GAMES WITH PURPOSE DEVELOPMENT METHODOLOGY BY A LUDOLOGY LABORATORY

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ABSTRACT

This article presents the formalization of the methodology used by members of a Ludology Laboratory to develop games with purpose. The methodology consists of a five-step process: Conception, Project, Development, Evaluation, and Packaging, and also by the tools and practices used during the execution of its tasks. It was defined by considering experiences of lab members while creating ludic artifacts, other works that also propose processes for this very same end, the study of documentation created during game development within the laboratory, and the logs of these processes. Three examples of the usage of this methodology are shown. This work hopes to contribute to developing new methodologies for designing serious games, which have greater dynamism and collaboration between those involved, whether they are researchers, programmers, artists, or game designers.

INTRODUCTION

This work presents the formalization of the games with purpose development methodology used by LUDES – Ludology, Engineering, and Simulation Lab. Thus, it describes a development process model and a set of practices and tools used for this

purpose. The construction of this methodology intended to make explicit the knowledge that emerged from the experience of members of LUDES, our guests, and collaborators during the development activities of academic and commercial projects.

Most LUDES' members have engineering or computer science backgrounds, although the Lab has members and collaborators from many other fields of study. This fact influences the practices of analysis, building, and development of ludic artifacts done by the Lab, which are heavily influenced by those used by Information Systems (Xexéo et al., 2021). Using iterative cycles, conception steps, designing, production, evaluation, and process packaging denotes this influence and clarifies some aspects of the LUDES' vision of games as systems. However, it is essential to point out that the methodology shown in this paper and the work done by LUDES are not restricted to digital games. It embraces board games and card games as well.

One of LUDES' goals is to build tools that support and facilitate game development. The laboratory presents proposals or collaborates with works that propose methods for developing games with many characteristics, such as sole developers (Confessor, 2019), games that communicate processes (De Classe et al., 2019), and educational games (Noël et al., 2021).

It is vital to establish a solid proposal and a precise method to be followed by everyone involved in serious games development to ensure the idea's success (Credidio, 2007). Therefore, this work presents a methodology modeled from production records, logs, and documentation from the development of many games. Also, the authors used reports of senior members of LUDES about practices and tools used in these development processes.

This work is organized as follows: Section Fundamental Concepts shows the concepts of game design, business process identification, discovery, and modeling, as well as the *Ba*, a space-time vortex at which knowledge is created and shared. Section Related Works presents other works about serious games design. Section LUDES-GD presents the LUDES' serious games development methodology. Section Demonstrating LUDES-GD shows examples of the methodology application. Finally, in Section Conclusion, a brief conclusion about the work is presented.

FUNDAMENTAL CONCEPTS

The theory behind this work has four fundamental concepts: the idea of employing explicit methodologies to guide game creation, the use of Business Process Model and Notation (BPMN) (Business Process Model and Notation, 2011) to visually represent processes, the idea of Ba (Nonaka, & Konno, 1998) as a way to define the notions of tacit and explicit knowledge and to conceptualize it in a space-time vortex at which knowledge is created, and game-based learning. These concepts are essential to fully understand the relevance of this work and the methods employed to reach the presented model.

Game Design

Defining game creation processes is not a recent challenge and is usually ignored partially or entirely by game companies and game initiatives (Credidio, 2007). Classic authors like Crawford (1984), Salen and Zimmerman (2004), Irish (2005), Adams and Rollings (2006), Fullerton (2008), and others wrote about their particular experiences and methods of game design.

According to Zagalo (2012), there are many ways and models of game creation. For instance, Schell's Tetrad (Schell, 2008) is a game design method well accepted by the industry (Zagalo, 2012). This model categorizes game elements into Mechanics, Narrative, Aesthetic, and Technology. Another well-accepted method for game development is the MDA framework, by Hunicke, LeBlanc, and Zubek (2004), which divides games into three distinct components: mechanics, dynamics, and aesthetics. The mechanics are the rules by which the game operates. At the same time, dynamics are the way the rules behave during gameplay, and aesthetic is the player's emotional response while dealing with dynamics.

Using these game design reports as a base, Table 1 compares these steps used by authors who are game designers. Mastrocola (2012) uses a similar analysis, proposing that the general steps used by most of the game design processes are: conception (idealization), Pre-Production (or project), Production (or development), and Evaluation (tests).

As for the game design of entertainment-centric videogames, there are endless proposals for the design of games with purpose. Thanks to the variety of skills and competencies that they may transmit, each game designer uses different ways to project those games. These methods are presented theoretically, lacking projects that show them in practice (Kelly et al., 2007; Siriaraya et al., 2018). By projecting an educational game with purpose, it is necessary to ponder which educational goals are to be transmitted, so the player can learn about what has been played at the end of a match (Kelly et al., 2007).

This work uses as cornerstones these game design proposals. Thus, it presents and details the game design steps of games with purpose used in previous projects by LUDES, considering that the development of games with purpose demands knowledge of the contexts, the learning objects, the target competencies, and so.

Table 1

Crawford (1984)	Salen and Zimmerman (2004)	Irish (2005)	Adams and Rollings (2006)	Fullerton (2008)	Schell (2008)	LUDES-GD
Theme Choice	Conception	Game Concept	Conceptualization	Brainstorm	Idea Formalization	Conceptualization
					Set Goals and Restrictions	
					Explicit Problem	
					Brainstorm	
					Determine Risks	
Design	Documentation		Elaboration	Physical Prototyping	-	Project
				Storyboard		
				Documentation		
	Production	Game Prototyping	Prototyping	Digital Prototyping	Prototype	Development
		Prototype Test	Tests	-	Tests	
Programming	Implementation	Prototype Redefinition	Refinement	Production	Implementation	
Tests	Tests	Evaluate	Finishing	Tests	Tests	Evaluation
Final Product	Final Product	Final Product	Final Product	Final Product	Final Product	Packing

Business Process Identification, Discovery, and Modelling

Business process management (BPM) is the study field and practice of analyzing how a task is done by an organization, striving to understand and improve it, reducing efforts, costs, and magnifying productivity. A characteristic of BPM is its phases: identification, **process discovery** mixed with **process modeling**, and initial phases with the utmost importance. Process identification happens at the moment processes are identified and delimited. At process discovery, they are raised, analyzed, and modeled, achieving as a goal a process model *AS-IS*, that is, how it is executed at the moment of elicitation (Dumas et al., 2013; Ter Hofstede & Weske, 2003).

Usually, this model *AS-IS* is shown in the form of a business process model. The formalization of a model characterizes the modeling of processes, being a simplified representation to show understanding related to the sequential execution of activities that compose the process flux (Sobreira Neto, 2009; Dumas et al., 2013). Experts recur to these models to comprehend how the process works, how its components are related, and its goals and decisions so the described processes can be executed in the most efficient way possible (Aguilar-Saven, 2004).

There are many ways and languages to model business processes like EPC, UML, I*, natural language, and narration, for instance (Fahland et al., 2009). BPMN is one of these languages, being one of the most used by companies to model their business processes. It consists of a notation that uses practices and elements common to many others already consolidated to facilitate its use by professionals of diverse knowledge backgrounds (Business Process Model and Notation, 2011).

In this work, BPMN is the chosen notation to model the designing of serious games in LUDES.

Ba, Tacit and Explicit Knowledge

Ba is a concept initially proposed by the philosopher Nishida (1992) as a shared ambient by individuals to create relationships. This concept, however, was rethought in 1998 when Nonaka and Konno proposed the usage of this concept as ambient to create knowledge, differentiating itself from other interpersonal relations once Ba has the specific goal of knowledge advancement, be it of the individual or the group (Nonaka & Konno, 1998).

In this context, we identified two distinct kinds of knowledge: the tacit and the explicit. Tacit knowledge is organic

knowledge, unique to each person. Because of that, it is tough to share with other people once this kind of knowledge is deeply intertwined with personal actions and ways of thinking. On the other hand, explicit knowledge is easily communicated as theorems, formulae, models, or manuals (Nonaka & Konno, 1998).

There are four great forms of *Ba*: socialization, externalization, combination, and internalization. The idea behind these forms is that they produce a cycle by which tacit knowledge can be shared between individuals from different groups inside an organization.
Individuals share knowledge without a formal representation through socialization and familiarity. This tacit knowledge can be made explicit through formulas or specifications and combined with other explicit knowledge. This newly acquired explicit knowledge can be internalized by individuals (Nonaka & Konno, 1998).

This paper describes the transformation of tacit knowledge into explicit knowledge. We make explicit the processes taken by developers and game designers combining informal reports from individuals about their personal experiences with development records and documentation.

Learning Process

The most important mental function for humans and animals is learning. Far beyond competencies, behaviors, and abilities, this function encompasses values and experiences that we acquire during life and through cultural, psychosocial, organic, cognitive, and emotional factors. As it can be analyzed from different perspectives, there are different theories of learning (Lefrancois, 2019; Huell, 2021; Zaric et al., 2021). Nevertheless, on careful observation, we will note that the basis of the vast majority of learning process models is made of three main domains: psychomotor, cognitive, and emotional. In pedagogy, we find other types of learning processes, to name a few: receptive learning, discovery learning, repetitive learning, and meaningful learning. All these models present the different ways of learning and at the same time demonstrate that each individual can benefit from different models. That is, learning is different for each one.

The idea that games are important tools available to the educator (Fishman et al., 2014) is not new. Prensky (2003) boldly argues that electronic games would be the engine of a revolution in education. Moreover, he also argues that learners born under the ubiquity of technology, the so-called digital natives, would require a revolution in the learning tools and processes and the effective use of games as a pedagogical resource (Prensky, 2003). Becker (2007) advocates that long-term immersion in a subject, which translates as engagement and depends on intrinsic motivation, characterizes the deep learning process. These characteristics are present in games. Van Eck (2006) states that the effectiveness of the learning process based on electronic games, Digital Based-Game Learning – DGBL, can be used to learn different topics. In A Theory of Fun, Koster (2013) argues that games, even for entertainment, "serve as a fundamental and powerful learning tool". In this way, electronic games would be the ideal media to promote the engagement of digital native students and meet their desire to play a leading role in the learning process. However, the challenges of repeatedly and successfully developing them are still unresolved.

Games provide a safe environment for learning, where students can "learn by doing" and be protagonists in the learning process (Beard, C., 2010; Xexéo et al., 2021). The engagement encourages interdisciplinary learning, cultural awareness, and many other skills. We dare to say that the game is a form of experiential learning based on constant reflection on "what is done" and that it brings two learning modalities, explanation and implicit (Xexéo et al., 2017; Palia, 2020). As explicit learning, the game can have a facilitator guiding the student in the actions, something that the game itself can also perform in the so-called tutorials. On the other hand, implicit learning occurs in playing, where students learn by interacting with the game's rules and exploring what can or cannot be done. We emphasize that explicit and implicit learning can be within the same game, offering greater opportunities to the student. On the other hand, these learning issues must be considered at design time.

RELATED WORKS

In the literature, several studies have been carried out to analyze how the process mapping is carried out by other people involved in the development of games with purpose. For example, the *Design, Play, and Experience* (DPE) framework aims to address the specific needs of serious games. The DPE focuses on the designer's relationship with the player, which conveys specific goals and sensations. This way, the designer controls the player's experience when playing the game (Winn, 2008).

Another contemplated study conceptualizes a model for the design of educational games, supporting the creation of documents such as the *Game Design Document* (GDD) (Roungas, 2016). In addition, there is also the *Persuasive Game Design* (PGD) (Siriaraya et al., 2018) model, which proposes the design of serious games from a set of components and methods such as effect definition, tools, design elements, among others, for building serious games.

Freitas *et al.* (2017) present a process whose focus is to reconcile the work method of electronic game developers responsible for programming with the work developed by artists, more divorced from engineering technologies software. This work recognizes the distinctions in approaches from different areas of knowledge and proposes a model that facilitates communication between professionals. The proposal is suitable for small groups such as those with the *indie* profile at which not everyone involved has an exclusive dedication to the project.

Albarrassim *et al.* (2020), in turn, describe the use of an already established method for the development of educational

resources in the creation of a game with a specific purpose. The work presents the application of a method established in previous works and reports the successful use of this process in a prototype validated by experts for "contingency training in an emergency communication repetition site" (Albarrassim et al. 2020).

Carreta (2018) proposes the Quest 3x4 method, based on quests for creating educational board games with four stages. In addition to a walkthrough for game creation, the method provides guidelines for game creation by using four aspects: space, items, actors, and challenges, where each aspect has three tricks possible. Thus, he intends to provide the teacher with a simple tool to prepare his game, enabling 81 possible types of games (Carreta, 2018).

Costa (2010), in a text with considerable repercussion in Brazil, describes a method based on seven principles that try to make educational games also have the power to entertain their players. His text, however, does not formally register the method, as we do here, and may lead to different achievements (Costa & Xexéo, 2020).

Karl (2016) presents myPMgame Canvas as suitable for implementing project management simulations. The 12 stages development framework could be used to "straightforward conceptualization and modular refinement of educational simulations with a special orientation towards the project-oriented industries" (Karl, 2016).

LUDES-GD - LUDES' SERIOUS GAMES DEVELOPMENT METHODOLOGY

Identification of the LUDES' Game Development Process

The game creation process can be considered a business process that encompasses a value chain (Dumas et al., 2013). In other words, it has a series of stages with the ultimate goal of producing and delivering a quality game to players and other stakeholders. When it comes to games with purpose, this "added value" involves, in addition to the entertainment provided by the act of playing, some real gain, by transmitting some message, teaching, training, or educational objective (Flanagan, & Nissenbaum, 2014; Michael & Chen, 2005).

Before graphically modeling a business process, performing a "process identification" or "framing process" step is common. This step delimits the scope of the process that one wants to describe (Dumas et al., 2013). One could achieve this by answering the "5W2H" (Where, Who, What, Why, When, How, How Much) action plan (Caetano et al., 2012).

LUDES, over the years, has been building serious games. However, the knowledge about the steps involved in this process was not formally specified. Despite presenting consistent and uniform practices, which evolved, the more experienced members of LUDES were responsible for guiding the development process, acting in the role of mentors or advisors, and being responsible for maintaining, propagating, and contributing to the evolution of this knowledge tacit. Thus, based on interviews, and the analysis of their game development records (log), it was possible to identify, discover and model the stages of this process. Taking "5W2H" as a starting point, the LUDES game development process is identified as:

- **Where**: LUDES.
- **Who**: Collaborators (professors, researchers, laboratory students), academic and commercial partners.
- **What**: Games.
- **Why**: Investigate game development methodologies and how to apply games to help society, educational goals, training, scientific dissemination, among others.
- **When**: Start of a game project (or idea).
- **How**: Using the LUDES-GD game design process, tools developed internally and others available in the literature on games, always considering the scientific progress and technological advances that can enrich the process currently used.
- **How Much**: The deadline, the number of human resources needed, and the financial costs related to the production of artifacts compound the forecast budget.

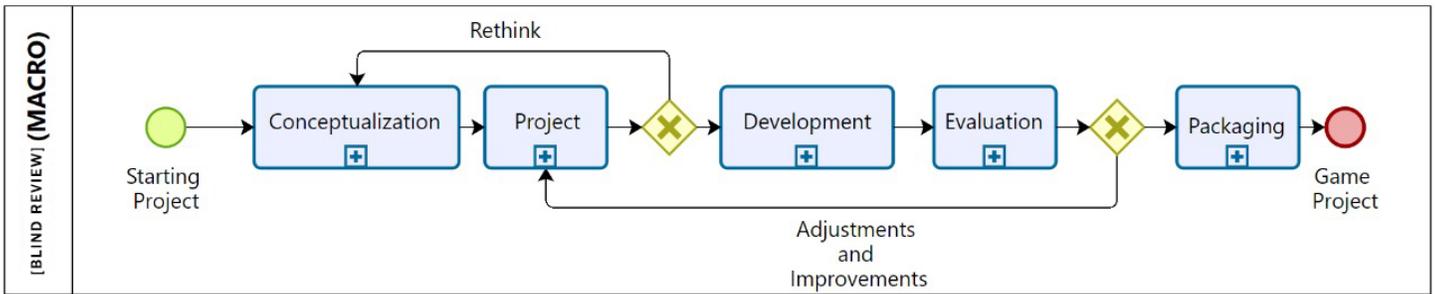### Discovery and Modeling of LUDES' Game Development Process

Observations of three serious game projects made in LUDES: **Léo & Maya**, **Mapa do Tesouro** and **Xô Corona**, were the basis for modeling the LUDES-GD process.

Like Mastrocola (2012) described, we identified five macro steps, which could be explained in different atomic steps. With diagrams, we described the sequence by which the macro steps advance, so the micro-steps which compose the macro steps, from the game conception until the publication of the final product.

In a macro view (Image 1), the process has five main steps: Conception, Design, Production, Evaluation, and Packaging. The flow between them is sequential and iterative so that the same step can be performed at various times in the process when there is a need to rethink decisions.

In the first stage, the creators must build a specific conception of the project, making decisions related to the topics covered,
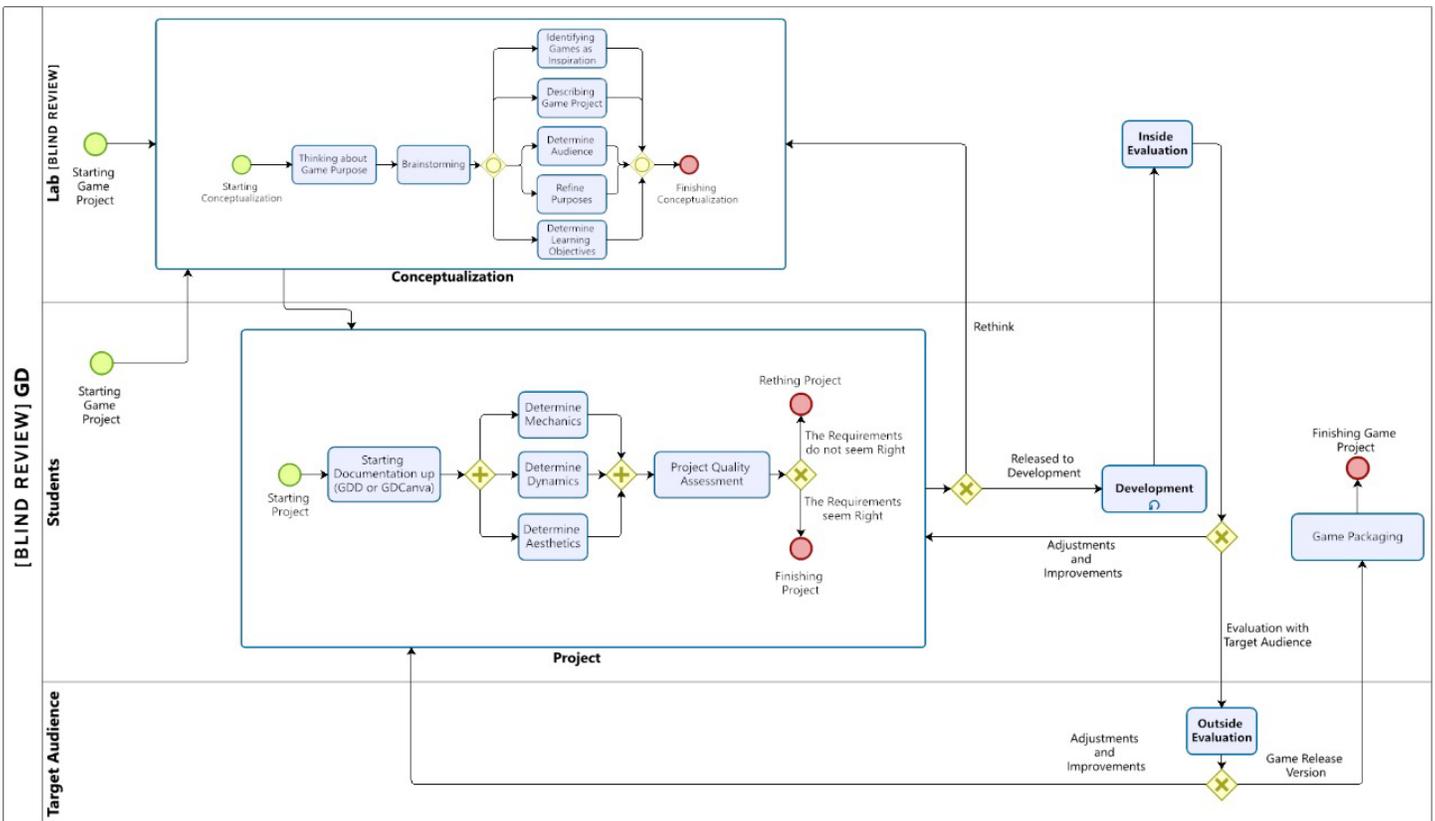
target audience, and educational purposes. From this viewpoint, in the Design stage, the process of documentation and accurate description of the mechanics and other components of the game takes place. Once the game elements are defined, there is a conceptual evaluation of the proposal, which may trigger the need to go through the Conception activity again.

Then the team moves to the Production stage, which involves structuring a backlog of priority tasks to form a minimum viable product (MVP). In the end, the Internal Evaluation stage begins an analysis of the team itself together with the other members of the laboratory. The result defines whether the team redesigns the game or continues to the External Evaluation, in which the ludic artifact is evaluated by its target audience. If that evaluation detects the need for improvements, it is possible to iterate the Production step again.

Finally, in the Packaging stage, the obtained results are disclosed at internal university events or symposia in the area; the final product is distributed. In the case of digital games from academic projects, it is openly available online.

From the macro view of the process, it is possible to see a clear inspiration of the classic steps used by influential authors and game designers (as described in Section Fundamental Concepts). However, the details (Image 2) of the process describe unique activities used in the lab to design games, influenced by the development processes of software and its tools. The process steps are detailed as follow:

IMAGE 2

Conception

The Conception stage starts the LUDES' purpose-driven game development process. The first activity is determining the purpose of the game, which can be an innovation proposal, a request for an academic or commercial partner, or an academic challenge.

The following activities in this stage comprise what the game would be and its details. Laboratory members, or members of the specific project, cooperate to define the target audience and describe the project. If necessary, they also refine the game's purpose to fit the original scope and determine the educational goals.

Project

At this stage, the preparation of the project documentation begins. LUDES does not use a standard documentation model but encourages documentation practices that adhere to the agile and iterative nature of the process described in this paper. So, in place of extensive initial documentation, a single-page GDD or canvas is often used to record the most important aspects of the project at the moment.

During this stage, the concepts of the framework MDA (Hunicke et al., 2004) are used as a basis for determining the desired sets of mechanics, dynamics, and aesthetics for the game. The articulation of these elements with the proposed educational purpose and objectives is made using concepts such as procedural rhetoric (Bogost, 2010; Harper, 2011), Bloom's revised taxonomy (Krathwohl, 2002), and tools such as Endo-GDC (Taucei, 2019).

LUDES members evaluated the project and its documentation before proceeding to the production stage. This activity can occur collectively and take place in one of the laboratory meetings, where projects are presented or carried out by one of the senior members in the role of advisor. The team uses this analysis to ascertain the feasibility of proceeding. If the result is not satisfactory, the return to the previous activity or even to the Conception stage may occur to reassess the decisions taken.

All developments in the project's design and understanding of the problem are recorded in the documentation throughout LUDES-GD.

Development

Agile development methodologies are used during the production stage, particularly Scrum (Sabbagh, 2014), to guide the artifact development process. Thus, the documentation, whether in GDD or canvas format, provides the basis for constructing a detailed set of activities to be developed for the game's production, called a backlog.

Along the LUDES-GD, the team goes through this step more than once. In the first cycle, the team must select priority tasks from the backlog, which allows a quick proof of concept of the game. Thus, the result of the first iteration is the construction of a minimum viable product for internal testing. In later cycles, adding new features directs the project towards the idealized product.

Evaluation

The Evaluation is a two-folded stage. In the Internal Evaluation, the game scrutinizes laboratory members who use concepts of quality of use, product quality (ISO/IEC., 2011), and quality of experience (Brunnström et al., 2013) to evaluate the presented artifact. They perform it by observing, mainly, implementation problems of abstractions contained in the documentation and possible dissonances between the pedagogical objective and the game experience.

In the External Evaluation, the target audience tests the game. Two main axes are analyzed: quality of use and learning effectiveness or achievement of purpose. The External Evaluation only occurs if the game has successfully passed the Internal Evaluation. It could use tools such as MEEGA+ (Petri et al., 2019) or forms built especially for this purpose.

In both stages, general aspects of quality inherent to games are observed, such as the emergence of undesirable game aesthetics or dynamics. The team recorded and evaluated the results, which may require redesigning the game or even abandoning its development.

Packaging

The LUDES' purpose-driven game development process aims not only at the production of the ludic artifact *per se* but also at the production of knowledge for the improvement of the process itself and scientific contribution. As a result, at the end of LUDES-GD, knowledge acquired is also disseminated, in addition to making the game available.

In the packaging stage, the team makes the game available through the appropriate means for each case: via the internet, in the case of digital games, or print-and-play, or physical production and distribution, in the case of board or card games. In addition, the knowledge obtained during the process is organized in the form of results for dissemination in academic papers, university internal events, area symposia, or scientific publications.

DEMONSTRATING LUDES-GD -- APPLICATIONS OF LUDES' SERIOUS GAMES DEVELOPMENT METHODOLOGY

This section shows a detailed exploration of some processes used throughout creating games with purpose by LUDES, which were used as a base for LUDES-GD's modeling.

In each subsection, the development team of each game reports on the execution of LUDES-GD's macro steps, the duration of each of them, and how the game's production flowed through the steps.

Léo & Maya

Léo & Maya (Henriques, 2021) is a serious game developed by LUDES students for personal computers and Android mobile phones for teaching computational thinking to children from seven to twelve years old. The game achieves this objective through twenty-two phases. Each phase presents a problem that must be solved through an algorithm that the player must describe with the tools provided in-game.

The game production followed the steps described by LUDES-GD. The Conception stage occurred during the project's first week, with a brainstorming session between the students responsible for the production and other laboratory members. Learning objectives, games with similar objectives, and target audiences were considered to define a viable proposal during this session. From this discussion, students produced a proposal document that would serve as a basis for the documentation for the next step.

The Project stage took two months. It started with a refinement of the project proposal, aiming to have a Game Design Canvas for Endogenous Games (Endo-GDC) (Taucei, 2019). The beginning of the documentation generated a seminal version of Endo-GDC. As the game elements, *vis-à-vis* the MDA Framework (Hunicke et al., 2004), were better defined and other laboratory members helped review it, the Endo-GDC canvas was refined. Once this macro step was finished, a Game Design Document (GDD) was produced based on the information present in the Canvas. The GDD also described the game screens e determine the player's interaction with the game.

The Development stage took eight months until the first version went public. Over these eight months, the team generates a prototype every three weeks to test decisions made during the design stage. Suppose a previous decision proved to be inefficient or inadequate. In that case, the team changed the Endo-GDC, which was reviewed by the laboratory members and served as a basis for altering the GDD to suit the reality of the game. The beginning of production focused on implementing art assets that could be used to assemble phases in the future.

The Evaluation stage took two months and consisted of collecting feedback from elementary school teachers about the game. Due to the COVID-19 pandemic, contact was made via email and personal messages on Facebook. The message consisted of a brief explanation about computational thinking and the objectives of the contact, a link to access the game on the platform itch.io (Henriques et al., n.d.), and a five-page quiz. Teachers exposed his opinion about the game's suitability as a pedagogical tool and a playful device. Since then, the game has undergone an update to answer more serious questions raised by the quiz, focusing on solving more common technical issues.

Finally, the Packaging stage began by disseminating the game's evaluation at university events, thus serving as a final project for two students involved with the laboratory. Currently, the game is available on a page on the itch.io website, available for personal computers that can run the game through browsers and for Android devices in the form of a .apk file.

Mapa do Tesouro

Mapa do Tesouro (Marques et al., 2021) is a digital game for children from 4 to 10 years old. Its main objective is to make the learning of Concurrent Computational Thinking accessible, a concept related to planning in situations with multiple simultaneous agents. There are fourteen stages in which the player uses command blocks to create a step-by-step guide for the characters, who must find the hidden treasure.

The Conception stage consisted of identifying a problem (the lack of teaching tools on the subject) and searching for works to solve it. That fact defined a target audience and the main concepts that the game would address. This stage lasted 20 days and was fundamental as the foundation for our proposal, focused on exploring the competition and inspired by applications such as Scratch (*Scratch.,* n.d.) and Scratch Jr (LLC, M., n.d.).

From the primary objectives, the next step was the documentation in GDD (Game Design Document) and the use of the MDA concepts (Hunicke et al., 2004) to structure the game components. Different combinations of Mechanics were explored, always without analyzing which Dynamics and Aesthetics arose and whether they were related to the pedagogical objective of the game. The game's theme, treasure hunt, was chosen because of its appeal to the target audience, which associates it with adventure. After 13 days, the decisions were presented to the laboratory and evaluated as satisfactory.

The entire development took five months, divided into three iterative cycles, each with a final product to pass through an evaluation.

The first cycle generated a prototype without final art, intending to check if the decisions made by the player explored the pedagogical objectives. The team added new mechanics and graphics to the game with that confirmation.

At the end of the second iteration, the game was well-received internally at the laboratory. The main points that needed working on were the usability and how the player declared the chain of commands. The objective at this point was to be the most intuitive possible.

With the end of the third iteration, the final product underwent an external evaluation, with children between 5 and 10 years old, who already had six months of experience in a Computational Thinking course. Players were observed during game sessions. Members of the development team recorded their impressions and reactions. In the end, players answered a questionnaire about their willingness to play again, the level of difficulty they encountered, and whether the game had been fun.

The team propagated results through internal events at the university and scientific articles. The game is available, free to play, at Google Play and itch.io (Marques, n.d.).

Xô Corona

The game Xô Corona (Kritz et al., 2020) was developed as a card game and soon after was adapted for its digital version, available online (Costa, L. M., n.d.). Its entire conception aimed to develop a game to raise awareness about the contamination of the virus that causes COVID-19 and its ways of prevention, given the current global situation.

The Conception phase lasted about ten days. During this interval, the first brainstorm occurred among the laboratory members. Also, the team developed a clear project description, defined the target audience, and elucidated how to raise awareness in the game. Exploding Kittens (EK) was chosen as a reference game. During an EK game, players use the cards in their hands to avoid encountering explosive cats by manipulating their opponents' deck and hands. This idea proved to align with Xô Corona's objective, serving as the basis for the game.

In the Project step, the team explored game variants that, applied to Exploding Kittens, would reach the purpose of awareness. They used MDA to analyze the original game and help other possible changes. In addition, the layouts of the cards and game screens were also defined. Altogether, this step lasted about 20 days.

The development of the game's digital version started in sequence. It lasted about four months, presenting a cyclical structure of development, evaluation by those involved in the project, and application of adjustments and corrections.

Finally, the evaluation took place in two stages: internal and external. In the internal evaluation, lasting three days, members of the laboratory were invited to play Xô Corona to assess the general functioning of the game, but mainly its balance. The matches took place with the latest version available on the game's website, and minor corrections were made after receiving feedback from the participants. In the external stage, lasting nine days, a form was developed based on the MEEGA+ (Petri et al., 2019) model and had the participation of 21 players.

After conducting the last evaluation, specific corrections were made to solve the most critical issues discovered through the questionnaire. A new version was made available at the same URL, and the articles were written, presented, and published at an event in the area.

CONCLUSION

LUDES-GD is a method based upon LUDES members' experiences to help make games with purpose, being a logical step in the knowledge creation process to capture and share tacit knowledge from the laboratory's members (Nonaka, & Konno, 1998). Born from known processes of game development (Mastrocola, 2012; Winn, 2008; Siriaraya et al., 2018; Roungas, 2016) mixed with the mindset of games as Information Systems (Xexéo et al. 2021), LUDES-GD is composed of five macro steps: Conceptualization, Project, Development, Evaluation, and Packaging. It also has practices and tools, which are documented throughout this work.

Although been a formally defined process, LUDES-GD does not hinder the development team creativity. The process is tool-agnostic and adaptative. Its iterative steps, with many planned evaluations, ensure game quality and can use different tools to achieve this. It can produce video games, board, and card games with varied purposes and many different levels of complexity. The collaborative nature of the process proved to be very suitable for addressing heterogeneous teams.

LUDES-GD is the consolidation of a methodology that evolved during the successful development of many games. It will continue to be used, studied, and redesigned on LUDES' following projects. The method was built upon LUDES members' statements, past projects' documentation, and activity logs. While Presenting the LUDES-GD, this work hopes to contribute towards new game development methods that are dynamic and collaborative, allowing researchers, programmers, artists, and game designers to have a set of tools to work upon developing new games with purpose.

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