game that exercises memory. The list of selected games is presented in Table II,

which also presents the number of installations and evaluations of each game.

Each of the selected games will be described in the following.

1) Arcade and action: *Fruit Ninja Free*

This is an action game. Fruits are displayed on the screen and should be cut by means of movements made with the finger on the screen (Fig. 2). As the player cut fruits, he/she gains points and some bombs that should not be cut begin to emerge, working in this way the user attention.



Fig. 2. Images of the game *Fruit Ninja Free*

2) Arcade and action: *aTilt 3D Labyrinth Free*

aTilt 3D Free Labyrinth is a maze game with 3D graphics (Fig. 3). The player moves the mobile device to move the ball. The goal is to put the ball on the target bypassing the holes. The game features 258 levels and offers the option for the player to create his/her own level/scenario.

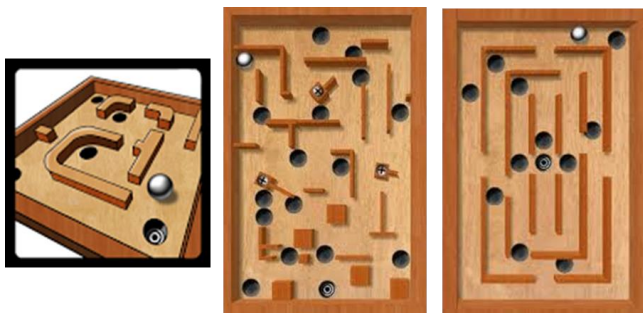


Fig. 3. Images of the game *aTilt 3D Labyrinth Free*

3) Cards and Casino: *Uno Free*

Uno Free is a classic card game, in which the player can match colors or numbers of the cards. It offers the option of tournament mode which increases the challenge for the player (Fig. 4). To play it, the user has just to drag and drop cards using his/her finger on the screen.



Fig. 4. Images of the game *Uno Free*

4) Brain and puzzle: *Cut the ropes: Full Free*

Cut the ropes: Full Free is a game in which the player must separate the connection of the strings with the sweet,

so it falls into the monster's mouth (Fig. 5). There are hidden prizes in golden stars. The mechanics of the game is based on physics. This game won several awards: Apple Design Award, BAFTA Award, Pocket Gamer Awards, GDC Award and Best App Ever Award.



Fig. 5. Images of the game *Cut the ropes: Full Free*

5) Brain and puzzle: *Palavras Cruzadas – Passatempo*

Palavras Cruzadas – Passatempo is a game in which the player can test his/her memory (Fig. 6). For each sequence, either horizontally or vertically, it is displayed a hint and the number of letters. The answer must fit in the space available.



Fig. 6. Images of the game *Palavras Cruzadas – Passatempo*

D. Data Collection

The experiments were conducted with 30 elderly users, who played each of the selected games for 5 minutes. Before starting a game the participants received basic and quick (around one minute of explanation) information about how to play it. Some participants had difficulties and doubts were clarified so that the game had not been interrupted, during the defined period. The tests occurred between May and July of this year.

Tests were conducted with people aged 60 years or older. The choice for inviting seniors among the people we know is due to previous studies which showed the importance, for the elderly, of personal relationships and that the use of volunteers from a personal and family sphere provides good results [17, 21]. Data was collected through the application of the three questionnaires discussed in Subsection III.B.

In the tests we used two models of smartphones: Motorola Defy and Samsung ACE, both with the version of Android 2.3.6 and screen of 3.5" and 3.7", respectively. We chose

smartphones due to the usability of the touch screen [1, 37, 38] and the growing use of mobile devices by seniors, as presented in TIC Domicílios 2011⁴. Besides, we have not chosen devices with larger screen (5", for example), because of their higher cost and, therefore, because they are more difficult to be acquired by the elderly. All participants used the two devices, playing the games in a random order.

E. Statistical Analysis

Statistics works with the collection, organization, summarization and presentation of data collected from a sample aiming to represent the population under study. The data are interpreted allowing the analysis of the fact, based on the inference and on the interpretation of the data. According to [35], sample is a representative part of the whole, that is, sample is a portion of the current population with the characteristics set in the study.

In the study, the focused characteristic that governs the analyzed data is defined as Variable, which can be classified as Quantitative or Qualitative [35]. Quantitative variables are those whose data can be expressed within the number set; in other words, they are measurable. Qualitative variables express qualities, attributes, or can not be measured. An example is the classification of which game the user most liked and least liked. In this study the variables assessed in the questionnaires are qualitative in nature.

According to [35], the proper data collection is essential for the non-commitment of the analysis and the most appropriate way is to use randomized experiments to avoid biased data. In this study the order of the use of the games was random, being modified for each participant.

1) Measures of Position

According to [36], the measures of position are measures of central tendency because they tend to describe the distribution center, or in other words, they describe a position within a data set. Measures of position are: mode, median and mean. Mode is a measure of central tendency defined as the value that occurs most in the sampling distribution. Median is a measure of central tendency defined as the value above which is half of the values and below which is the other half of the values. Average value is obtained by summing the elements of a set and dividing it by the number of elements.

The mean or average value is the most used measure of central tendency [36]. It serves to estimate the mean when the data was collected using an interval scale or ratio. The data should show some central tendency, with most responses distributed around the mean.

2) Statistical Tests

In the questionnaires, we used a Likert scale [36] to facilitate statistical analysis of the data, since it is applied in surveys, aiming to categorize the opinions that are relevant to the search. It is one of the most known and used psychometric

scale, and it makes possible the recording of the level of agreement or disagreement with a given statement [36].

A priori we have used descriptive statistics, aiming to organize, measure and analyze the collected data. As this research is based on qualitative data, charts and tables were constructed in order to illustrate and analyze the relationship between the variables involved in the study.

IV. RESULTS AND DATA ANALYSIS

A. Data Analysis

We performed a descriptive statistics for variables Age and Gender, in order to estimate the percentage of respondents in each age group. The distribution of classes for the variable Age was an option of the authors of this research in order to enable a thorough reading of the participants.

TABLE III. DESCRIPTIVE STATISTICS OF SEX BY AGE

Age Sex	60 65	65 70	70 75	75 80	≥ 80	Total
Female	4	1	5	4	2	16
Male	4	6	2	1	1	14
Total	8	7	7	5	3	30

From Table III it is possible to visualize the homogeneity of the respondents in relation to sex, with the highest incidence of them having up to 75 years old (around 73% of the sample).

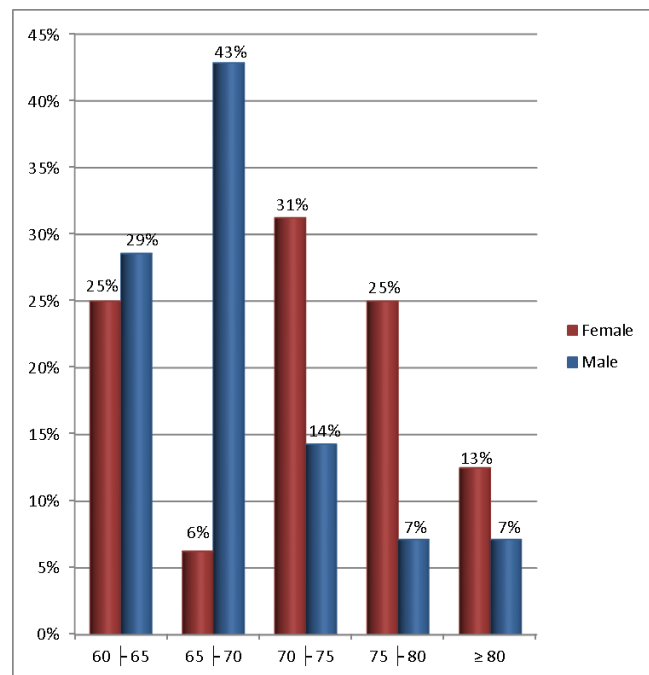


Chart 1. Age Group by Sex

By checking this analysis by gender, it is possible to verify from Chart 1 that 69% of the female participants have 70 years or more. Considering the male participants, Chart 1 shows that

⁴ <http://www.cetic.br/usuarios/tic/2011-total-brasil/rel-semfio-02.htm>

71% of male respondents are in the range between 60 and 70 years.

About marital status of the respondents, there was no incidence of single or divorced people and 73% of respondents reported being married, as shown in Chart 2. Regarding the marital status, it should be noted that among the 8 widowers only one is male; all the others are female.

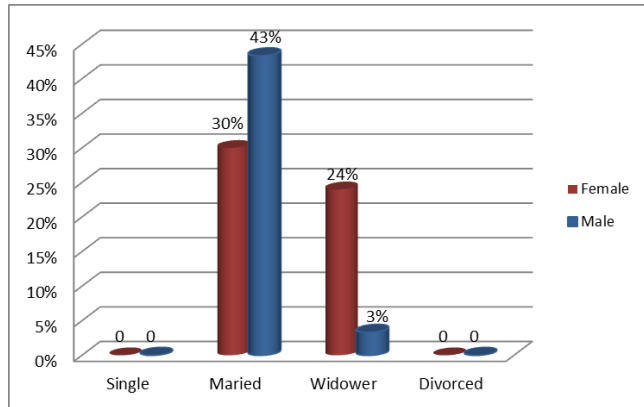


Chart 2. Marital status of the participants

With regard to Education Level, it is possible to infer from Chart 3, that 67% of respondents have concluded only the Primary Education Level. Among the 17% of respondents who reported having higher education, only one is female. In this study there was no incidence of participants with specialization, master or doctoral degree.

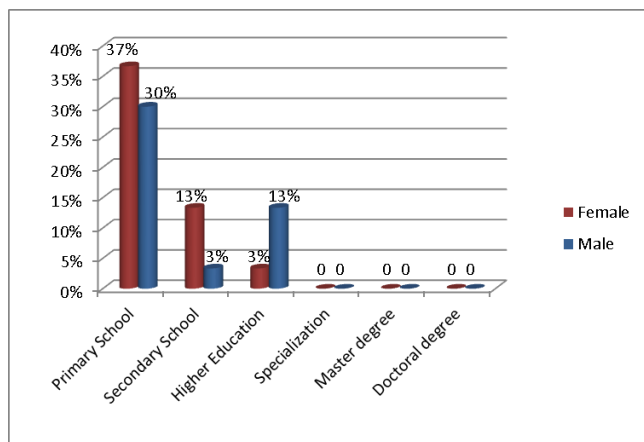


Chart 3. Education level of the participants

When analyzing the variable Profession, it was observed that 53% of respondents are retired, 20% are housewives and the others are divided almost equally between Engineer, Firefighter, Locksmith, Mechanic, Systems Analyst, Teacher and Seamstress (Table IV).

The results did not correlate the preference of a particular group of seniors for a game genre. In other words, we observed no relationship between the preference for a game and characteristics of the elderly, such as gender, education, marital status or previous experience with mobile phone or computer. This indicates that, in general, the elderly have the same

preferences for casual games on mobile phone, which enables the development of games that meet this group of people as a whole.

TABLE IV. PROFESSIONS OF THE PARTICIPANTS

Profession	%	Number
Housewife	20%	6
Engineer	3.3%	1
Firefighter	3.3%	1
Locksmith	3.3%	1
Mechanic	3.3%	1
Retired	53.3%	16
Seamstress	6.7%	2
Systems Analyst	3.3%	1
Teacher	3.3%	1

Regarding the limitations experienced by the respondents, 47% reported not having visual impairment and 43% said they had, but it did not interfere with their activities or interfered little. About 73% said that they had hearing impairment and 23% said they had, but it did not interfere with their activities. In relation to restricted mobility in hands or arms, the results remains satisfactory, because 87% of the participants reported not having it and 10% said they had, but it did not interfere with their activities. The same percentage was achieved when approaching memory deficit. With respect to attention deficit, 87% of them reported not having it and 13% said they had, but this limitation did not interfere with their activities (Chart 4).

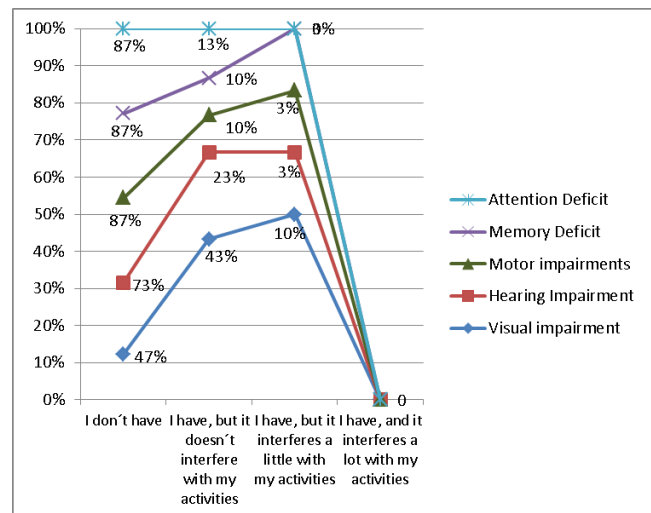


Chart 4. Limitations experienced by the participants

Among the participants 53% own a mobile phone of the traditional model, 37% have no mobile phone and only 10% have a smartphone. Regarding the participants' experience with the use of the mobile games 90% had not played before testing and only 10% had already played. Those who had already played mentioned the games *Tetris*, *Angry Birds* and *Cut the Ropes*.

Continuing the analysis of the results, we carried out a quantitative approach to establish the Average Ranking for the questionnaire using a 5-point Likert scale to measure the degree of agreement among the respondents. In order to prevent the participant from being obliged to report an item without conviction, it was included on the scale the value 6 to the premise “Don’t know”, since the response could be unknown by the participant.

In order to check the agreement or disagreement of the issues evaluated for each of the tested games, we used the Average Ranking obtained from the frequency of responses. Values less than 3 are considered discordant and values greater than 3, concordant, considering the Likert scale of 5 points. The exact value of 3 is considered “indifferent” or “with no opinion”, and the “neutral point” is equivalent to cases where participants left blank responses.

TABLE V. SUMMARIZATION FROM LIKERT SCALE

Characteristics	Games					G	DNK
	G1	G2	G3	G4	G5		
1 It allows one to easily identify the main objective	4.9	4.7	3.4	4.4	4.6	4.4	1
2 It allows one to view the status of the game, giving information about what is happening	4.1	4.7	3.8	4.7	4.5	4.3	8
3 It has an easy to understand language	4.9	4.7	3.7	4.8	4.3	4.5	4
4 It provides information objectively	5.0	5.0	4.1	4.9	4.5	4.7	13
5 It allows one to exit / stop the game at any time	5.3	5.1	5.3	5.2	5.1	5.2	70
6 It follows a standard in the available language and actions	4.5	4.6	4.1	4.6	4.4	4.4	9
7 It has mechanisms to prevent errors, confirming taken actions (e.g.: when exiting or configuring something)	5.8	5.7	5.7	5.9	5.7	5.8	130
8 It has intuitive interface whose actions do not need to be memorized	4.8	5.0	4.1	4.8	4.1	4.6	27
9 It enables flexibility to use / configurate the difficulty level	5.5	5.3	5.4	5.3	5.0	5.3	90
10 It has controls / commands easy to understand and to use	5.0	4.9	3.7	4.6	3.4	4.3	1
11 It has visual representations (drawings, pictures) that are easy to understand	5.0	4.8	4.6	4.8	4.4	4.7	2
12 It has easy to see pictures	5.0	4.9	4.6	4.9	4.2	4.7	0
13 It has nice colors	4.8	4.8	4.8	5.0	4.3	4.8	1
14 It has pleasant sounds /soundtrack	4.7	4.6	4.4	4.6	3.1	4.3	16
15 It has clear rewards and punishments	4.5	4.8	4.2	5.0	4.2	4.6	23
16 It offers an online help that is easy to use	5.6	5.7	5.6	5.7	5.4	5.6	127

Notes: G1 = aTilt3D Labyrinth, G2 = Fruit Ninja, G3=Uno, G4=Cut the ropes, G5=Palavras Cruzadas, G=General, DNK= “Do not know”

Table V shows the Average Ranking for each item addressed in this study, for each game, in addition to the General Average Ranking and the number of responses “Don’t know”. From this table it is possible to see that 87% of participants did not know how to evaluate whether the games covered in this study “have mechanisms to prevent errors confirming actions taken”. This perception is due to the fact that the participants had not performed tasks that would allow

them to assess this characteristic. It is also noteworthy that for each item raised in this research there are 150 responses, as 30 participants played the five selected games.

From Table V it can be seen that all the features covered in this research are classified as positive, since the General Average Ranking always show values greater than 3 (three), which has being classified as Concordant.

Adjusting the calculation of the Average Ranking to perform a correction of the data, we excluded responses “Do not Know”, which were used when the participant did not identify a feature in the game (Table VI).

TABLE VI. SUMMARIZATION FROM LIKERT SCALE WITH CORRECTIONS

Characteristics	Games					G
	G1	G2	G3	G4	G5	
1 It allows one to easily identify the main objective	4.9	4.7	3.4	4.4	4.5	4.4
2 It allows one to view the status of the game, giving information about what is happening	3.9	4.6	3.8	4.6	4.3	4.3
3 It has an easy to understand language	4.8	4.7	3.7	4.8	4.3	4.5
4 It provides information objectively	4.9	4.8	4.0	4.7	4.5	4.6
5 It allows one to exit / stop the game at any time	4.9	4.0	4.4	4.7	4.3	4.5
6 It follows a standard in the available language and actions	4.5	4.5	3.9	4.5	4.3	4.3
7 It has mechanisms to prevent errors, confirming taken actions (e.g.: when exiting or configuring something)	4.8	4.3	2.0	4.0	4.0	4.1
8 It has intuitive interface whose actions do not need to be memorized	4.7	4.7	3.7	4.5	3.8	4.3
9 It enables flexibility to use / configurate the difficulty level	4.6	4.2	4.5	4.3	3.9	4.3
10 It has controls / commands easy to understand and to use	5.0	4.9	3.7	4.6	3.3	4.3
11 It has visual representations (drawings, pictures) that are easy to understand	5.0	4.8	4.6	4.8	4.3	4.7
12 It has easy to see pictures	5.0	4.9	4.6	4.9	4.2	4.7
13 It has nice colors	4.8	4.8	4.8	4.9	4.3	4.7
14 It has pleasant sounds /soundtrack	4.4	4.5	4.3	4.6	2.2	4.1
15 It has clear rewards and punishments	4.0	4.7	4.0	4.9	3.8	4.3
16 It offers an online help that is easy to use	2.8	3.5	3.4	4.0	3.0	3.3

Notes: G1 = aTilt3D Labyrinth, G2 = Fruit Ninja, G3=Uno, G4=Cut the ropes, G5=Palavras cruzadas, G=General

From Table VI we can see the perception of the players on the considered characteristics. Features less noticeable in every game were: i) *aTilt3D Labyrinth* (G1) received 2.8 points on characteristic 16 and the main complaint from users was about the help available. They said that the game had no help on how to play the game. For example, the game did not offer help/instructions for differentiation between the holes, neither about which is the target that leads to win the game, and neither about which black hole restarts the match; ii) the game *Fruit Ninja* (G2) received 3.5 points on characteristic 16. In this case, users have commented on the need of the game to provide a level where fruits are displayed at a slower rate; iii) the game *Uno* (G3) had 2.0 points on characteristic 7,

indicating that the players did not observe the existing mechanisms that prevent errors in the game; iv) the game *Cut the ropes* (G4) had no characteristic scored in the range of 3, indicating that users perceived only positive characteristics in this game; v) and the game *Palavras Cruzadas* (G5) received 2.2 points on characteristic 14, due to the fact that the game actually has no sounds.

Aiming to compare the data obtained by the Likert scale and the opinion of the respondents in the categories “Which game did you like the most?” and “Which game did you like the least?”, we built in Chart 5.

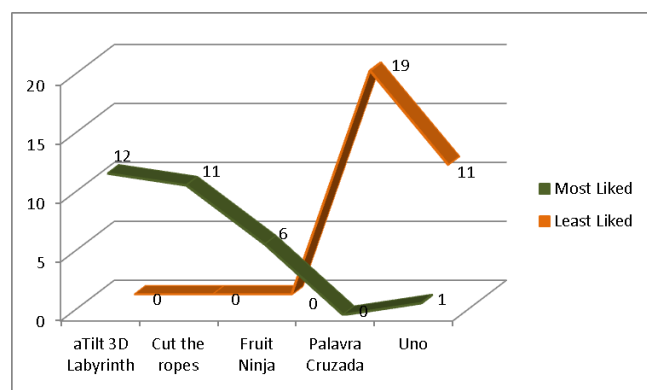


Chart 5. Preference Games

From Chart 5 it can be seen that 40% and 36% of respondents prefer, respectively, the games *aTilt 3D Labyrinth* and *Cut the Ropes*. None of the participants in this study pointed out the game *Palavras Cruzadas* as the preferred one. Regarding the less preferred game, 64% of participants chose the game *Palavras Cruzadas* and 36% chose the game *Uno*.

These results support the degree of agreement and disagreement obtained by Likert scale. Most participants in this study stated that despite knowing and liking crosswords, the game *Palavras Cruzadas* has very small print, is trivial and difficult to play on smartphone. The game *Palavras Cruzadas* offered a greater difficulty in learning due to the fact that the player needs to know the arrangement of letters on the virtual keyboard. Given the size of the keys, some participants were unable to play the game since it was difficult for them to hit only one letter. However, it was praised the fact that the game highlights in red the mistakes, better informing players during the match. This result reaffirms the importance of applying specific usability features in the development of games for seniors.

Others stated that the game *Uno* has many rules, is confusing and the gamer needs to rely on luck. The game *Uno* is not easy to learn due to the fact that it has several cards that generate different actions during the match, and so, requires the player to know the meaning of these cards to succeed in the game.

Participants were also asked about the degree of importance they attributed to some characteristics related to games (Table VII). The results show that participants

classified most characteristics as important or very important. From the total of 25 characteristics, just 6 were assessed as being unimportant. The characteristic 7, related to the sound adjustment, was rated by 17% of respondents as of little importance and by 10% as unimportant. The characteristic 9, which indicates the presence of the soundtrack, was rated by 27% of respondents as of little importance and by 7% as unimportant. Some participants did not like music in the background while playing.

TABLE VII. SUMMARIZATION OF THE GAME CHARACTERISTICS

Characteristics	UI	OLI	I	VI	DNK
1 To make clear the main goal of the game	0	1	18	11	0
2 To present information throughout the match (e.g.: score, number of lives)	0	1	12	15	2
3 To have an easy to understand language	0	0	9	21	0
4 To provide information objectively	0	0	15	15	0
5 To have visual representations, like drawings and pictures	0	0	13	17	0
6 To be colorful	0	1	10	19	0
7 To enable to adjust the sound or turn it off	3	5	9	13	0
8 To have sound effects / sounds	1	3	13	13	0
9 To have a soundtrack	2	8	11	9	0
10 To have an intuitive interface whose actions do not need to be memorized	0	1	14	13	2
11 To allow to exit / stop the game at any time	0	2	12	15	1
12 To allow to return to game using the recorded information	2	7	10	10	1
13 To enable the adjustment of the challenge according to your ability	0	1	17	12	0
14 To possess different levels of difficulty	0	1	14	15	0
15 To offer consistency/standard in the available language and actions	0	1	16	11	2
16 To have mechanisms to prevent errors, confirming taken actions (e.g.: when exiting or configuring something)	1	0	6	10	13
17 To provide rewarding mechanisms according to the actions performed	0	1	12	13	4
18 To offer an online help	0	1	7	15	0
19 To be easy to learn	0	0	10	20	0
20 To exercise the mind	0	0	3	27	0
21 To exercise creativity	0	0	8	22	0
22 To enable fun	0	0	9	21	0
23 To allow to perform activities that are not done daily	0	0	11	18	1
24 To allow competition against other people	0	8	10	9	2
25 To allow collaboration	1	4	7	11	1

Notes: UI = Unimportant, OLI = Of little importance, I = Important, VI = Very important, DNK = Do not know

It is also possible to verify that the characteristic 12 which is related to continuing the game using recorded information, was rated by 23% of respondents as of little importance and by 7% as unimportant. The characteristic 24 was rated by 27% of respondents as of little importance indicating that competition for seniors is not something important in a game.

On the other hand, some questions were evaluated by all participants as being important or very important, demonstrating the homogeneity regarding their classification. The characteristic 3 reinforces the importance of a game having an easy to understand language. The characteristic 4 is related to how information is made available, and the results make clear that it is important to provide information objectively. For older people it is important to have visual representations in a game, which is confirmed by the evaluation of characteristic 5. The importance given for the characteristics 19, 20, 21 and 22 confirms previous studies which indicates that games for the elderly need to be easy to learn, should exercise the mind and creativity and must be amusing [2, 3, 19, 21, 30]. It is also noteworthy the importance of the characteristic 23 related to the ability to perform tasks that are not performed on a daily life.

V. CONCLUSIONS

This work aimed to present usability heuristics to evaluate casual mobile games related to the elderly. For this, first was done a literature review which has served as the basis for the organization of a set of usability heuristics for casual mobile games for the elderly. These heuristics in turn have been validated through a case study conducted with 30 individuals, 16 females and 14 males.

Tests conducted in the case study had focused on verifying the usability and on the first impressions of the participants; not on their experience with each game. That is why the usage time was defined as 5 minutes for each game. The definition of the time duration was also based on our intent of evaluating a larger number of games for identifying if the genre of the game could impact the evaluation of the game by the elderly.

The study showed that casual mobile games may be useful for the elderly in several aspects, for example, an option for entertainment, recreation and mental exercises. This is confirmed by the results of the research, since the characteristics “Being easy to learn”, “Exercise the mind”, “Exercise creativity” and “Enable fun” were classified by all participants as *Very Important* or *Important*. In particular, the characteristic “Exercise the mind” was rated as “Very Important” by 90% of participants, which can be attested by the choice of the preferred games: *aTilt 3D Labyrinth* and *Cut the Ropes: Full Free* enable exercising the mind with new challenges every round.

The participants of the test also agreed that visual representations should be easy to understand, which indicates a characteristic to be respected in the development of casual games for seniors. Besides easy to understand, visual representations should be easy to see, that is, confusing or very small images should not be used. Another feature that stood out is the existence of colors: seniors considers important for a game to be colored.

It was also observed that participants liked least the games that are more difficult to learn, like *Palavras Cruzadas - Passatempo* and *Uno Free*.

The elderly need options that enable entertainment and recreation [2, 4, 22]. This fact was observed during the case

study. When invited to contribute to the research, some seniors were standing against technology, saying they were not the appropriate person due to the fact that they do not use mobile phone. However after playing the games, these seniors changed their positioning, identifying that the casual games are a way to exercise their mind while having fun, and as so, casual games can be considered an option of leisure and entertainment.

After analyzing the results of the case study with the elderly, it was confirmed the validity of the set of heuristics organized to evaluate casual mobile games for the elderly. But it was not clear if they are enough to develop good games for the elderly. Because of that, as future work we propose the development of a casual mobile game with the characteristics rated as important or very important by the elderly. This game will allow a new case study, aiming to identify more specific heuristics for casual mobile games for the elderly.

It is also important to consider, in this new set of heuristics, a broader vision of user interface for games, as four of the characteristics that were best evaluated in this study are not directly related to the usability of a game, but with the player experience: to exercise the mind, to exercise creativity, to enable fun, to allow to perform activities that are not done daily.

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