GAME DESIGN FOR EDUCATION-ORIENTED EXERGAMES

DISEÑO DE JUEGOS PARA EJERCICIOS EDUCATIVOS

DESIGN DE JOGOS PARA EXERGAMES ORIENTADOS PARA A EDUCAÇÃO

Jonas Godtsfriedt [1]

Abstract
Digital games cover a variety of forms and are designed for multiple platforms. This article aims to bring the knowledge of the industry and the academy closer to the development of educational digital games, through design proposals for the development of a model that will base the composition of an educational game design document (EGDD) involving exergames. This is an applied descriptive research. As for data analysis, it fits the qualitative type. Its methodological approach will be conducted through Design Science Research. The article is proposed with a study on the information of a Game design document, the essential elements of digital games, and the Cognitive Theory of Multimedia Learning will also be addressed.

Keywords: Games and Toys; Videogames; Motor Activity.

Resumen
Los juegos digitales cubren una variedad de formas y están diseñados para múltiples plataformas. Este artículo tiene como objetivo acercar el conocimiento de la industria y la academia al desarrollo de juegos digitales educativos, a través de propuestas de diseño para el desarrollo de un modelo que basará la composición de un documento de diseño de juegos educativos (EGDD) que involucra ejercicios. Esta es una investigación descriptiva aplicada. En cuanto al análisis de datos, se ajusta al tipo cualitativo. Su enfoque metodológico se llevará a cabo a través de Design Science Research. El artículo se propone con un estudio sobre la información de un documento de diseño del juego, los elementos esenciales de los juegos digitales y la teoría cognitiva del aprendizaje multimedia.

Palabras Clave: Juegos y juguetes; Videojuegos; Actividad del motor.

Resumo
Os jogos digitais abrangem uma pluralidade de formas e são projetados para várias plataformas. Este artigo tem como objetivo aproximar o conhecimento da indústria ao da academia quanto ao desenvolvimento de jogos digitais educacionais, por meio de proposições de design para o

[1] Doctoral student in Human Movement Sciences at the State University of Santa Catarina. Scholarship by the University Scholarship Program of Santa Catarina UNIEDU/Postgraduate. Master in Physical Education from the Federal University of Santa Catarina. University technician at the University of the State of Santa Catarina. Participating member of the Health, Education, Movement & Evolution Research Group.
ORCID: https://orcid.org/0000-0002-3349-8912
Contact: jog1000@hotmail.com

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desenvolvimento de um modelo que baseará a composição de um documento de design de jogos educacionais (EGDD) envolvendo exergames. Esta é uma pesquisa descritiva aplicada. Quanto à análise dos dados, ela se enquadra no tipo qualitativo. Sua abordagem metodológica será conduzida através da Design Science Research. O artigo é proposto com um estudo sobre as informações de um Game design document, os elementos essenciais dos jogos digitais, e também será abordada a Teoria Cognitiva da Aprendizagem Multimídia.

Palavras Chave: Jogos e brinquedos; Videogames; Atividade motora.

Introduction

Scientific advancements on game studies have opened up a world of possibilities, including the idea of "digital games". Digital games encompass a variety of forms and are designed for several platforms based on computational resources, consoles and other devices. Also, they can be played both individually and collectively (SALEN; ZIMMERMAN, 2012).

Digital games have become ubiquitous in today's society, with youths and adults using them as entertainment in the most diverse environments (VAGHETTI et al, 2013). To Quiroga et al. (2009), digital games are being created to educate or train human skills, including movement. In the Brazilian scientific production, there is no specific term to designate motion digital games; authors refer to these games using the names of consoles or accessories, or even names of specific pieces of software for motion digital games (DA SILVA, 2012).

Investigations on motion digital games have shown no concern about finding a specific nomenclature, except for one (VAGHETTI; BOTELHO, 2010), which suggests the term "exergames", due to its higher incidence in the American literature. Exergames are digital games that require greater physical effort and generate a higher energy expenditure to be played, compared to conventional ones (VAGHETTI et al, 2012).

Motion digital games, i.e., exergames, oriented to education have been, for some time now, used in learning based on digital games. However, this popularization does not ensure the quality of the artifacts offered to students because, for numerous reasons, many of them fall short of the quality of entertainment games (SENA, 2017). To

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Bahia (2016), this qualitative difference is due to a lack of dialogue and a distancing between the entertainment industry and the academia (universities).

The lack of experience of developers of motion digital games, educational exergames, in the academia, leads to the risk of emphasizing the pedagogical content to the detriment of the motivating characteristics that are typical of motion digital games. The industry, being unaware of pedagogical aspects, may also end up valuing gameplay over learning processes (SENA, 2017). A difficulty is established when developers of motion digital games, exergames, need to talk to educators, since both have different ways of reasoning (ALVES, 2008).

This distance between educational digital games and entertainment digital games leads to the production of low-quality educational digital games that only highlight pedagogical contents when it comes to game-design-specific aspects, such as interface, graphic quality, gameplay and interactivity (ALVES, 2008). Thus, in a project of educational digital games (educational game design document - EGDD), knowledge on game design and education must be in synergy in order to ensure the quality of the artifacts (BAHIA, 2016).

Game studies have gained greater expression in the academia and spans various fields of knowledge, including the science of human movement (through exergames). However, the predominance of these studies is a consequence, above all, of the impact that games have on human cognition and learning, with only few studies addressing the design of these artifacts. Considering that educational games are artifacts meant for disseminating knowledge on a number of skills and disciplines, there is a need for deeper studies covering the methodologies for their conception and development (SENA, 2017).

This article derives from the study by Sena (2017), which addresses the knowledge that permeates the conception of digital game projects, and whose author sought to answer the following question: How to develop a game design document (GDD) for educational games? Thus, we have here in this theoretical essay that brings a proposal of an educational game design document (EGDD) for exergames, which will

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suggest design categories to analyze the game design document (GDD), as well as to create a proposal on an educational game design document (EGDD) for exergames.

In this context, the present theoretical essay aims to bring the knowledge of the industry closer to that of the academia concerning the development of educational digital games, by means of design propositions for the development of educational digital games, based on a template meant for the creation of an educational game design document (EGDD) for motion digital games, i.e., exergames.

Method

This research, approved by the Ethics Committee of Santa Catarina State University, under legal opinion No CAAE 10430119.6.0000.0118, has as one of its secondary objectives to analyze, theoretically, the contributions of digital games and ludic games with human movement to school Physical Education.

According to its nature, it is typified as an applied research (GERHARDT; SILVEIRA, 2009), because its proposal is to seek solutions to concrete problems, contributing with practical alternatives. As for its theoretical and epistemological framework, this essay is founded on the Design Science, which is about adjusting a paradigm for the conduction of research addressing artifact production, projects study or investigations intended for problem solving (SIMON, 1996). With respect to its purpose, this article will characterize a descriptive study because it will describe a certain phenomenon and establish its possible variables (GIL, 2008).

As for the study phases, considering the creation and presentation of a methodological proposal for the composition of an EGDD, it will resort to bibliographic research through books and scientific articles covering this game design document (GDD) theme, and to document research (by analyzing different types of GDDs developed for digital games), seeking to survey good practices for implementing the creation of an educational game design document (EGDD), since sources that have not received prior analytical treatment were accessed as well (GIL, 2008).

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About data analysis, this research is qualitative, as it will employ several investigation strategies and methods for data collection, analysis and interpretation. (CRESWELL, 2010).

The methodological approach of this research relies on Design Science Research (DSR), for being a method that founds research conduction when the goal to be achieved is the proposal of an artifact or the prescription of a solution to a problem. This methodology seeks to comprehend the issue and to create artifacts in order to transform situations and propose solutions, shortening the distance between theory and practice (DRESCH; LACERDA; ANTUNES JÚNIOR, 2015).

To develop this article, two stages were adapted from the methodology proposed by Dresch, Lacerda & Antunes Júnior (2015) for DSR-based investigations:

- Present design categories to analyze the game design document (GDD) and to create a proposal on an educational game design document (EGDD), for exergames, as displayed in Figure 1.

- Study basic GDD information: game presentation, gameplay, genre, audience, platform, and GDD type.

- List the essential elements of digital games (aesthetic, mechanics, narrative, technology).

- List the components of digital games (world, character, interface).

- Study the Cognitive Theory of Multimedia Learning (this theory consists of seven principles for the creation of multimedia educational contents, namely: multimedia, contiguity, modality, redundancy, coherence, personalization, segmenting, and pre-training) and propose its application as a design category to game design document analysis for educational digital games – EGDD.

- Analyze different types of GDDs developed for digital games, seeking to survey good practices on EGDD implementation and creation.

- Develop design propositions for the EGDD.

- Present design propositions as a generalizable template for various profiles of educational digital game projects.

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To meet this study proposal, the present articles aims to prepare an EGDD and proposes a study on the basic information of a GDD, such as game presentation, gameplay, genre, audience, platform, and GDD type (SAUNDERS; NOVAK, 2012). The essential elements of digital games will be also listed, namely: aesthetic, mechanics, narrative and technology (SCHELL, 2015). The components of digital games will be considered as well, with them being: world, character and interface (SCHELL, 2015).

As a distinctive factor in the preparation of this EGDD, a study on the Cognitive Theory of Multimedia Learning, a theory proposed by Clark and Mayer (2016), will be executed. The objective of studying this theory will be to propose its application as a design category to the analysis of a game design document for educational digital games – EGDD (exergames).

As a means to organizing and exposing the results and discussions stemmed from this study, we will describe three different but converging moments. To start, we will circle back, sequentially, to some of the concepts and definitions of games, digital games and exergames. Then, in a second study moment, we move on to a discussion around the understanding of what digital-game design is; afterwards, we will cover the basic information of a GDD, then address the essential elements of digital games; at the end of this second moment, we will speak of the components of digital games. In a third moment, we will look into the cognitive theory of multimedia learning and, subsequently, as for its application, we will present the proposal of a template for creating an educational game design document (EGDD) for motion digital games, exergames.

Games, Digital Games and Exergames

- Games

Highlighting the importance of ontological matters, it is worth asking: What are games? What are their main characteristics? Which of them are fundamental and which are dispensable as to their specificity? In a search for answering these and other

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questions, some names and pieces of work have emerged and gained popularity, which currently can be considered "classic" among productions on the theme. One of the main representatives of this group is the Hungarian historian Johann Huizinga, whose grand piece of work is "Homo Ludens" (CRUZ JÚNIOR, 2016).

Games represent a cultural element that precedes culture itself, constituting an autonomous reality. Although they are influenced by webs of meanings that are specific to each historical space-time, their existence transcends the very idea of civilized life. Thus, we can understand that games are some sort of "inclination". It is interesting to note that games, in this case, are a rupture, or even better, a kind of "interval" that suspends the modes of acting and thinking that habitually govern one's daily life (HUIZINGA, 2008).

Roger Caillois (1990) takes on the task of continuing the intellectual legacy left by Huizinga in "Man, Play and Games", his most important book published on the theme and in which he systematizes the former's contributions. It is important to stress that, from Caillois's viewpoint (1990), the characteristics common to all existing games are:

- Unproductivity – They must be exempt from the responsibility of generating material goods and/or profit.
- Freedom – Their participants must be involved of their own free will, not under external pressure;
- Reversibility – For taking place in an imaginary space-time detached from everyday life, they must restore, as soon as they are finished, the "state of things" and the configurations suspended when they started;
- Unpredictability – Outcomes are decided on the basis of the player's actions.
- Rules – They have norms that regulate the participants' behaviors and are fundamental in creating challenges.

One of the main contributions of Caillois's book (1990) is the separation of games into different categories, which the author establishes from the mental and behavioral schemes that each one of them activates in the players. These categories are:

- Agon (competitive) – Performance measurement and comparison (e.g.: warm wrestling);

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- Alea (luck/bad luck) – Happenstance is elevated to the status of decisive element, overriding the participants' competence (e.g.: dice game);
- Mimicry (representation) – It consists of interpreting and playing characters and stories (e.g.: theater play);
- Ilinx (vertigo) – It is based on the temporary disorientation of the senses (e.g.: parachuting).

- Digital Games

In the realm of game studies, designation received by said field of knowledge, there is a series of different disciplines and approaches, among which, in terms of contributions to research on games, the following stand out: History, Anthropology, Psychology, Sociology, Education Sciences, Computer Sciences and, later, Literary and Artistic Studies. This fact can be easily symbolized by the creation of (electronic) magazines exclusively dedicated to the games theme, including the online journal Games Studies, one of the pioneers in this category. A reason for that is the belief in the existence of an unquestionable theoretical linearity between games and videogames. In other words, it is common to assume that digital games symbolize the direct result of some sort of natural development of traditional games (CRUZ JÚNIOR, 2016).

As for that, if we look at this matter from a historical point of view, we will be able to observe that the birth of digital games as a means for entertainment is an accidental event: "Tennis for Two", the first documented digital game, was invented by military engineer William Higginbotham, who, by changing the operating mode of an oscilloscope, subverted the logics of a device whose functions have nothing to do with any leisure activity. It is important to keep in mind that the purpose of this observation is not to establish a hierarchy between different theories applied to understanding of (digital) games. Facing a phenomenon that, though emerging in the academic circle, raises increasingly heterogeneous questions, one is not supposed to grant this or that discipline epistemological authority over the others. It is worth noting that this fragmentary tendency is usually more explicit in the efforts to define and conceptualize

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the notions of digital game, videogame, electronic game, computer game, etc. (CRUZ JÚNIOR, 2016).

Also interested in the symbiosis between games and technologies, Jesper Juul (2003; 2005) is one of the authors who proposes looking back at the main classic writings on the theme. One of his main concerns was to analyze how electronic and digital media interfere with the original constitution of games. To do so, he identified all specificities attributed to games by each one of the classic authors, comparing them and highlighting those that proved to be consensual in all or in most of them. Juul (2005) named the set of principles resulting from this effort "classic game model", a synthesis in which he presents the main consensual characteristics attributed to games in all analyzed pieces of work. They are:

- Rules: Games are rule-based systems;
- Variable and quantifiable outcomes;
- Outcome valuation: Different potential outcomes are assigned different values, some positive, some negative;
- Player effort:
- Player attached to outcome: The player is emotionally attached to the outcomes of the game, in the sense that they can be both a "happy" winner in case of a positive outcome, and a "sad" loser in case of a negative one;
- Negotiable consequences: the same game (set of rules) can be played with or without real-life consequences.

First, Juul (2003; 2005) identifies the existence of some compatibility between the classic model and computer games. In this sense, it is worth pointing out that games are transmedia manifestations, an attribute that allows them to move through different types of resources, instruments and materials.

When it comes to digital games, the computer is their physical medium, which represents their materials, just as other types of games use other materials to be produced. Confronted with the computer, a game designer needs to understand how to use this resource for creating a ludic and meaningful interaction (SALEN; ZIMMERMAN, 2012).

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Salen and Zimmerman (2012) refer to four exclusive characteristics of digital media that a designer can resort to when creating digital games:

- The first one is immediate, but restricted, interactivity, which refers to the immediate and interactive feedback that technology provides to digital games. Thus, technology allows gameplay to happen in real time and to react dynamically to the player's actions.

- The second characteristic is information manipulation, which deems digital media a machine with great encyclopedic capacity (Murray, 2003), capable of storing a large amount of data.

- The third characteristic pointed out by authors Salen and Zimmerman (2012) is called complex and automated systems, which enables procedures that facilitate disputes and progression in games without the player's direct interference with their components, something that would not be possible in analogic contexts.

- The last characteristic listed by the scholars is communication network, which refers to the easy communication that digital games promotes between players, which is mediated digitally.

- Exergames

According to Silva (2012), motion digital games, before being "motion", are digital, and digital games, before being "digital", are games. Thus, da Silva (2012) argues that games, as a playful activity, are similar to and oftentimes mistaken for play and toys, being understood, in the current and sometimes academic use, as synonyms. Some authors have sought to demarcate the distinction between these notions, without, however, consolidating them.

Exergames combine digital games and physical exercise, allowing the ludic side and the fascination of digital games to be experienced during physical activities (LAM; SIT; MCMANUS, 2011; LANNINGHAM-FOSTER et al., 2009). They are active videogames that need body motion to be executed, with options that simulate sports gestures,

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increasing physical and cognitive demands. Exergames are digital games that mix videogames with physical activity, enabling body interaction, be it individually or with other players (GRAVES et al., 2010).

In this type of digital motion game, exergames, the outcome is determined by the body movements of the player, who uses their body (or some of their body segments) to control games that simulate physical activities and/or sports (O'LOUGHLIN et al., 2012). This way, exergames make players more active because of the game situation and can be a fun alternative to fight a sedentary lifestyle as well as its consequences (GRAF et al., 2009; GRAVES et al., 2010; RIBEIRO, 2013).

As for the sedentary behavior, the main argument is that players stay seated during the execution of games (SMALLWOOD et al., 2012). Intending to raise physical activity levels among fans of traditional videogames, experts in the field have launched active videogames, later known as exergames (RIBEIRO, 2013).

Technological advancements in recent decades have sparked the interest of researchers in investigating motion digital games, exergames, as an alternative to raise physical activity levels in people of different ages (LIEBERMAN et al., 2011; LARSEN et al., 2013). About exergames, it is known that they are active digital games that require the player to move so that their goals are achieved. Movements are captured by motion detectors, such as boards, joysticks and cameras (LIEBERMAN et al., 2011).

Exergames can be played in many places, especially at home, giving players autonomy to choose the day and time to experience them. Players can also choose to play individually or in groups. Exergames are usually fun and pleasant, motivating people and stimulating them to perform several body movements (WOLLERSHEIM et al., 2010; LIEBERMAN et al., 2011; MAILLOT et al., 2012; YUEN et al., 2013).

Interventions that use digital games, that involve this mix of physical activity and digital play, are known as exergames; they have been discussed, and their potential effect on the health of players has been observed (MOLINA et al., 2014; PRIMACK et al., 2010; BARANOWSKI et al., 2008). These motion digital games encourage players to interact with the digital environment by means of body movements, so those who engage in it become an interactive part of the digital game itself (SKIBA, 2008).

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Exergames have been showing positive responses, from higher energy expenditure to better physical and cognitive capacity, and greater quality of life for individuals (PADALA et al, 2012; MAILLOT et al., 2012; WITTELSBERGER et al., 2013), besides being a ludic and fun way to exercise.

What is Digital-Game Design? Basic GDD Information, Essential Elements of Digital Games, and Components of Digital Games

- What is Digital-Game Design?

The simplest answer to the question "What is digital-game design?" is: digital-game design is the ground plant of a digital game. A designer is the person designated to create the ground plant; from it, with the adequate combination of talent and effort, a digital game will arise (SCHUYTEMA, 2008).

What is a digital game exactly? There is a simple definition for what a digital game can be: a series of processes that leads the player to an outcome. Analyzing the classic digital game "Pacman" for a moment, when you think about playing it without the ghosts that wander around the maze, you see that he is free to roam and eat the pills until beating this level of the game. About this situation, exemplified with "Pacman", would it be a digital game? When we recall, for a moment, all digital games each one of us has played, we can think about the context of the digital game and the skills required by it; it is known that all these aspects of the experience with digital games are vital and that all contribute to what we consider a "digital game" (SCHUYTEMA, 2008).

A little more robust definition of interactive digital game, according to Schuytema (2008), would be: a game is a ludic activity composed of a series of actions and decisions, limited by rules and by the universe of the digital game, which result in a final condition.

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From the perspective of philosophical superiority, there are four components in a playful experience with digital games: receptiveness, expectations, subjective tastes, and the "X ingredient" (SCHUYTEMA, 2008). Below is a description of each playfulness component in digital games:

- Receptiveness: First, before having a truly fun ludic experience, you need to be prepared to receive it, to be receptive to having fun and enjoying the experience.

- Expectation: When you are ready to have a ludic experience, your interpretation of said experience will be ruled by your expectations. For an experience to be satisfactory, it needs to meet or exceed your habitual expectations.

- Subjective tastes: The third component deals with subjective habits; take it as an enhancement of cultural expectations.

- "X" ingredient: The main point, the "X" ingredient", is that "something else" that turns an experience from interesting to fun and joyful; but, first, we have to fulfill all previous requirements of fun in digital games, and only after that we will be ready to receive the "X" ingredient, the ingredient that meets or exceeds our expectations, that touches the deepest of our subjective tastes and positive experiences, and so on. What is the "X" ingredient, after all? It is a combination of factors: surprise, coincidence, geniality insights, extreme emotion, and transience. The "X" ingredient is the moment when your expectations are not only exceeded, but shaken in new and unexpected ways.

As a blockbuster movie, digital games require a great team of specialists, from artificial intelligence programmers to developers of tools, effects, particles, or even texture compression. The digital games of the modern age rely on the "ground plants" of digital-game design (known as design documents), usually created by teams of designers that guide the development of a digital game from start to end, providing a model to professionals (SCHUYTEMA, 2008).

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Each digital game goes through several steps, and, in general, there are three major periods in each development cycle: pre-production, production and post-production. At each step, the role of a designer is fundamental to have the digital game ready on time. At pre-production, the whole development team creates a concept for a digital game, and the actual creation of items has not begun yet. Designers also spend time, during pre-production, working with programmers on script tools; some of these documents are drafts that illustrate the concepts in general terms, while others are long and technical and serve as ground plants for other members of the development team. At production, the digital game is built. Artists create models for characters and levels, programmers write and revise the source code, the marketing staff develops an advertisement strategy, the tests department starts evaluating the digital game, and designers compose the gameplay script. The post-production cycle that starts as soon as the digital game is launched may include downloadable content (DLC) and patches (expansion packs) (SCHUYTEMA, 2008).

A digital-game design is not an end in itself, but a tool that allows a team of skilled individuals to create a digital game; a digital-game designer must be capable of creating this model in their mind and on paper. And this is a serious and ingenious craft; digital-game design is the ground plant of a digital game, and a real ground plant is made up of a series of big pieces of paper with architectural drawings. The same happens to a game design document (GDD). The audience can be an editor interested in funding a digital game, or a voiceover actor who wants to understand the context of the character they will play. However, the main audience of a game design document is the team that develops digital games: programmers, artists and level designers, who will create the digital game from concept (the document) to reality (the CD-ROM you buy at a store, or the digital game you download on the internet) (SCHUYTEMA, 2008).

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- Basic GDD Information

The basic information relating to a GDD, according to Saunders and Novak (2012), are: game presentation, gameplay, genre, audience, platform, and GDD type. For better understanding, below is a description of each one of these basic GDD pieces of information:

- Game presentation: It is popularly known as high concept; it is the primary idea of a game and consists of a short text containing a maximum of two sentences that describe the distinctive features of the product.
- Gameplay: It is the way that the player experiences the game. This section must list 10 to 20 gameplay items that characterize the product.
- Genre: This section of the document must be clear about the genre of the game to be developed, based on its gameplay. It is advisable to add a brief description of the genre chosen, or an explanation, if the genre is a combination of genres, or even a proposal of a new genre, because the last two aspects can be considered risk factors for the project.
- Audience: This section states at which audience the game will be targeted. Knowledge on the demographic data about the audience for which the game is meant must be applied to said section, because a specific age group must be focused. The target audience description must also include the gender for which the game is intended to be developed.
- Platform: In digital games, the software depends on the type of hardware for which the game is being developed. In the case of personal computers, there is no concern about the hardware manufacturer, but, when developing games for mobile devices or consoles, one must mind the requirements of system owners. The platform to be chosen is directly linked to the target audience chosen. It is necessary to make sure that the project is clear about the minimum technical requirements for the selected platform.

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- GDD type: There is no consensus in the literature about the format of the document or how its items should be organized. The most commonly used format for preparing a GDD is text, along which all items are described sequentially and organized through titles and subtitles.

- Essential Elements of Digital Games

The essential elements of digital games are: aesthetic, mechanics, narrative and technology (SCHELL, 2015). For a better explanation of these elements, they will be described below:

- Aesthetic: In digital-game development, the term look & feel is frequently used for referring to the aesthetic qualities of a digital game, covering everything from audiovisual aspects to the sensations and emotions they evoke. The aesthetic is experienced by the user, especially through the art, sounds and sensations proposed by gameplay, and has the role of attracting the player to a digital game in which they would have no interest at first, making the world of digital games look solid, real and magnifique, raising its value and causing the player to take the digital game more seriously (SCHELL, 2015).

- Mechanics: Mechanics is a determinant element for a piece of media to be considered a digital game, with its characteristic being exclusive. According to Schell (2015), there is no standardized taxonomy to describe the components of mechanics, because it represents a complex element, even when it comes to simple and casual digital games.

- Narrative: It is a sequence of events that the player completes to achieve their goals. It is an element that digital games share with other areas of entertainment, such as cinema and literature. However, in digital games, the narrative is always connected to gameplay, which gives it context and meaning, even in the simplest casual digital games. Together, narrative and gameplay work as a machine for creating experiences (SCHELL, 2015).

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- Technology: Technology is the most dynamic, volatile and unpredictable element in the elemental tetrad, because it advances so fast that it is hard to predict what could be produced in the future (SCHELL, 2015). Technology can be defined as the means by which the digital game will work, the physical object that renders gameplay possible.

- Components of Digital Games

The components of digital games, according to Schell (2015), are: world, character and interface. Below is a description of each one of them:

- Characters: Characters are important elements in the construction of the narrative experience of digital games, since, unlike in other types of media, the "hero" of the narrative of digital games is the players themselves (ROGERS, 2014).

- World: It is an artificial and imaginary universe where the events of a game unfold (ADAMS, 2014). The world of a digital game is a location distinguishable by its visual design and by its theme, being usually composed of many smaller locations. These smaller locations are known as levels and correspond to the scenarios where gameplay happens (ROGERS, 2014). Digital games usually have complex worlds made up through a detailed aesthetic work that creates a unique atmosphere composed of scenarios, objects, characters, animations, music and sound effects. However, aesthetic is not enough to define the world of a digital game, because gameplay and mechanics are also factors that determine its design (ADAMS, 2014).

- Interface: It is the resource that connects the player with the world of the digital game. Its main objective is to make players feel in control of the experience, providing essential information on their status and on what to do in the game. It is also classified as physical interface and virtual interface (SCHELL, 2015).

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Cognitive Theory of Multimedia Learning and the Preparation of an EGDD for Exergames

- Cognitive Theory of Multimedia Learning

The Cognitive Theory of Multimedia Learning is composed of seven principles for the creation of multimedia educational contents, namely: multimedia, contiguity, modality, redundancy, coherence, personalization, segmenting and pre-training (CLARK; MAYER, 2016). This article will propose the application of said theory as a design category to analyze the game design document (GDD) for educational digital games, EGDD (exergames). The principles of this theory are described below with their conceptual information:

- Multimedia: It is the first principle and refers to the right combination of words and graphic images. People learn better through a combination of words and images, rather than through words alone (CLARK; MAYER, 2016). Words, in this context, can be presented in the form of written or narrated text, whereas images can be static illustrations, animations or videos. When presented simultaneously, words and images create meaning for users. Nonetheless, not every type of image enrichens learning.

- Contiguity: It is the second principle and refers to the proximity between words and images. When images and their corresponding texts appear separated physically, as when using scroll bars, external links and new windows opening, there is, according to Clark & Mayer (2016), a time separation between the words and their corresponding images, increasing the cognitive load due to the external process that the user undertakes to put the pieces together and give the message a meaning. When words and images are presented in an integrated manner, the user needs less cognitive processing and create immediate meaningful relations between said words and images. This principle assumes that words, in both written and narrated forms, and

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their corresponding images must be seen all together by the user, so that the latter's cognitive processing is not wasted.

- Modality: It is the third principle and refers to a greater learning effectiveness when audio is used instead of words in the written form. This is because the processing of the written word happens in the same cognitive channel that processes images, the visual channel, whereas sounds are processed through a separate cognitive channel, the auditory channel. Thus, when words are presented in the written form and processed through the visual channel at the same time as images are, there is a cognitive overload for the message to be processed, which renders learning less effective. In this sense, this principle suggests that audio resources must be prioritized whenever images – be they illustrations, animations or videos – are the focus of the instructional material, and that both must be presented simultaneously to the user (CLARK; MAYER, 2016).

- Redundancy: It is the fourth principle and assumes that, when words are presented in the written form and, simultaneously, audio narrated, they impair learning, because users tend to pay more attention to the written word than to the image and try to reconcile what is written with what they are hearing, which thus generates a cognitive overload. Nevertheless, Clark & Mayer (2016) point out four situations in which using audio and written text simultaneously are advantageous: (1) when there is no image; (2) when the presentation of the material is slow and its pace is dictated by the user; (3) when the narration includes technical words with which users are not familiar; (4) when the text is shorter than the narration.

- Coherence: It is the fifth principle and recommends that the instructional material must only contain information that is essential to learning, without using extra material. That is, adding complementary resources, even if they are interesting and coherent with the approached content, such as images, background sounds, dramatic plots, and external links, can impar learning, as they require a greater effort from the cognitive capacity in order to be

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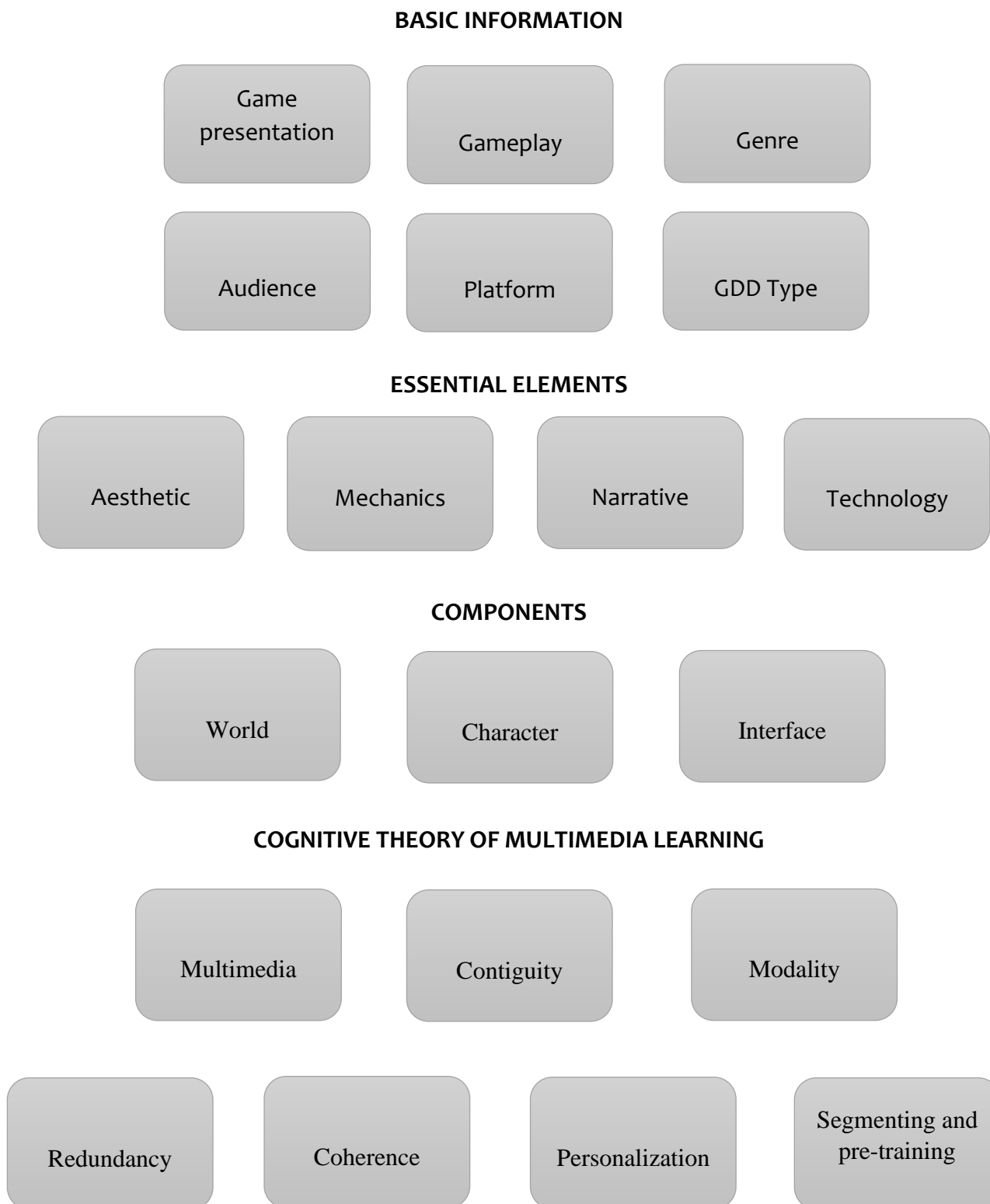
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assimilated, leaving less capacity available for processing what is essential (CLARK; MAYER, 2016). Based on said principle, the authors suggest using short narrations, with concise content descriptions.

- Personalization: It is the sixth principle. It assumes that users learn better when texts, whether written or narrated, are presented as a conversation, that is, in a more familiar and less formal language, in the first or second person, using polite words for feedbacks and a friendly human voice. This principle is efficient because it is closer to human interaction. According to the authors, people apply themselves more to understanding contents when they feel they are talking to a partner than when they receive information in a formal way. Thus, creating instructional materials with a more personal tone promotes a greater psychological engagement (CLARK; MAYER, 2016).

- Segmenting and pre-training: It is the last principle. It defends that the material to be learned must be split into parts, depending on its complexity, especially for contents with which the learner is not familiar. This principle aims to make the individual learn the essential, without being overloaded with the complexity of the content. For this segmenting, the material must be separated by the number of elements, concepts and interactions between them. This way, the user will receive this material in parts, thus being spared a cognitive overload.

- Preparing an EGDD for Exergames

We have shown the proposal of a template for the creation of an educational game design document (EGDD) for motion digital games, exergames. Figure 1 displays design categories for the analysis of the game design document (GDD) and the creation of a proposal for an educational game design document (EGDD): 1):

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Figure 1 – Design categories for GDD analysis and EGDD preparation for exergames

BASIC INFORMATION

| Game presentation | Gameplay | Genre |
| Audience | Platform | GDD Type |

ESSENTIAL ELEMENTS

| Aesthetic | Mechanics | Narrative | Technology |

COMPONENTS

| World | Character | Interface |

COGNITIVE THEORY OF MULTIMEDIA LEARNING

| Multimedia | Contiguity | Modality |
| Redundancy | Coherence | Personalization | Segmenting and pre-training |

Source: Model adapted from Sena's EGDD proposal (2017).

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Further Considerations

Game design ceased to be an activity exclusive to the entertainment industry because, with the expansion of research on motion digital games (exergames) for education, universities have been playing an important role in developing these artifacts, supported by funding agencies and research notices. In this context, the distancing between two worlds is detrimental to the industry, since, when they need to develop something for education, they have difficulty communicating with the pedagogical field; on the other hand, in the academia (university), there is a lack of access to the development expertise consolidated through years of experience accumulated by the entertainment industry.

In this sense, an alternative practice could be design documentation, which, in the industry context, is an indispensable activity. Despite being basic for companies, it is most of the times an informal activity, without standards or consistent bibliographic sources. On the other hand, the academic practice can contribute to the industry, because it is where knowledge is systematized and methodologies are proposed (SENA, 2017).

Regardless of the contributions of the present article to broadening knowledge on educational game design documentation, by means of this EGDD proposal for exergames presented in this theoretical essay, future investigations in this field are necessary so that they can analyze the impact of this proposal and of other EGDD proposals on exergames for education.

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