

# Game Design for Training of Elderly People in Mouse and Keyboard Use

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## ABSTRACT

Over the years as a result of the natural process of aging, there are significant changes in both physical and motor capabilities, as well as in the cognitive capacity that decline from the age of 60. Several studies report the cognitive benefits of games, especially serious games that aim at the training of skills and the digital inclusion of the elderly, involving processes of relearning and learning. This work aims to present the design of games for elderly population to train the use of computer mouse and keyboard using regional culture of Rio Grande do Sul in Brazil as theme and the design evaluation. As result, some kinds of design issues were identified through heuristic evaluation, but other issues were observed just during user testing, demonstrating that this tests are essential to game design process. The choice of theme and design style was also approved by the elderly.

**Keywords:** elderly, serious games, game design.

## 1 INTRODUCTION

Great advances of medicine and pharmacology, in addition to improvements in overall health, have boosted the life quality and also have increased the life expectancy of population. Thinking on quality of life also means thinking on a continuous development, being able to live in an active way and keep cognitive abilities. As Garcia [17] points out, human development is a process that runs from the conception to the death of the individual, changing the paradigm that only develops in adolescence and that would happen a process of progressive stagnation until the decline.

In Brazil, several surveys assert that the number of people with age above 60 years old, as known as the Third Age, is increasing [6, 7, 8, 12, 14]. Usually, the potential of these people is forgotten or neglected by themselves or by society due to lack of encouragement, and many elderly people believe that they are not able to produce or perfect knowledge and they are no longer useful to community. Therefore, it is necessary to create ways to include the Third Age people into the engine of society's intellectual and economic production[6, 16, 22].

According to Kachar [16], some people of the Third Age faces sensory, motor and cognitive problems that lead to have interaction difficulties with computers. The biggest limitation to use a traditional desktop computer is mouse handling: the main barrier is the visual-motor coordination involved, so they need to look at the computer screen without looking at the mouse and move, click

or scroll it. The keyboard is another barrier, and Kachar [16] cites as problems strained hands, heavy fingers and excessive pressure on the keys, causing the input of several characters instead of one. People who do not know how to use the computer and access the Internet are considered illiterate digital [10][16], making it difficult to upgrade or even a return to the labor market.

Research shows that digital games and simulators can improve the physical and mental health for elderly people. With the use of simulators, it is possible to do dance movements, yoga and walking, while digital games bring cognitive, motor, educational, awareness and emotional improvements [1, 3, 9, 11, 21]. In addition, digital games make it possible to practice repetitive mouse and keyboard movements with people of the Third Age in a playful way, so that fun becomes an incentive to continue practicing [11, 19, 21].

According to Farias, Castro and Almeida [11], and Monteiro, Velásquez and Silva [19], there is no scientific interest in the digital inclusion of people of the Third Age and, consequently, this population has not received the necessary support. In this context, the goal of this work is to present the design of a game for training Third Age people in the the use of computer mouse and keyboard through mechanics that exercise a set of fine motor skills.

The document is organized as follows: Section 1 presents scientific papers related to design of games to the elderly; Section 3 presents materials, methods and procedures applied in the steps of this paper; Section 4 shows the results achieved on each step; and Section 5 brings final considerations and future work.

## 2 RELATED WORKS

In this section is present the related scientific papers that have a focus on game design for the Third Age, as can be seen in the Table 1. Basically, these studies corroborated to better perception of the specific design features needed for games for the elderly. All works found are in the theme of design of serious games for the Third Age.

Table 1: Selected Papers

Paper	Paper Focus
[4]	The use of affordances with user-centered design.
[13]	Cognitive factors in thinking in game design for the elderly.
[15]	Associates game design with elderly culture and accessibility pillars.

Papers that specifically address game design for keyboard and mouse training were not found in the scientific literature. The chosen works [4, 13, 15] only broadly cover the design of serious games for the elderly.

The main differential between the present study and related works consists essentially in designing and demonstrating a game created for mouse and keyboard training, bounded to the local culture, by facilitating the immersion of players into the game and by putting away technical software in initial learning of computer use.

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### 3 MATERIALS AND METHODS

This section describes the methodology used to perform this work. The main procedure was divided in 6 steps which are presented in the course of the Section.

Step 1 consisted in the definition of the theme. This specification was made from an semi-structured interview [5] with a elderly citizen, bringing questions about life experiences and interests of the interviewee. Based on answer analysis, the game theme of local culture was defined.

In step 2, the functions performed through mouse and keyboard peripherals were mapped. These devices were chosen because desktop computers are the main focus of this research and because problems faced by elderly people by indirect manipulation of screen elements through them.

Step 3 implied the game design and the creation of low fidelity paper prototypes [5], based on the chosen theme and the functions mapped in the previous step.

In step 4, prototypes were evaluated according to the Nielsen usability heuristics [20] through a heuristic evaluation [5] aiming the detection of eventual problems in the design of each game. The technique was performed by four evaluators with some experience in usability.

Step 5 corresponds to the current stage of this work, which includes the development of high fidelity prototypes based on paper prototypes and the solving of problems found in heuristic evaluation. The design of the games is being developed through Phaser JS framework in order to the games be playable directly in web browsers and to avoid the needs of additional runtime environment. In parallel to step 5, a 6th stage was established that includes play tests and application of a satisfaction questionnaire. Six elderly players participated of game sessions in order to fulfill questionnaires.

### 4 RESULTS

This section presents the results obtained in each of the steps described in the previous Section. At the end, a general analysis of the obtained results is performed.

#### 4.1 Theme definition

The Pampa Gaúcho theme was defined through conversations with people of the Third Age, in which they report that the most interesting theme for the game would be the one according to the environment where they are, since it is common for them, since they are adapted with images and routines of the region. In this context it was elaborated the main characters: The “Gaúcho” and the “Prenda”, which represent men and women born in Rio Grande do Sul - Brazil, respectively. While the horse, in addition to being used in the work of the field, is seen as a pet by owners. Another motivational factor in the definition of the theme is the sense of belonging of this elderly person to cultural elements that are part of the environment that the elderly are inserted and that use and explore metaphors, that is, the mental model of the elderly should be in agreement with the mental model presented by the game design [2].

#### 4.2 Functions mapping

In order to carry out the development of the game we analyzed the problem with fine motor functions and motor sights of the elderly, adapting all the games in an easy and pleasant manner, soon after, were mapped all functions that elderly people have more difficulty in computer use. As reported by Farias, Castro and Almeida [11], the use of mouse and keyboard is the greatest difficulty of people of the Third Age in the use of the computer. Therefore, the games developed are intended to work specific motor functions that provide improvements in the interaction with the mouse and keyboard. The functions worked for the use of computer.

In the mouse utilization, the following functions have been mapped: left-click (using one or more clicks), right-click, scrolling, and move the mouse to all possible directions.

While the mapping performed on the keyboard resulted in obtention of the functions: press specific key, push specific key while holding another key, push a certain sequence of keys, and push a key while holding other two keys (e.g.:Ctrl + Alt + Del).

#### 4.3 Prototypes creation

In this subsection we will briefly present the conception idea of each prototype<sup>1</sup>, as well as the objectives and the specific training (mouse or keyboard) that each one has.

The first prototypes were developed in paper, once, according to Barbosa and Silva [5], it is the cheapest and fastest design method and allows heuristic evaluation before the construction of the digital, high quality prototypes.

Figure 1 shows the paper prototype of Game 5 (Level 1), named “Pulando Cupinzeiros”, that aims to train just the simple click with the left mouse button without the need for fine precision. In the game “Pulando Cupinzeiros”, the user will be in the role of the horse and should observe the obstacles (termite mound) coming toward it. Each time an obstacle approaches, it is possible to jump using one, two or three clicks. The number of clicks depends on the size of the obstacle, that is, the more clicks are done, the higher will be the horse’s jump. To complete the game, the player must reach 2000 points, where in the upper left corner the points will be shown. If the player can not jump a termite mound, the horse will stand still waiting for the player to jump and continue the game.



Figure 1: “Pulando Cupinzeiros” (Paper Prototype)

The paper prototype of Game 6 (Level 1) called “Fazenda Campeira”, aims to train the movement of the mouse (left, right, up, down, diagonals and freestyle) and click with the left mouse button. In the game “Fazenda Capeira”, the user has the role of a recruiter who will call the gaúchos, and must click with the left mouse button on the Gaúcho that is hidden behind the objects of the scenario. To complete the game, the player must reach 2000 points, where in the upper left corner the points will be shown. If the player delays to click on the Gaúcho he disappears and reappears in another place.

The paper prototype of Game 7 (Level 1) called “Laçando a Vaca”, aims to train the accent keys and vowels of the keyboard with key sequences to form accents and special characters õ, â, á, è, among others. In the game “Laçando a Vaca”, the user will be in the role of a Gaúcho and his objective will be to lasso the cow. For this, 2 movements will be used. The first is to click on the accent key, or hold the Shift key and then click on the accent key displayed

<sup>1</sup> All the prototypes are available at <http://bit.ly/TrainingElderly>

on the cow, causing the Gaúcho to swing his lasso. The second is to press the letter displayed on the cow, making the Gaúcho tie the cow. When the cow is laced, the points are counted. If the user misses any of the movements, the Gaúcho will speak through the dialogue balloon and show that the accent or letter does not correspond to the one presented in the cow, but the user does not have any losses. The game ends when the counter reaches 5000 points.

#### 4.4 Heuristic Usability evaluation

The usability evaluation [5, 20] in the paper prototypes, was performed by the authors using the 10 Heuristics of Nielsen [20], which are presented in the following Table 2.

Table 2: Usability Heuristic for User Interface Design [20]

H1	Visibility of system status
H2	Match between system and the real world
H3	User control and freedom
H4	Consistency and standards
H5	Memory recognition rather than recall
H6	Flexibility and efficiency of use
H7	Aesthetic and minimalist design
H8	Error preventions
H9	Match between system and the real world
H10	Help and documentation

Four evaluators separately inspected each game prototype to find usability problems. When a problem was found, details about it were registered, the violated heuristic was identified, and a severity level was assigned. The severity are classified into four levels: cosmetic, little, big and catastrophic.

The analysis of the usability problems has followed the protocol proposed by Barbosa e Silva [5]. So, after individual inspection, the evaluators gathered together, discussed each problem found, agreed on severity of problems, and brainstormed solutions. In Table 3, the main problems are presented.

These problems will be prioritized in the development of the final version of the games (that is not covered in the scope of this paper). Aesthetics issues were not discovered at this point, even those related to matching between the system/game and the real world. However, this kind of design problem had appeared in the user evaluation by using the high fidelity prototypes.

#### 4.5 Development of high fidelity prototypes

The developed prototypes are classified as high fidelity, that is, they provide a first contact with the main functionalities of the game, allowing a better immersion of the elderly in the game and helping to make a more accurate diagnosis of possible usability problems. The engine chosen for prototype development was Phaser JS, a JavaScript-based engine that works with elements of HTML5 and canvas, which made it possible to experience the elderly directly in the computer browser proposed by this article. The predominant style of design in the prototypes was Cartoon, in order to providing a greater integration of the elderly with other generations.

Basically the design of the game essentially sought to minimize the load of cognitive skills required to learn how to play, and the spatial visualization of the environment of the game, to focus on the training and insertion of this elderly with the use of mouse and keyboard [13]. To define the design of the games, a study was carried out on the biome and geography of the Pampa, where it was characterized in cartoon aesthetics. Figure 2 shows the design of the game “Pulando Cupinzeiros”, demonstrating the animals, trees, field and hills of the Pampa.

Table 3: Each problem found by 4 evaluators, ranked by severity

Problem	Heuristic	Final Rating
The prototypes haven't the options: exit, pause, play, change the game and/or restart.	3	Catastrophic
On the selection of games it is not displayed which kind of training.	5	Catastrophic
it does not exist any interaction between the buttons.	6	Little
The games do not advise in case the player is realizing a wrong action or delaying too much.	9	Little
It does not exist an advice when the mouse is out side of the game screen.	8	Little
It does not have any documentation, button of contact and help.	10	Little
The frame text colors of the game panel, level and subject don't follow a standard.	4	Cosmetic



Figure 2: “Pulando Cupinzeiros” (High Fidelity Prototype)

#### 4.6 User Evaluation

The questionnaires focused essentially in the design experience and their insights regarding the elements presented to the players. They made it possible to have a better idea of high fidelity prototypes from the perspective of the elderly, providing enriching feedback to the work.

A total of six people participated of game session: two people aged 64, one person aged 69, one person aged 73, one person 77 aged, and one person with 81 years old. The evaluated games were “Pulando os Cupinzeiros”, “Laçando a Vaca” and “Fazenda Campeira”. The questionnaire<sup>2</sup> was applied to elderly people at the end of a game session in an informal way. In order to minimize problems related to answering the questionnaire, a researcher read the questions and marked the answer of the player. Questions had been elaborated to evaluate overall game design, game mechanics and game aesthetics, e.g., the choice of the theme, characters, scenarios, colors, matching with the real world, and an open question for suggestions.

<sup>2</sup>The questionnaire is available at <http://bit.ly/questionnaire>

The user satisfaction evaluation was structured by statements in the form of “Likert items” [18] by measuring the level of agreement or disagreement to the statement. Likert items used in the questionnaire consisted of five levels of agreement response as follows: (1) Strongly disagree; (2) Disagree; (3) Indifferent; (4) Agree; (5) Strongly agree.

In general, the Pampa Gaúcho theme and the choice of the cartoon style of high fidelity prototype design were well accepted, with some cosmetic problems that the elderly pointed out in the question about the correlation of design with the real world. In the design of the game “Laçar a Vaca”, the floor should be in a darker tone alluding to the earth, because according to the elderly, planting of sunflowers could not be performed in the sand. In that same game, they claimed that the character cow should not eat flower, as presented in the design. While in the design of the game “Fazenda Campeira”, they proposed the change of coloration of the tree, which was in purple for green and also missed the representation of a farm in the background. Regarding suggestions of possible themes to be approached, quite interesting themes appeared, revealing some inclinations of this public, such as: environment, recycling, sports and card games.

## 5 CONCLUSIONS

With the construction of digital games for the elderly, it is possible to develop sensory, cognitive and physical skills in a playful way, and to improve the life quality for these people [1, 3, 9, 11, 19, 21]. Even though the importance of scientific research and entertainment products in this field is evident, a lack of material was identified during the search for related works in this paper. Therefore, this work had the goal to present design and evaluation process of a serious digital game for the elderly.

The theme chosen addresses daily issues of the southern region of Brazil. Thus the local public perceives itself familiar with the environment of the games. However, older people from other localities may find it more difficult to understand the games. The developed games are focused on training the use of computer mouse and keyboard, aiming at digital inclusion for the elderly people.

In order to develop games that elderly citizens could achieve and wish to play, two evaluations were performed during the game development process: a heuristic evaluation on initial paper prototypes and user evaluation on high fidelity prototypes.

The heuristic evaluation identified design errors related to usability that would cause interaction problems. Although this evaluation on initial paper prototypes allows us to detect problems in the games before their development, it makes it difficult to evaluate certain heuristics. Therefore, as future work it is necessary to perform heuristic evaluation with high fidelity prototypes.

The user evaluation was composed of aesthetic issues of the games and performed with a reduced number of elderly, which represents another limitation of this work. Also, the elderly constitute a public with a differentiated profile, also justifying the need to perform usability evaluation with the end user.

Correction of aesthetic errors, development of more games, and the application of visuomotor test to identify the benefits of training with games in the elderly are also cited as future work.

## REFERENCES

- [1] Jogos móveis casuais para idosos: um estudo de usabilidade. *SBC - Proceedings of SBGames 2013*.
- [2] A. L. B. Abrahao. Estudo de acessibilidade e interação multitouch com utilizadores seniores. Master's thesis, 2013.
- [3] S. A. C. d. N. Assis, Â. J. G. Bós, J. d. C. Myskiw, M. S. Pinho, F. Silva, C. H. A. Schwanke, I. A. Izquierdo, et al. Efeitos do treino com jogos de videogame na cognição de idosos&58; revisão sistemática &61; effects of video game training on cognition in the elderly&58; systematic review. *Scientia Medica*, 25(3):1–12, 2015.
- [4] M. Awad, S. Ferguson, and C. Craig. Designing games for older adults: an affordance based approach. In *2014 IEEE 3rd International Conference on Serious Games and Applications for Health (SeGAH)*, pages 1–7. IEEE, 2014.
- [5] S. Barbosa and B. Silva. *Interação humano-computador*. Elsevier Brasil, 2010.
- [6] A. B. Z. Berlink and J. A. M. Berlink. Terceira idade e tecnologia. *Comunicação & Educação*, (11):48–52, 1998.
- [7] O. BRASIL. A onu e as pessoas idosas, 2018. disponível em: <<https://nacoesunidas.org/acao/pessoas-idosas/>>. <https://nacoesunidas.org/acao/pessoas-idosas/>, 2017. Accessed: 2018-03-17.
- [8] P. Brasil. População idosa no brasil cresce e diminui número de jovens. <http://www.brasil.gov.br/ciencia-e-tecnologia/2011/04/populacao-idosa-no-brasil-cresce-e-diminui-numero-de-jovens-revela-censo>, 2014. Accessed: 2018-03-17.
- [9] V. B. de Moraes, M. M. A. Andrade, C. Y. Toyoda, and R. D. C. T. Araújo. O uso do videogame nintendo wii como recurso terapêutico para idosos: uma análise da atividade na perspectiva da terapia ocupacional/the use of nintendo wii as therapeutic resource for elderly: an activity analysis from the occupational therapy perspecti. *Cadernos Brasileiros de Terapia Ocupacional*, 24(4), 2016.
- [10] D. Duran. *Alfabetismo F Digital e Desenvolvimento das Afirmações às Interroga ções*. PhD thesis, 2008.
- [11] A. A. Farias, C. A. Castro, and W. R. Almeida. Desenvolvimento de jogos digitais como estratégia na melhoria de cognição e motricidade de idosos utilizando técnicas de memorização e movimentação. *Anais do Computer on the Beach*, pages 081–090, 2015.
- [12] R. Ferreira and L. Ishitani. Jogos educacionais digitais para idosos: uma revisao sistemática de literatura. In *Brazilian Symposium on Computers in Education (Simpósio Brasileiro de Informática na Educação-SBIE)*, volume 26, page 404, 2015.
- [13] K. C. Fua, S. Gupta, D. Pautler, and I. Farber. Designing serious games for elders. In *FDG*, pages 291–297, 2013.
- [14] D. Garcia et al. A terceira idade e a internet: uma questão para o novo milênio. 2001.
- [15] W. Ijsselstein, H. H. Nap, Y. de Kort, and K. Poels. Digital game design for elderly users. In *Proceedings of the 2007 conference on Future Play*, pages 17–22. ACM, 2007.
- [16] V. Kachar. Terceira idade e informática: aprender revelando potencialidades. In *Terceira idade e Informática: aprender revelando potencialidades*. 2003.
- [17] K. Knapp, J. B. Morton, Y. Munakata, L. Michaelson, M. Jane Barker, N. Chevalier, M. R. Rueda, P. M. Paz-Alonso, J. Benson, M. A. Sabbagh, et al. Estimulação cognitiva síntese. *Relation*.
- [18] R. Likert. A technique for the measurement of attitudes. *Archives of psychology*, 1932.
- [19] L. d. C. S. Monteiro, F. S. C. Velásquez, A. P. S. d. Silva, et al. Jogos eletrônicos de movimento e educação física: uma revisão sistemática. 2016.
- [20] J. Nielsen. 10 usability heuristics for user interface design. *Nielsen Norman Group*, 1(1), 1995.
- [21] L. I. B. d. Santos. A percepção do idoso sobre os jogos do projeto promoção do desempenho cognitivo e o uso de jogos computacionais em programas de estimulação cognitiva. 2013.
- [22] M. M. K. Tavares and S. T. C. de Souza. Os idosos e as barreiras de acesso às novas tecnologias da informação e comunicação. *Revista Novas Tecnologias na Educação*, 10(1), 2012.