An Introduction to Educational Games Virtualization

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ABSTRACT

Games Virtualization is a process of digital versions creation for traditional/ physical games. In education, this process aims to create digital versions of traditional/ physical educational games, keeping psychological and pedagogical concepts from traditional version, as well as associate these concepts to contemporary game design elements. In this sense, this chapter presents a practical introduction to Educational Games Virtualization, addressing the introduction to this concept, some effort conducted in the last years, a review of challenges and opportunities in this field, as well as a practical approach about Educational Games Virtualization.

Keywords: education games virtualization, games virtualization, educational games.

1 INTRODUCTION

In the last decades, the international industry of game development has been increasing, becoming an important worldwide industry. According to a recent report of Entertainment Software Association [5], only in the United States, there are approximately 155 million of players moving, in 2014, approximately $ 22.41 billion around the word. Additionally, another interesting recent study showed that 74% of *K-8*[1] teachers use digital games in the classroom Lofgren [9], enabling a considerable growth of the Educational Games industry in the last years.

In the academic context, a series of recent studies have been done in order to investigate effects of video games in different educational aspects (*e.g*. [2], [16] and others). These studies have highlighted a series of discussions related to video games positive effects in student's learning, such as game fullness, motivation, and others; and negative effects, such as: violence, social interaction absence and extreme appreciation of "digital" (digital activities conducted using some kind of technological device), in detriment to "traditional" (traditional (physical/ manual) activities).

Recent studies addressing Games Virtualization, (*e.g*. [15] and [10]), in order to create digital versions to traditional/physical Educational Games, aim to keep the pedagogical and psychological aspects from traditional/physical, and associate these aspects with contemporary game design elements. Like this, recent studies have shown different benefits of virtualized games, as well as highlighted a series of discussions related to design, application and evaluation of Educational Games developed based on Virtualization Games.

[1] K-8 schools are schools in the United States that enrol students from kindergarten/pre-K (age 5) through 8th grade (up to age 14), combining the typical elementary school (K-5) and junior high or middle school (6-7-8).

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However, Educational Games Virtualization is a current theme, whose most of the studies are recent works, generally pointed about Educational Game development to specifical contents, such as Math or Biology. Thus, this chapter presents an introduction to Educational Games Virtualization, addressing the concept of Educational Games Virtualization, some recent important efforts in this field conducted in the last decade, as well as a practical approach in order to guide future studies in this domain. Finally, this chapter presents a series of challenges and opportunities on Educational Games Virtualization.

2 BACKGROUND

In this section, we present the main topics addressed in this study: Educational Games and Educational Games Virtualization, as well some recent efforts conducted in this field.

2.1 Educational Games

Over the last 20 years, computer games have been increasingly replaced the most traditional games as leisure activities and have had a transformational impact on how we spend our leisure time Connolly *et al*. [3]. According to these authors, Educational Games provide engaging activities and it seems like that, far from waning, interest in games for leisure is still growing.

At this point, in the last decades, Educational Games have been used in many teaching contexts of different topics as: Business, Geography, History, and others [3], as well as studied in different perspectives as violence [1], learning [8], *playfulness* [16] and others.

According to recent studies, a series of empirical results related to games-based learning has shown that despite the overwhelming publicity given to the negative impact of games, like most technologies before them, computer games can have both positive and negative impacts [3]. These results are important to demonstrate not only the efficacy of games in an educational context but also to highlight the importance of new studies in a different kind of Educational Games.

2.2 Educational Games Virtualization

In the contemporary world, the idea of 'virtualization' is considered and studied by philosophy, psychology, physics, biotechnology, arts, and others Kerimbayev [7], increasing topics related to virtualization in different contexts as social life, industry, and education. In this perspective, Educational Games Virtualization is a process to create digital versions of traditional/physical Educational Games before used to the teaching of a determined topic.

The main goals of Educational Games Virtualization are kept/preserve the aspects of the traditional/physical version of the educational games version and combine these aspects with the contemporary game design elements, in order to increase students' learning.

Educational Games Virtualization can be used in different contexts and be support on different educational topics. According to Oliveira and Silva Junior [10], the Educational Games Virtualization process should be start with the choice of the traditional educational game and end with the process of game evaluation, in order to identify if the educational game (in the digital version) keeps/ preserves the main aspects from traditional/physical game version, as well identify if the game can be increase students' learning.

According to Santos *et al*. [14] and Santos *et al*. [15] this process involves a multidisciplinary team, with professionals from Computer Science (especially Human-Computer Interaction (HCI)), Pedagogy, Psychology and those from specific educational games application fields, for instance Mathematic, Language, Biology, and others. The concept of Educational Games Virtualization is summarized on the conceptual map presented in Figure 1.

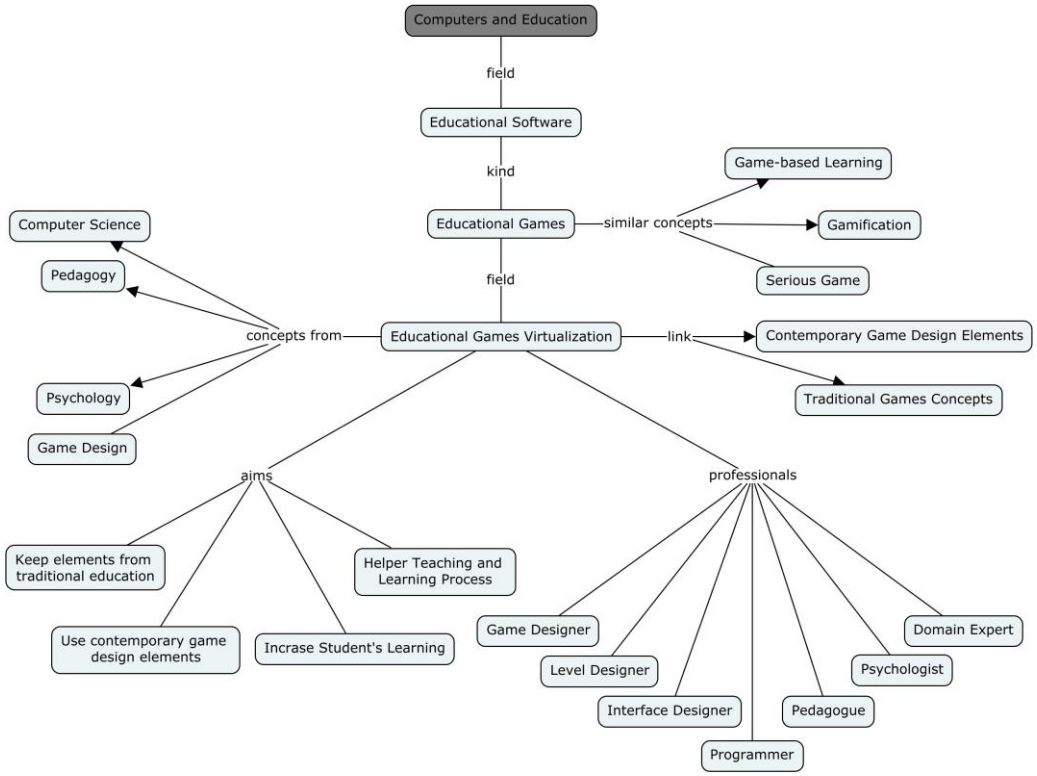

Figure 1: Conceptual map of Educational Games Virtualization.

2.3 Recent Efforts

Different efforts have been conducted in this field in the last years. Togni *et al*. [18] developed a game based on the traditional card game, aiming to teach basic concepts of geometry. The game was developed based on the *Meaningful Learning Theory* and was used with students in a real context (See Figure 2).

Oliveira *et al*. [10] developed a game named Conquering with the Rest (original name in Portuguese: *Conquistando com o Resto*) aiming to teach concepts of the division to elementary students. This game was developed based on the Educational Games Virtualization and evaluated with elementary school students in real life (see Figure 3).

Santos *et al*. [15] proposed and developed a game named Challenges with Sticks (original name in Portuguese: *Desafios com Palitos*) that provide different challenges to teaching concepts of geometry, numerical conversion, logical reasoning, and others. This game was developed based on a specific methodology to Educational Games Virtualization, as well as evaluated with elementary and high school students (See Figure 4).

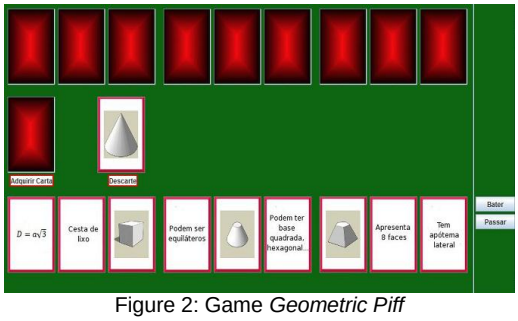

Figure 2: Game *Geometric Piff*

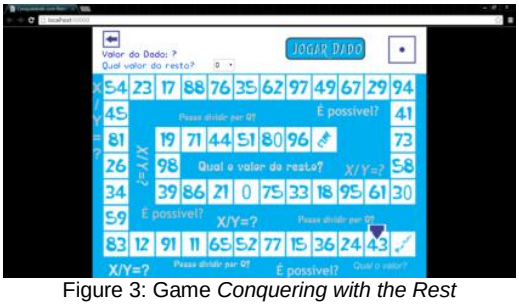

Figure 3: Game *Conquering with the Rest*

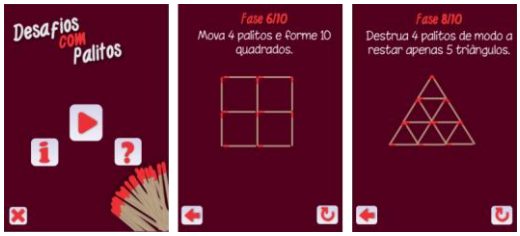

Figure 4: Game *Challenges with Sticks*

3 PRACTICAL APPROACH

This section aims to help students and professional to start to virtualize Educational Games. In this sense, we present a specific methodology to Educational Games Virtualization and series of tools capable to facility the development process.

3.1 Development Methodology

Besides, in the year's different efforts have been conducted, a big challenge in this field is obtained resources to the development process, as methodologies. So, in this section, we will present a methodology used and evaluated in some recent projects [10] and [15]. This methodology is named EGV® and addresses the different steps of Games Development, highlighting special structure regarding Games Virtualization.

This Methodology is a 'high level[2]' methodology, developed in order to provide a general structure encompassing the main phases of Educational Games Virtualization process, starting with the choice of traditional game, addressing all game development process and finalizing in the game release and divulgation, aiming to auxiliary professionals regarding Educational Game Design field to develop Educational Games based on the Educational Games Virtualization process. It is composed of three main phases[3]: **Preproduction**, **Production,** and **Postproduction**. Figure 5 presents a general structure of methodology.

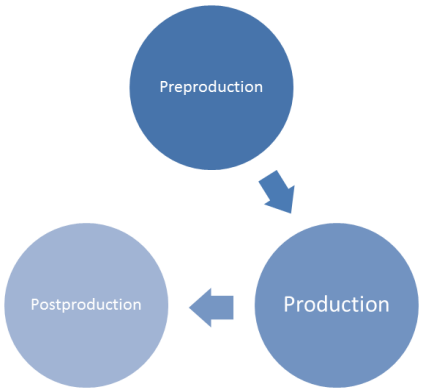

Figure 5: Methodology structure

Preproduction phase aims to cover the steps related to the choice of traditional game, requirement analysis and game prototype, **Production** step, aims to cover steps related to game implementation, from game documentation until the game test, and **Postproduction** phase, aims to cover steps regarding the game evaluation, release and real use of the game.

Preproduction phase is composed of two general steps: **Traditional Game Choice** responsible to Problem Evaluation and Requirements Analysis (Functional Requirements and Nonfunctional Requirements), and **Prototyping** responsible to Physical Prototyping and Virtual Prototyping.

Production phase is composed for four general steps: **Game Design** responsible to Game Design Document, **Project** responsible to Game Modeling, Phase Diagrams and Data Base Project, **Implementation** responsible to Programming, Art, Interface, Scenario, Characters, Resources and Audio, and **Test** responsible to Component Integration, Test Run and Test Flow.

Post-production phase is composed of three general steps: **Conceptual Evaluation** responsible to Qualitative Evaluation, (Pedagogical Evaluation and Psychological Evaluation), **Design Evaluation** responsible to Quantitative Evaluation (HCI Evaluation and Game Design Evaluation) and **Implantation** responsible to Release, Divulgation and Game Installation/Activation.

3.2 Tools

A challenge related to Educational Games Design is to choose a tool capable to auxiliary in the development process, in order to help students and professors to start the in the Educational Games Virtualization, this section present five different engines to 2D games development, the tolls presented in this section are easy to use privileging the drop-and-down programing, in order to help non-programmers to develop games. The engines presents will be *Construct 2 (see Figure 6)*, *Game Maker (see Figure 7)*, *Cocos 2D (see Figure 8)*, *RPG Maker (see Figure 9)* and *Game Salad (see Figure 10)*.

Construct 2 is an *HTML5*-based 2D game editor, developed by *Scirra Ltd*. It is aimed primarily at non-programmers, allowing quick creation of games in a drag-and-drop fashion using a visual editor and a behavior-based logic system. The primary method of programming games and applications in *Construct* is through "event sheets", which are similar to source files used in programming languages.

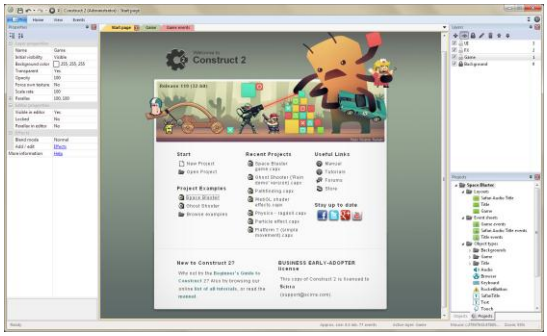

Figure 6: Contruct 2 interface

GameMaker is a proprietary game creation system and accommodates the creation of cross-platform and multi-genre video games using drag and drop action sequences or a sandboxed scripting language (known as *Game Maker Language*), which can be used to develop more advanced games that could not be created just by using the drag and drop features.

[2] Concept used to describe operations that are more abstract in nature, where overall goals and systemic features are typically more concerned with the wider, macro system as a whole.

[3] Only a summary regarding the methodology concept, as well as of the methodology proposed are presented in this paper, however the full description of methodology, as well as the main resources associated are available in this link: http://migre.me/tYfpe

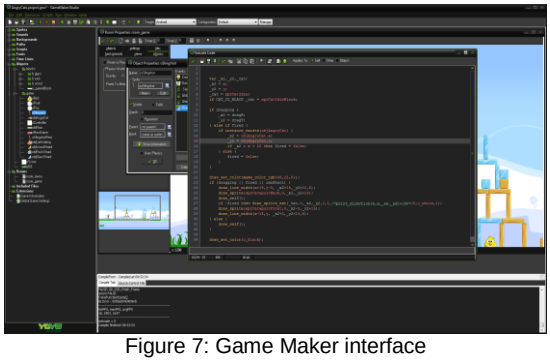

Figure 7: Game Maker interface

Cocos2D is an open source software framework. It can be used to build games, apps and other *cross-platform GUI* based interactive programs. There are some independent editors in the *cocos2d community*, such as those contributing in the areas of *SpriteSheet editing*, particle editing, font editing and *Tilemap editing* as well as world editors including *SpriteBuilder* and *CocoStudio*.

Figure 8: Cocos 2D interface

RPG Maker is a program that allows users to create their own *role-playing video games*. Most versions include a tile set based map editor, a simple scripting language for scripting events, and a battle editor. All versions include initial premade *tilesets*, characters, and events which can be used in creating new games.

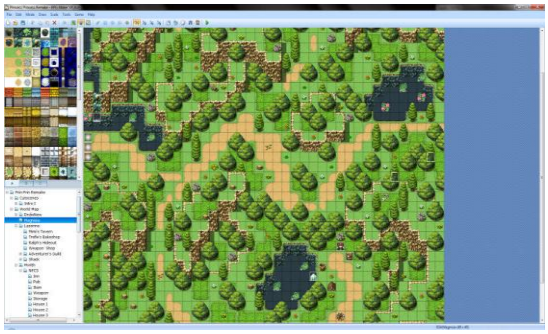

Figure 9: RPG Maker interface

GameSalad Creator is an authoring tool developed by *GameSalad, Inc.* aimed primarily at non-programmers, for composing games in a *drag-and-drop* fashion, using visual editors and a behavior-based logic system. It is used by consumers and creative professionals such as graphic designers, animators, and game developers for rapidly prototyping, building and self-publishing cross-platform games and interactive media.

Figure 10: GameSalad interface

4 CHALLENGES AND OPPORTUNITIES

Starting in the recent studies in this field, was possible identify a series of challenges. Firstly, Santos and Silva Junior [13] conducted a state of the art on this topic, providing for identifying and to confirm a series of challenges and opportunities. Additionally, in a similar study Santos and Silva Junior [12] proposed five current challenges for Games Virtualization applied to Educational Games Virtualization and presents a lot of guidelines for each challenge proposed.

Some challenges are present following and Table 1 and Table 2 presenting, respectively, a summary of these challenges and opportunities: (*i*) design of methodologies for educational games virtualization, (*i.i*) design of methodologies for educational game evaluation, (*i.ii*) resources recommendation for Educational Games Virtualization, (*ii*) multidisciplinary of educational games virtualization, and (*iii*) professional training to Educational Games Virtualization.

Table 1: Challenges and Motivations (synthesized of [13])

Challenges	Motivation
Challenge 1	In the last years, some studies have been made addressing Educational Games Design based on Games Virtualization. However, these studies present different methodologies and process for the development of games or use others methodologies from traditional game design. On the other hand, Educational Games Virtualization, different of conventional Educational Games Development, use concepts from different fields as Pedagogy, Psychology, Computer Science and others.

Challenge I.I	Recently, some studies have been done aiming to propose methodologies to Educational Games evaluation. However these methodologies are focused in specifics fields, without elements with allowed use in different contexts, or yet, focus only on the game interface evaluation, in detriment of pedagogical elements, or focus only on pedagogical elements, in detriment of game interface, hindering apply these methodologies in Educational Games developed based on the Games Virtualization. Beside recent studies proposed qualitative and quantitative approach to the interface and pedagogical evaluation in Educational Games, including Educational Games developed based on Game Virtualization, generally, these approaches do not presents concerns related with specifics points of Educational Virtualization Games, as the maintenance of Pedagogical and Psychological principles of traditional games.
Challenge I.II	In the last decades, with technology advent in several society contexts, a series of new technologies in the software development industry have daily emerged and a series of new programming languages, tools, engines and others general resources emerged too. In the Educational Games industry, this situation is highlighted because professionals need integration between technical and pedagogical contexts (Chaudy *et al*. 2014). On the other hand, few studies have been done to help professionals of educational game design.
Challenge II	Recently, a series of studies addressing Educational Games Virtualization have been done. However, the majority of studies have been carried in the Math domain. On the other hand, considering the concept of Game Virtualization, many others domains use/used traditional games in the classroom to increase students' learning in several activities, as well as to improve the involvement of the students, in domains for instance: Biology, Geography, Literature, and others.
Challenge III	Professional training has become a big challenge in the industry and education in the last years. In the past few years, various studies have been conducted to provide professional training resources in different domains, inclusive in the Educational Game industry. Starting with the updates before showed, as well as increasing specifics points, for instance: multidisciplinary team, different evaluation process, integration with educational context, and others. Educational Game industry suffered even more with this updates and was necessary to invest annual big amounts with the training of professionals.

Table 2: Challenges and Guidelines (synthesized of [13])

Challenges	Guidelines
Challenge I	(*i*) methodologies must be implemented with multidisciplinary team and collaboration of professionals of Game Design, Computer Science, Psychology, and Pedagogy, in order to aggregate different knowledge areas and implement a methodology with potential scientific and industrial; (*ii*) methodologies hereafter proposed must be evaluated by different professionals in different academicals and industrial scenarios to develop a methodology able to be used in both contexts; (*iii*) methodologies hereafter proposed should provide resources to virtualize Educational Games for different courses, not being addressed to specifically contexts.
Challenge I.I	(*i*) methodologies hereafter proposed should develop with professionals of different domains as: Pedagogy, Psychology and Computer Science (especially Software Engineering and HCI), in order to provide a methodology capable to evaluate games according to different criteria, from Pedagogy, Psychology and Computer Science (HCI); (*ii*) methodologies hereafter proposed should provide minimally the following resources: evaluate if the game keeps the Pedagogical and Psychological principles allied to contemporary game design elements, evaluate the game quantitatively and qualitatively in aspects of Computers Science (specially HCI) and Pedagogical aspects, as well as evaluate if the game contributes to students' learning.
Challenge I.II	(*i*) future studies that aim to identify programming languages, tools, engines and general resources should be developed with empirical metrics in order to provide resources to futures replications in different contexts; (*ii*) studies hereafter conducted to identify resources to development of Educational Games based on Virtualization Games should be developed with partnerships professionals of Science Computers and Education, in order to recommend resources capable to facilitate the process of development and maintenance of Educational Games (integration between technical and educational concepts).
Challenge II	(*i*) games hereafter virtualized should be developed and evaluated according to specifics methodologies of Educational Game Virtualization, in order to permit a robust evaluation in Computational and Pedagogical aspects, as well as permit future applications of works; (*ii*) game hereafter virtualized should be evaluated in different real contexts (with real classroom and real students).
Challenge III	(*i*) before the importance of professionals to development of educational resources, we consider necessary invest in the professional multidisciplinary capacitation and specialization, in order to form professionals capable of dealing with different situations (in the industry and academy), as well as they will be able to deal with the integration of technology (game design approach), and education; (*ii*) futures research groups, companies, and others professional groups interested in Educational Games Virtualization can invest in the integration academy-industry, in order to training professionals capable of dealing with these different scenarios.

In addition, to identifying these challenges, the studies before highlighted allowed to find others important challenges in this field. Actually, few works conduct empirical studies in order to evaluate Educational Game (virtualized) influences in students, for instance, evaluate if the game can be increase student's learning, student's motivation or if the students reach some good emotional experience, such as *gamefulness* Deterding *et al.* [6] or *flow state* Csikszentmihalyi [4].

Since that recent studies have highlighted the importance of to analyse these concepts in Computers and Education context (*i.e.*

[11]), as well the importance of evaluating if the educational game really provides positive consequences for students (*i.e*. [17]), others contemporary challenges are perceived in these studies, for instance: conduct empirical studies in order to the educational game regarding these concepts, as well as perhaps, compare the virtualized game with traditional game in different contexts. Figure 11 synthesize these challenges.

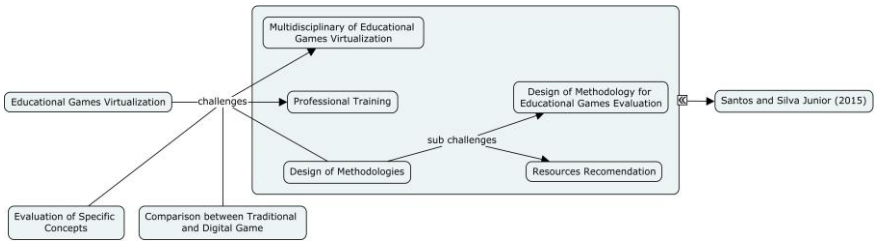

Figure 11: Conceptual map of Educational Games Virtualization Challenges.

5 Concluding Remarks

In the past few years, Educational Game Virtualization have been addressed as a promising topic of Educational Game, especially to provide to students, pedagogical and psychological aspects of traditional/physical games, allied to modern game design approaches (*e.g*. [15] and [10]). However, these studies recently conducted in Educational Virtualization Games, open a series of discussions regarding this field.

This paper presented an introduction to Educational Games Virtualization, showing an over view of this concept, recent efforts and challenges and opportunities in this field, as well as a practical approach in order to auxiliary students and professionals to start in the Educational Games Virtualization.

Finally, we highlight that this research domain, is a very young topic, with a series of challenges to the next few years, for instance: design of methodologies for educational games virtualization, design of methodologies for educational game evaluation, resources recommendation for Educational Games Virtualization, multidisciplinary of educational games virtualization, professional training to Educational Games Virtualization, and others. Future studies in this field could to considerate these challenges, as well identify and propose new challenges.

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