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A Human Centred-Design Approach to a Serious Game in Health Training for the Open University of the Unified Health System (UNA-SUS/UFMA) in Brazil

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ABSTRACT

A serious game is a media based on the narrative of a game focused on learning. The narrative of a game brings elements and mechanics that motivate the participation and engagement of the players. This is because games are a constant in human development as they formalize cultural activities with social function, being full of meanings. Moreover, the possibilities found in the game narratives contribute to the construction of more participatory plots, since the player can act actively in the course of the story. The narrative and engagement of serious games are of prime importance to distance learning in the health field. In Brazil, the Open University of the Unified Health System (UNA-SUS/UFMA) develops serious games as educational resources to train health professionals. This paper presents the design process of the Clinical Case Game, a serious game for diagnosis and treatment of medical conditions, addressed to doctors in Brazil. A multidisciplinary and human-centred design approach was adopted to develop the game. It involved medical doctors, educators, IT professionals, information designers and game designers, who coordinated the team and acted on the balance of the dynamics involved, that is, the narrative and playful pleasure. The methodology employed consisted of a workshop; content and prototype production; prototype testing with users; and refinements for the final version of the game. The results suggested that narrative unity must be coherent for serious games on health and highlight the relevance of serious games as high potential resources in the educational process.

1. Introduction

Games generally provide tension, joy and fun, have a certain meaning and have a meaning-filled function (Huizinga, 1944). It is this function that transcends the immediate needs of life and gives meaning to action because every game means something.

Learning happens intrinsically, even in entertaining games, because playing implies learning and optimizing the rules of the game to improve the chances of winning (Adams, 2014). However, the so-called serious game is a game developed for a primary purpose other than

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pure entertainment. Serious games are designed to improve some specific aspect of learning (Hagglund, 2012).

The development of serious games is a complex and interdisciplinary activity that involves actors from various areas in an intense exchange of knowledge. The literature presents several methodologies that emphasize different aspects of this development, whether they are game elements, simulation, or seeking to integrate the different phases through the use of open-source tools (Rocha, Zem-Lopes, Pedro, Bittencourt, & Isotani, 2015). But most of the authors agree that serious game development teams should involve actors from design, technology, and education fields (Gloria, Bellotti, Berta & Lavagnino, 2014).

These actors vary in the position of coordinators/head of the team depending on the focus of the serious game. When the game project is content-centred the team coordinator is usually an educator (Kaufman, Gayowsky, Sauvé, Renaud & Duplàa, 2019). When the project is focused on technology, the coordinator is usually a computer professional (Alcover, Jaume-i-Capó & Moyà-Alcover, 2018). And, when the project is centred on interactivity the team coordinator is often a designer (what is common in game design teams in general).

However, the literature indicates that one of the most important factors in making learning more meaningful is to incorporate storytelling into its design (Naul & Liu, 2019). Storytelling has been applied in many areas of communication because it is a tool that helps to condense and remember experiences and help someone to understand the time and temporal events. Moreover, it is through stories that people exchange information, as they provide a greater degree of meaning and emotion than simply a list of facts (Ryan, 2017). Stories create memorable and engaging experiences and thus provide a way to understand and make sense of the experience (Forlizzi & Ford). Therefore, Polkinghorne (1991) argues that the human being thinks, perceives, imagines, interacts and makes moral choices according to a narrative structure.

Since the narrative is considered the basis for human-centred design, a study with a multidisciplinary design approach was conducted to develop a serious game to train health professionals for the Open University of the Unified Health System of the Federal University of Maranhão (UNA-SUS/UFMA) in Brazil. This approach involved medical doctors, educators, IT professionals, information designers and game designers, who coordinated the team and acted on the balance of the dynamics involved, that is, the narrative and playful pleasure. This was due to considering the game designers those who have the expertise for designing the game as a whole, and therefore should led the team.

This paper discusses the design process of the Clinical Case Game, a serious game for diagnosis and treatment of medical conditions, addressed to physicians in Brazil. For that, this paper is organized as follows. Section 2 presents the methodological procedures, which consisted of a workshop, development of the game content, prototype production, prototype testing with users and, refinements for the final version of the game (see Fig. 1). Section 3 discusses the results from the user testing and Section 4 draws some conclusions.

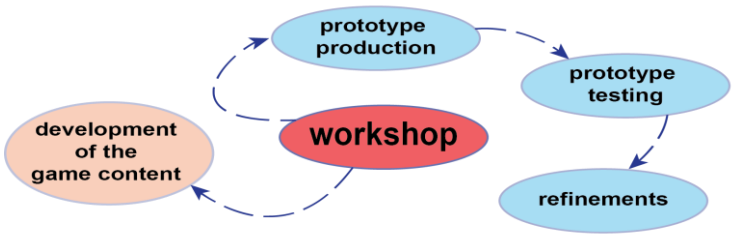

Figure 1.
Diagram showing overall methodological procedures for the design of the Clinical Case Game for UNA-SUS/UFMA in Brazil
Source: The authors

2. Methodological procedures of the Clinical Game Case

A serious game involves a lot of expert knowledge, as it is an artefact with complex elements and content. Serious games for health still represent a different degree of complexity because they need to capture a high degree of tacit knowledge. This is because health professionals develop their own skill in practice and the coherence of the narrative presented in the game depends greatly on this knowledge. Thus, the methodological approach to develop the game brought together components of human-centred design and game design (Munhoz, 2018). From the game design method, its elements and mechanics were designed, including the characters, scenarios, rules, challenges, rewards and narrative. From the human-centred design, the various stakeholders were involved to elaborate a comprehensive table of both content and functionality requirements for the Clinical Case Game.

2.1 The workshop

The workshop was held at the Federal University of Paraná – Lab DSI during May 23rd and 24th, 2019 and the Research Group SAITE (an acronym for Health Innovation, Technology and Education in the Portuguese language) organised it. A total of 13 professionals from different regions of Brazil gathered to build the information flow, content and functionality requirements for the Clinical Case Game. They were: 2 general managers/coordinators of the distance-learning project (UFMA|USP); 3 game designers (UFSC|UFPR); 3 information designers (UFPR | UFMA); 2 IT programmers (UFMA); 2 doctors – content writers (UFMA); and 1 instructional designer (UFMA).

This composition covered the main aspects and competences that contribute to the success of a serious game: gameplay (game designers), content (content writers and instructional designer), interface (information designers), interactivity (information and game designers), programming (IT programmers) and costs (managers).

The workshop started with the participants introducing themselves and discussing the form of the workshop. Next, the game designers presented a game outline, which they built from content information previously shared by the content writers. Thus, the discussion was conducted to establish how the content and interface could contribute to the gameplay, i.e., the dynamics and mechanics of the game. The results of the workshop were compiled to produce a framework with the structure and attributes of the game to support the prototyping phase.

2.1.1 Results of the Workshop

During the workshop activities, the game designers (workshop coordinators) gave voice to the participants and highlighted the key features that value the artefact from different views (McLuhan, 1964). For example, for the content developers/writers (doctors and instructional designers), content is the most important part while for the information designer is the way that content is presented. As coordinators of the workshop, the game designers sought the balance between content and form and presented the qualities of a good game to be resolved both in terms of form and content.

Based upon the game outline - previously produced by the game designers - each section of the game in terms of content, gameplay and technology was discussed in depth by the participants. Thus, the designers understood the flow of information in a clinical case and the content writers understood the gameplay requirements. The programmers and the manager ensured that the requirements considered in the game outline were feasible for programming and production.

During the workshop participants reworked the contents of the Clinical Case Game and agreed on the following complexity and characteristics: the gameplay mechanics are simple and focused on the environment, with limited range of game advancement options, a first-person viewpoint and the users play against the system.

The main output of the workshop was a game framework with the requirements for developing the Clinical Case Game. In order to do that, participants designed the flow of information of the game using the procedures recommended by the Ministry of Health of Brazil and enriched by their tacit knowledge and practice. These supported the following phase of the project (content and prototyping production), which is summarized next.

2.2 Content and Prototype Production

The Clinical Case Game was developed using a protocol created based upon the game framework of the workshop. This protocol guided the creation of the game dynamics and the content of a clinical case as a story (narrative). Thus, the content writers (doctors) should describe the various moments of this story that make up the case narrative: (a) the contextualization of the Clinical Case that is composed by social, biological behavioural and epidemiological variables; and (b) the physical description of the patient and his/her complaint (e.g., pain, nausea). The game was, then, structured in five sections in the following order:

(1) Anamnesis (questions to patients),
(2) Physical Exam;
(3) Additional Exams,
(4) Diagnosis; and
(5) Procedure/ conduct or Treatment (based upon the given diagnosis).

For each section of the game, the content writers were also asked to provide three kinds of contents: the correct ones, the plausible ones, and the incorrect ones for the clinical cases. These options of contents would make up the gameplay. In addition, for each section, the content writers should describe in the protocol conditions that could hinder the physicians' action (the player/user), such as a blackout during the Physical Exam.

While the content writers elaborated the Clinical Case, the designers team began designing the interface using the content provided and following the human-centred design method which consists of the following phases: analysis and synthesis of similar games employing the descriptive protocol proposed by Munhoz (2018) structuring and sensory creation for the Clinical Case Game, prototyping and testing (Fig. 2).

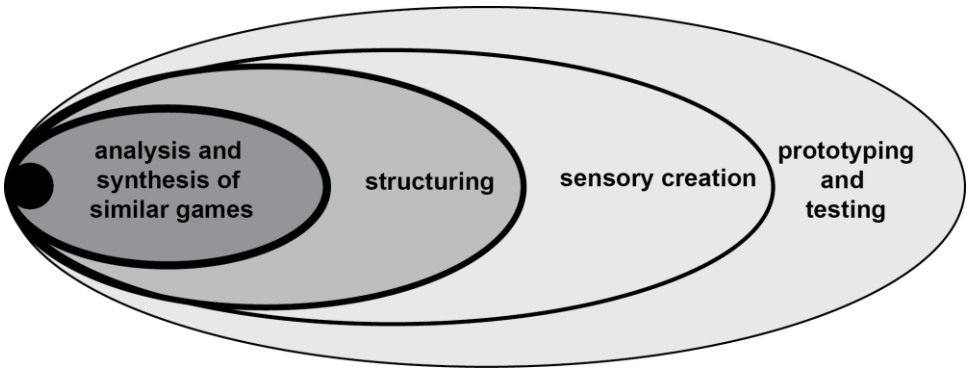

Figure 2.
The human-centred design method adopted to develop the Clinical Case Game.
Source: The authors

2.2.1 Results of the Content and prototype production

As a result of the **content production**, a clinical case on hypertension was developed by the writers to be tested with users, which was named *The Vera Clinical Case*. This case presented several options for the questions in the Anamnesis; Physical Exam; Complementary Exams,

Diagnosis; and Treatment, each displaying correct, plausible and incorrect options, which were presented to the players (physicians) through multiple choices in the game interface.
For the gameplay and interface design, the design team examined a sample of 8 popular games for learning or training in the *analysis and synthesis phase* **(**Munhoz et al, 2019). The results showed that the games were all suitable for mobile, the risks (challenges) presented in the game exponentially increased during playing, some games demanded an increasing of player's skills for different phases, some were open world and have customizable avatar. Next, the designers created the table of requirements using the information collected. An example follows in Table 1.

Table 1.

Example of the table for the content and functionality requirements
Source: The authors

Stakeholders' goals	**Content Requirements**	**Functionality Requirements**	**Priority**
Learn about the case	Specific content from a specialist	Feedback about performance	High
Identify which exams are most appropriate for a particular case	List of physical exams List of complementary exams	Feedback on the choices made	High
Play without an Internet connection		Download the game	High
Fell in control		Help page	High
Allow creating more cases		Relational database	High
Compare patients	Data of each patient		High
Read the image for the required exams	Images and reports		High
Replay the same case		Replay mode	Medium
Compare the results with friends		Leader board	Low

In the **structuring phase,** basic navigation and interaction's maps were created using the draft designed for each screen of the game. Due to time constraint, either wireframe was developed, or low fidelity paper tests were conducted in this step of the design process, which would allow exploring the interaction and navigation possibilities for the game. This, therefore, led to navigation and interaction problems, which were corrected in the next step of the process: the sensory creation.
In the **sensory creation phase,** the game screens were developed according to the visual identity of the UNA-SUS/UFMA. The illustrations followed a realistic style and the game colour palette and icons conformed to their visual guidelines. Figures 3 and 4 show examples of the game screens.

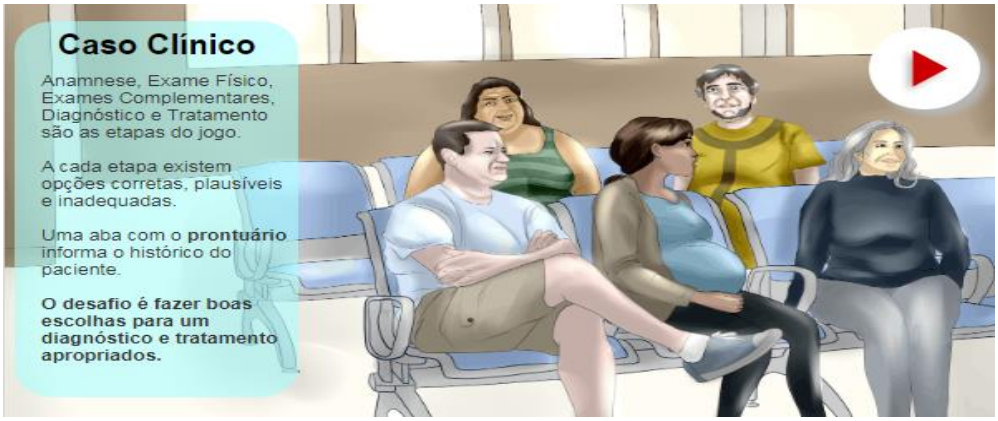

Figure 3.
Screenshot of the waiting room
Source: The authors

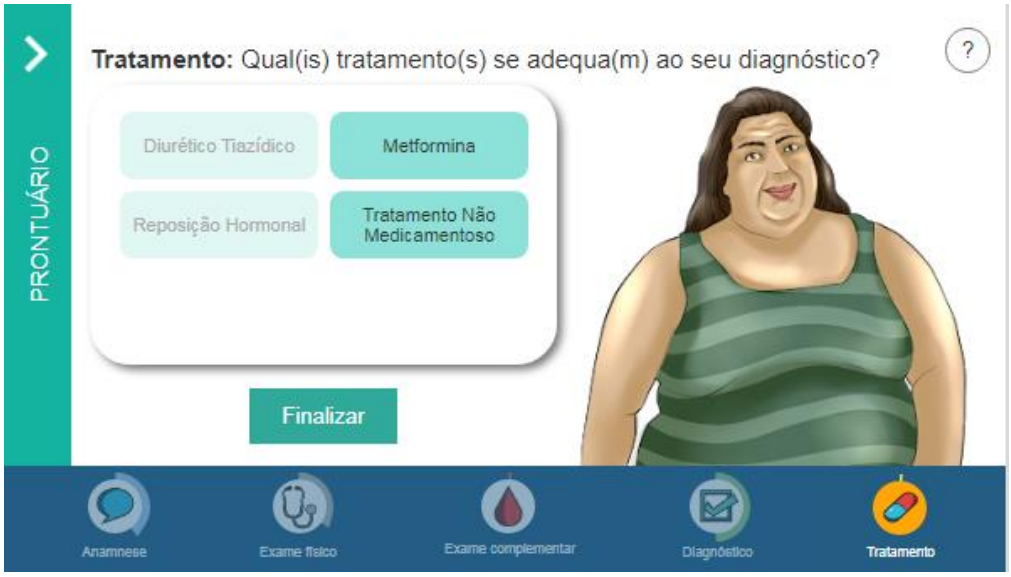

Figure 4.
Screenshot of Treatment Section of the game with two options selected for the diagnosis given to Vera's health condition
Source: The authors

2.3 Prototype Testing with Users

The purpose of the test was to verify usability and gaming experience. The questionnaires developed by professor Dr David Kaufman of Simon Fraser University, Canada were adapted for the Clinical Case Game (The Vera case). The questionnaires correspond to five indicators: demographic profile; usability; game design; player interest and interface readability.

Two doctors and three medical students tested the prototype. The test was conducted individually and at a time with the participants in a location of their convenience. The tests lasted about 20 minutes. Initially, it was explained to participants that the game is part of the UNA-SUS/UFMA health-training program and that they will test a functional prototype of the game. Each participant should speak out what they were thinking of making any choice during the game, exposing their doubts and uncertainties. This would allow the researchers to record various aspects of the participants' reactions to the interface and game mechanics. For this, the participants agreed to record the test. The collected data were gathered in a table following the indicators verified by the questionnaires, mainly: usability, game design and readability.

The researchers observed and made notes about the players' behaviour regarding the focus of attention and interaction. At the end of the test participants also reported their experience with the game and suggestions for improving gameplay.
In the next session, the results of the conducted testing are presented. Testing with the users is one of the most important data collecting in a human-centred design approach because it reviews how much the users understood the interface. First, the results of the test to investigate the experience with the game are reported. Secondly, the results that revealed the degree of the usability perceived by the users are explained.

3. Results and Discussion of The Prototyping Tests: Contributions from The Users

3.1 About the Game Experience

The experience with the game was inferred from the results of the indicators Game design and Interest of the players in the questionnaires, from the observations noted by the researchers, as well as from the participants' reports about the experience with the game.
The researchers observed that the users were more focused on the content of the game than exploring the game options. As a consequence of this behaviour, the users did not notice the progress bar around the phase icon nor noticed that the medical record was being updated. One of the users argued about the mismatching between the illustration and the content. For example, the data about the patient Vera stated that her BMI was 30.7, but her illustration would correspond to a BMI of 37.
The users also suggested to better contextualizing the clinical case, because they did not understand very well what they were supposed to do, what is their role, and what are the rules of the game.
In additions, the users considered the pace and duration of the game good. When asked, they said that they were interested in playing the final version.

3.2 About Usability

Whilst the game experience considers the users' holistic experience with the artefact, usability relates to the pragmatic aspects of using it, or "effectiveness, efficiency and satisfaction with which specified users achieve specified goals in particular environments" (ISO9241-11, 1998). Thus, the questionnaire focused on the legibility of the interface, and the interaction aspects between the user and the artefact, such as how easy were to use or understand the interface elements.
Participants did not assimilate three basic requirements of the game: 1 - that there were inadequate alternatives that should not be selected; 2 - that there was a medical record for consultation throughout the service; 3 - that the progress was shown at the bottom of the screen. In addition, the questionnaire revealed that users were not sure in which session they were in each moment of the game, and how or if they could return to a specific session to play it again.

3.3 Discussion of the prototyping tests

The literature shows that narrative is one of the most important elements in the game experience in terms of immersion, engagement, motivation and learning gain (Naul & Liu, 2019). This study contributes to these results by proposing a multidisciplinary team in the construction of this narrative. We argued that the different elements of a game are interpreted holistically by the player, and therefore need to be constructed with a holistic understanding as well. In this case, this study suggests that a designer should coordinate the design team of a serious game. This is because the designer is trained to design meanings and not just artefacts (Grimaldi, Fokkinga, & Ocnarescu, 2013; Krippendorff, 2005; Blythe, Overbeeke, Monk, & Wright, 2004). Considering that meanings are constructed from the artefact use, language, life cycle and ecology (Krippendorff, 2005), these dimensions are used to discuss the results.

3.4 Meaning of the game in use

Krippendorf argues that the meaning in use is elaborated in three phases of use: initial recognition, intermediate exploration, and ideally, unproblematic reliance. During the first phase, participants applied their experience with other games to interpret the elements of the game and thus were bothered by the lack of control over navigation.

In the exploration phase, after the first contact with the game, participants did not notice the feedbacks, not the progress bar nor the increments o the medical report, which caused a break in engagement as they reported that they did not know whether to proceed or continue selecting items.

3.5 Meaning of the game in language

This meaning is constructed when the player establishes a dialogue with the artefact or speaks to others about it. When interacting with the artefact the player establishes a dialogue, which in this case mainly revealed the inconsistency between the illustrations and the content. Meaning in language is the most important in a serious game, as the content belongs to the player's reality and its interpretation and assimilation are the primary goals of the game.

3.6 Meaning in the life of the game

The game discussed in this article is the first version of three planned versions. Its lifecycle is projected for one year until the deployment of version 2. The results suggest that participants accept the easy level of interaction proposed in this first version but require other options for increasing complexity, such as content. This request is in line with the increased challenge to maintain engagement (Csikszentmihalyi, 1990).

3.7 Meaning in an ecology of the game

Although this study concerns an isolated artefact, it is suggested that the integration of this game into the online learning project conducted by the Open University of the Unified Health System (UNA-SUS / UFMA) in Brazil should take place in order to contribute to its meaning. This requires planning its integration with the other objects offered in health training. That is, it is necessary to answer how this game collaborates in the formation of the individual if another can replace it, if it depends on another artefact and technology, such as the minimum smartphone model needed. The user perceives these relationships and will give meaning within the conceived logical context. The results suggested that narrative unity must be coherent for serious games on health and highlight the relevance of serious games as high potential resources in the educational process.

3.8 Refinements for the final version of the game

The results suggested the need to improve the introduction to the game. Thus, the interface design team drew the initial screen of the game and a text contextualizing the story.

They also removed the progress bar to increase the icons of each step and emphasized them using a different colour at the background (see Fig. 5). Performance feedback is now presented along with the information attached to the chart.

Figure 5.
Screenshot of the game showing the improvements made in the interface design, showing on the top the original screen and at the bottom the improved version.
Source: The authors

Each system response (such as the patient's response to a player question) is emphasized through micro-interactions. In addition, the designers revised every single visual element to improve the dialogue between the player and the game. They also reorganize the menu options to match the mental map of the user, which means to design interactions close to the expected dialogue between the user and the interface. Following this direction, the help page that was showed after entering the game, now only opens if the player requests it.

4. Conclusions

This paper presented the design process of the Clinical Case Game, a serious game for diagnosis and treatment of medical conditions, addressed to doctors in Brazil. A multidisciplinary and human-centred design approach was adopted to develop the game and argued that the game designers are the appropriate professionals to coordinate the team because they can act on the balance of the dynamics involved, that is, the narrative and playful pleasure. The methodology employed consisted of a workshop; content and prototype production; prototype testing with users; and refinements for the final version of the game. Each of these stages was reported and the results collected with users were discussed. These results suggested that narrative unity must be coherent for serious games on health and highlight the relevance

of serious games as high potential resources in the educational process. This is because the content on a serious game is the most important aspect that the users perceive. Thus, the accuracy of language and content drive the narrative texture that will engage and entertain the gamer.

References

Adams, E. (2014). *Fundamentals of game design.* USA: Riders.

Alcover, E. A., Jaume-i-Capó, A., & Moyà-Alcover, B. (2018, May). PROGame: A process framework for serious game development for motor rehabilitation therapy. *PLOS-ONE*.

Blythe, M., Overbeeke, K., Monk, A., & Wright, P. (2004). *Funology From Usability to Enjoyment.* Netherlands: Springer.

Csikszentmihalyi, M. (1990). *Flow: The Psychology of Optimal Experience*. New York: Harper Perennial Modern Classics.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011). From Game Design Elements to Gamefulness: Defining Gamification. *15th International Academic MindTrek Conference* (pp. 9-15). Tampere: MindTrek.

Forlizzi, J., & Ford, S. The Building Blocks of Experience: An Early Framework for Interaction Designers. *DIS '00* (pp. 419-423). New York: ACM.

Gloria, A. D., Bellotti, F., Berta, R., & Lavagnino, E. (2014). Serious Games for education and training. *International Journal of Serious Games*.

Grimaldi, S., Fokkinga, S., & Ocnarescu, J. (2013). Narratives in Design: Studies of the Types, Applications and Functions of Narratives in Design Practices. *DPPI 2013 - Praxis and Poetics* (pp. 201-210). Newcastle upon Tyne: ACM.

Hagglund, P. (2012). *Taking Gamification to the Next Level: A detailed overview of the past, the present and a possible future of gamification.* Umeå: Umeå University.

Huizinga, J. (1944). *Homo Ludens: Study of Play-element in Culture.* London: Routledge & Kegan Paul.

ISO9241-11. (1998). *Part 11: Guidance on usability.* Geneva: International Organisation for Standardisation.

Jannidis, F. (2003). Narrative and Narratology. In T. Kindt, & H.-H. Müller, *What is Narratology?* (pp. 35-54). Berlin: Gruyter.

Kaufman, D., Gayowsky, T., Sauvé, L., Renaud, L., & Duplàa, E. (2019). Benefits of digital games for older adults: Associations with demographics and game use patterns. *Gerontechnology, 17* (1).

Krippendorff, K. (2005). *The Semantic Turn: A New Foundation for Design.* Boca Raton: CRM Press.

McLuhan, M. (1964). *Understanding Media: The Extensions of Man.* Cambridge: The MIT Press.

Munhoz, D. R. (2018). *Design de jogos de tabuleiro e dinâmicas cooperativas: uma abordagem histórico-cultural.* Curitiba: UFPR.

Munhoz, D. R., Mazza, L. U., Taguchi, M. S., Spinillo, C. G., Fadel, L. M., Oliveira, A. E., et al. (2019). Análise de mecânicas de jogos e tendências gráficas na representação de jogos

de procedimentos médicos, visando o estímulo e motivação para o aprendizado. *9° Congresso Internacional de Design da Informação.* Belo Horizonte: SBDI (In Press).

Murray, J. H. (1998). *Hamlet on the Holodeck The Future of Narrative in Cyberspace.* Cambridge: MIT Press.

Naul, E., & Liu, M. (2019). Why Story Matters: A Review of Narrative in Serious Games. *Journal of Educational Computing Research*, 1-21.

Polkinghorne, D. E. (1991). Narrative and Self Concept. *Journal of Narrative and Life History, 1* (2), pp. 135-153.

Polkinghorne, D. E. (1988). *Narrative knowing and the human sciences.* Albany: State University of New York Press.

Rocha, R. V., Zem-Lopes, A. M., Pedro, L. Z., Bittencourt, I. I., & Isotani, S. (2015). Metodologia de Desenvolvimento de Jogos Sérios: especificação de ferramentas de apoio open source. *XXVI Simpósio Brasileiro de Informática na Educação (SBIE 2015)* (pp. 489-498). Maceió: CBIE-LACLO 2015.

Ryan, M.-L. (2017). Narrative. In I. S. Sully, *A Companion to Critical and Cultural Theory* (pp. 517-530). John Wiley & Sons Ltd.

Zimmerman, E. (2004). Narrative, Interactivity, Play and Games. In N. Wardrip-Frui, & . ,Harrigan*First Person: New Media as Story, Performance, and Game* (pp. 154-164). Cambridge: MIT Press.