A Literature Review for Game Design Frameworks Towards Educational Purposes

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ABSTRACT

Creating a game is a complex process, full of layers and steps in which different team members should contribute to the final product in order to be appreciated by the public. To control the steps and maintain everything guided towards the same objective throughout the entire development there are several frameworks that help in the organization during the creation flow of games. A game design framework is a group of techniques to be applied at each stage of the project, depending on the needs of the game designer.

The purpose of this paper is to identify and review academic and scientific papers regarding the elaboration, creation or application of game design tools for educational purposes. Its elaboration will work as a research basis for a master's thesis regarding the use of game design frameworks for creating educational games.

Therefore, a review of the literature (10 years or less) will be carried out, using periodical resources and a database of academic papers. The following topics will be explored in order to verify the relevance of the works studied: (1) target audience, (2) game design framework used, (3) scope of work creation, and (4) result obtained. As a result, we performed an analysis and led a discussion about these academic studies and applications of different game design frameworks for pedagogical purposes, thus we could realize the advantages and limitations that these frameworks may present for this intention. Under those circumstances, we established our work based on the research questions and we showed their possible scientific contributions to the area of game design for educational purposes.

Keywords: Educational Games; Game design; Game Design Tools.

Introduction

Electronic games have attracted the attention and time of countless children and teenagers around the world since its emergence in the late 1970s, and their fascination with digital entertainment is greater than ever. However, as digital games

became a frequent activity in people's lives, their possible effects on the audience has begun to be discussed. The main concerns that has been raised are about the possibility that the practice of video games may become an addiction or provide other harmful behaviors, such as aggression or depression (Griffiths, 1998). Although, lots of people saw the astonishment of the younger audience as a possibility to turn electronic games into a new educational tool. By offering fantastic environments, rich visual and audible elements and by enabling interactive storytelling. Electronic games are a comforting and exciting environment with recognizable and interactive features (Poole, 2000). In the early 1990s several games for educational purposes began to emerge (such as "Reader Rabbit" by *The Learning Company* in 1986, or "Dr. Brain" by *Sierra* in 1992) which, in addition to being a success with the public, they revealed the new possibilities that educational games propose.

Nevertheless, despite the growth of the discussion about the use of games for educational purposes, being either about the contrast between the intrinsic motivation of the younger audience and disinterest with the school content (Prensky, 2003), or the greater acceptance of the use of digital tools within the classrooms by the academic community (Kirriemuir, 2002),

Studies that approach the processes of development of educational games are necessary to be explored, in order to understand the results achieved and to establish their state of the art. On the one hand, there are studies that use game structures to create environments which are capable of motivating learning (Malone & Lepper, 1987) since the 1980s, these studies focus on understanding the use of motivational aspects of games as an artifact for supporting the engagement during the learning process, on the other hand, there are others studies aimed to the effects of digital games in learning, which also understand the characteristics that make them attractive to their audience and analyze which of these characteristics differ from commercial to educational games (Schaller, 2006).

Methodology

It is a systematic review that adopts a detailed analysis of the literature related to educational games and game design techniques. All papers were researched through the Internet, in different academic databases and specialized periodical

resources. Researches were carried out in English and Portuguese between September and December of 2017, and initially it was excluded papers which are older than ten years from its original publication. Papers were selected from the Brazilian Symposium on Games and Entertainment done at Science Direct, Sage Journals, Springer Open, British Journal of Educational Technology, Academic Conferences and Publishing International, Google Academics, Capes Periodicals, Brazilian Digital Library of Thesis and Dissertation, Journals for Free, FaSCi-Tech, Research Gate and Emerald Insight.

The criteria for inclusion was defined as: (1) Pre-filtering, original text, full text should be available in online format and publication date of a maximum of ten years; (2) First filter, thematic related to educational games or games creation techniques; (3) Second filter, target audience should involve game developers or game researchers; (4) Third Filter, specific game development reports were not allowed; And (5) final filter, the article needs to include both themes of educational games and game design. Therefore, papers which were not related to the mentioned areas were discarded. The selected papers were separated into two groups: articles on the use of games for pedagogical purposes and articles on game design techniques for game development. The separation was done with the intention of finding techniques or frameworks of game design aimed at educational games.

Table 1. Filtering Process

No.	Filter	Filtering details	No of selected articles
1	Pre-filtering	Ten years or early and available in online and	418
2	First Filter	Thematic related to educational games or games creation techniques	257
3	Second Filter	Target audience should involve game developers or game researchers	145
4	Third Filter	Specific game development reports were not allowed	41
5	Final Filter	Including both themes of educational games and game design	17

Results

A total of 418 academic journals related to the study, the development and the analysis of games applied to pre-filtering were collected from the databases mentioned. In a second moment the filters (2) and (3) related to educational games or

techniques of games creation directed to game developers or game researchers was applied, thus were selected 145 papers. In the third step the papers were analyzed more deeply, applying the third filter, in which were chosen only articles that were aimed at the purposes of this paper. Thereby 41 papers were chosen and separated, 29 focused on the use of games in education and 27 papers on tools or debates about game design. The ones in the Table 2 include both themes of educational games and game design.

Sixteen of the selected papers deal with both themes of educational games and discuss game design techniques, which are more relevant with the subject of study in this paper.

From the list, four papers deal with the benefits of teaching digital game development for teachers and students (Papers 4, 5, 6 and 14). They discuss the importance of learning programming and computer science by children, teenagers and teachers in the process of training as a way to adapt the way of learning and teaching the new paradigms of current technology and its availability to the majority of the population.

A prominence topic is the way in which the creators of the game, in this case students and teachers, must think during the development, putting themselves in the role of the player, understanding their needs. The papers propose that the games to be developed must be educational, therefore it becomes essential to determine which content to be taught and to propose the best ways to transmit it to the players. However, the papers do not present techniques for this goal to be achieved, focusing on the perspective of the educational content creator in children, teenagers and teachers.

Table 2. Selected publications that meet this paper specifications. The ones highlighted include both themes of educational games and game design

No.	Year	Author; Title;	Educational Institution; Location
1	2015	Vanisri Nagalingam; User Experience of Educational Games: A Review of the Elements	University Technology Malaysia; Malaysia
2	2011	Thiago G. Mendes; Jogos Digitais como Objetos de Aprendizagem: Apontamentos para uma Metodologia de Desenvolvimento	Federal University of Rio Grande do Sul, Brazil
3	2017	Sissy-Josefina Ernst; More than the Sum of its Parts – Towards Identifying Preferred Game Design Element Combinations in Learning Management Systems	University of Kassel; Germany
4	2016	Corbett Artym; Pre-Service Teachers Designing and Constructing 'Good Digital Games'	University of Alberta; USA
5	2016	Yun-Jo An; A case study of educational computer game design by middle school students	University of West Georgia; USA
6	2013	Fengfeng Ke; A case study on collective cognition and operation in team-based computer game design by middle-school children	Florida State University; USA
7	2015	Ismael Gaião Filho; Aplicação e Análise de um Framework de Concepção ao Desenvolvimento de um Jogo Educativo	Federal University of Pernambuco; Brazil
8	2015	Enza Rafaela de Nadai Victal; Avaliação para Aprendizagem baseada em Jogos: Proposta de um Framework	Federal University of Espírito Santo; Brazil
9	2015	Karen Schrier; EPIC: a framework for using video games in ethics education	Marist College; USA
10	2009	Brian M. Winn. The Design, Play, and Experience Framework	Michigan State University; USA
11	2015	Heraclito Amancio Pereira Junior; Modelo para um Framework Computacional para Avaliação Formativa da Aprendizagem em Jogos Digitais	Federal University of Espírito Santo; Brazil
12	2009	Bokyeong Kim; Not just fun, but serious strategies: Using meta-cognitive strategies in game-based learning	University of Virginia; USA
13	2010	Michelle Pereira de Aguiar; Proposta de um instrumento de auxílio ao design de jogos eletrônicos educativos	Federal University of Paraná; Brazil
14	2015	Alexander Repenning; Scalable Game Design: A Strategy to Bring Systemic Computer Science Education to Schools through Game Design and Simulation Creation	University of Colorado Boulder; USA
15	2010	Leonard A. Annetta; The "I's" Have It: A Framework for Serious Educational Game Design	North Carolina State University; USA
16	2010	Vicent Aleven; Toward a framework for the analysis and design of educational games	Pittsburgh; USA
17	2017	Félix de Souza Neto; Jogos Digitais e Aprendizagem: um estudo de caso sobre a influência do design de interface	SENAI/CIMATEC; Brazil

Some papers have focused their studies on analyzing aspects of game design, being educational or not, in order to understand their efficiency as educational material. The papers (8 and 11) propose frameworks that help to determine if a game is capable of promoting a formative assessment of the players. Both proposals clarify the differences between the traditional and the formative assessment, highlighting the benefits that the second promotes in the students. On the one hand, the paper *Avaliação para Aprendizagem baseada em Jogos: Proposta de um Framework* (8) presents a computational framework in which data would be collected during the process of playing, thus evaluating and suggesting improvements to the educational game, and the paper *Modelo para um Framework Computacional para Avaliação Formativa da Aprendizagem em Jogos Digitais* (11) plans heuristic processes to obtain the qualification of the game as a formative assessment product. Both frameworks seek to improve the game as an educational object in the future. On the other hand, the paper *EPIC: the framework for using video games in ethics education* (9) also establishes an evaluative tool for classifying digital games, but the study is concerned with the ethical aspects of the game. The author also suggests the use of games evaluated by the ethical question in the classroom, as a way to help students understand the subject.

The papers *Aplicação e Análise de um Framework de Concepção ao Desenvolvimento de um Jogo Educativo* (7) and *Proposta de um instrumento de auxílio ao design de jogos eletrônicos educativos* (13) outline tools that help to elaborate and evaluate the design of games based on methodologies not directly linked to the games area. The first paper (7) shows a case study of a board game development applying the knowledge of the German designer Bernd Löbach, specialist in industrial design. The second paper (13) proposes a heuristic tool that helps to verify the educational efficiency of the game already created.

Two papers (3 and 12) seek to understand how games are capable of developing skills in players who remain beyond playing. The paper *Not just fun, but serious strategies: Using metacognitive strategies in game-based learning* (13) explains how MMORPG games can strengthen strategic and organizational thinking in players, even if the purpose is not related to pedagogical elements. The paper *More than the Sum of its Parts* (3) shows the positive effects that the combination of different elements of game design can have on the player development and how these elements can be used in the gamification process in other environments.

The paper *User Experience of Educational Games: A Review of the Elements* (1) and the paper *Jogos Digitais e Aprendizagem: um estudo de caso sobre a influência do design de interface* (17) highlight the importance of UX (User Experience) so that the goals of the educational game are more easily achieved.. The first paper (1) seeks to list the main elements of UX and its implications within the game. The second paper (17) exposes the user interface as an object of study, detailing its functions and impacts on the users of the game.

Only four papers focus directly on game design during the process of developing an educational game (2, 10, 15, and 16), however only two propose a new framework (10 and 16), while the other two deal with the pedagogical and technical concerns that the development of an educational object may have for developers with no knowledge of the educational plan. The paper *Jogos Digitais como Objetos de Aprendizagem: Apontamentos para uma Metodologia de Desenvolvimento* (2) amplifies a discussion about the process of developing an educational game, separating it by stages and highlighting the difficulties and main reasons for failures that it may have in its goal of transmitting content. The paper *The "I's" Have It: A Framework for Serious Educational Game Design* (15) focuses on the pedagogical aspects that must be present during the development of an educational game. The addressed points seek to understand how to correctly spread knowledge to the players without losing the pedagogical goals or conflicting with other elements that constitute a digital game.

The paper *The Design, Play, and Experience Framework* (10), written by Professor Brian M. Winn, proposes the framework DPE (Design, Play, and Experience) as a tool for planning and developing *serious games*, including educational games . The author explains that DPE is an expansion of the MDA framework, published by renowned and popular Marc LeBlanc both by industry and academy. The author expresses that the MDA framework (Mechanics, Dynamics and Aesthetics) contributes to the developers' ability to improve the mechanics present in their projects, understanding the experience of the players, however only the improvement of the mechanics is not enough for the *serious games*, since its main objective is not the fun, but the possibility of learning. So it would be necessary to extend the MDA beyond the mechanics and dynamics within the game, taking into account the storytelling, UX and, mainly, the process of in-game learning. In addition to layering the components that constitute a *serious game*, the relationship between these layers

is explained to be essential for the game to be both efficient in its purpose (to transmit some content) and to engage the player in order to have a positive experience.

The other paper that aims on the process of development of an educational game is *Toward the framework for the analysis and design of educational games* (16), written by Vicent Aleven, elaborates a framework that seeks for evaluating the assertiveness of an educational game and helping his project. The paper establishes that the framework is based on three components: learning objectives, the MDA and the methods of instructional design. The first step is to establish the objectives that the educational object will have, in other words, what knowledge the game should improve in the players. The author emphasizes that setting these goals allows you to draw the direction of the project, and when those goals are inaccurate, the educational essence of the game can become fragile and inconsistent. The second component is the MDA framework, also mentioned in the paper by Brian Winn (10), widely used as a basis to establish the technical aspects that the game will have influenced by the experience that is sought in the player. The third component is instructional design, which is a pedagogical methodology that helps to develop knowledge in different environments. The author points out that there are different metrics to be followed, and the choice of these metrics should align with the design pretensions. The proposed framework was tested as an evaluative tool, being able to set which points the analyzed educational games meet the established metrics, otherwise, how to make them overcome these possible deficiencies. The framework is also evidenced as a useful tool during the game design process, establishing the guidelines to be followed respecting and interconnecting the three components that compose the framework. But the ideation of the game that establishes which of the components should be considered as a priority and, above all, how the relationship between the learning objective, the mechanics of the game and the pedagogical methods will be implemented.

Discussion

Conducting the research of papers, according to the selection criteria, in order to establish the state of the art of the theme proposed by this paper (game design frameworks for educational games) allowed to understand which problems the academy encountered when the games happened to be potential educational tools. It was possible to observe that the discussion about the use of games in

education is nothing new. The use of digital media as an instrument or simulation of educational environments has proven to be as efficient or even superior to traditional environments and methods (Butler, 1988). The discussion on reinvigorating the environment in order to allow young people to better develop their learning is not discussed as on the benefits they bring (Malone & Lepper, 1987), but it questioned how to transform the school atmosphere without losing their pedagogical values for entertainment.

As the objective was to understand the academic discussion about the processes of creation of educational games, the researched papers were directly focused on the area of development of digital games more than on pedagogy or educational psychology. Although it refers to a development area, the discussion and the concern about the educational qualities that the games might have are very common, even though the digital games industry does not focus on it. It is positive that part of the papers are from developers reporting their experiences in educational projects or from researchers working on problems and solutions based on experiments using digital games in the classroom. It is correct to affirm that for more than 30 years, there are concerns about applying the theories discussed in an appropriate way in schools and classrooms, and a question was raised about the results obtained when a game is used for educational purposes.

However, it is necessary to highlight two points that should be noticed based on the academic research done. First, the list of papers that analyze the post-production effects and the application of classroom games is much higher than those that promote analysis and improvement during the development of these games. Second, pedagogy and education professionals are excluded from the process of game development. Most are treated as consultants or final public.

About the first point, the total amount of papers initially researched, including the 40 selected for analysis, only 4 discuss about the game development process (2, 10, 15, and 16). We can observe that there is a lot of research material to aid in the understanding of an educational object, analyzing its efficiency and the characteristics that influence the players and ways to validate educational games, although a developer will not easily find the same amount of content that supports the elaboration process of the educational game or that advises how to define technical and pedagogical priorities in the project.

As for the second point, it is noticeable that, either in the frameworks that seek to validate the game or in those that serve as a tool for its development, the role of the education professional is not defined. They play a role of an external actor, either as an advisor for the educational goal or as an object of discussion in the choice of the game theme, the pedagogue or the teacher is not placed at the heart of the research. Even when the proper importance is given to pedagogical concepts, the role of these professionals is not designated.

It is not possible to measure in this paper how these factors reflect in the success and in the ease of insertion of this media as an educational tool within the educational institutions, however it is noticed a major concern in the validation of the games as educational material or in the understanding of their effects when applied in their best conception by those involved in the development process.

Conclusion

145 journals were selected from the initial amount of 418, the topics of game design and education in games are quite discussed by researchers and students of the digital game area. Nevertheless, these subjects may have different focuses which make their discussion, endless and rich, on the other hand some topics are not deal with the same enthusiasm. Specifically from the selection of papers that focus on the use of educational games, most part of the research focused mainly on three aspects: social approach, familiarized to the social impact of the game public; learning and digital games, studying the effects of the digital game on the learning of specific aspects; and games within the school, which includes the studies of the use of games as tools especially targeted at school approach (GROS, 2007). There is a lack of studies aiming to improve the process of developing an educational game, to help game developers, pedagogues and content specialists to make the player experience richer, more constructive and more engaging. This discussion is evidenced once that only two papers of the analyzed amount focus their studies to present alternatives and tools for educational game developers.

If we analyze the selection of papers focused on game design, this issue is even more prominent, since some of the papers do not deal with the educational bias, and even the ones that do, build their arguments in the same framework, MDA

(LeBLANC, 2005).), stating that the alternatives come from the same tool, therefore, with many similar elements. We can increasingly perceive a positive scenario for the use of games within the learning process, with professionals in the field of education dealing with games as tools with great pedagogical potential, as well as the greater concern of the developers and students of digital games in studying their effects when designed to teach. On the other hand we see this same scenario still uninterested and new to know how to improve the processes of developing an educational games. References which offers answers to the difficulties in balancing mechanics with pedagogical methods, to allowing the act to play to thrive, and to the role of the education professional to be assigned when planning the flow of the game have not been found.

There is no denying, however, that the search for the improvement of the insertion of different media, one of them the digital games, in the educational environment is a discussion in progress, and even the topics narrowly studied have perspectives of evolution when their gaps are evidenced. Given this point of this research, it is possible to adequately raise the questions that lead to a future research on how to develop an educational game that includes pedagogical methodologies in the process of game design, in order to build a game designer assistance tool that proposes a product with educational purposes.

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