

# Unfolding for creation of educational games

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**Abstract**—Many students with little class time have already lost their attention to what is being taught. This may be a reflection of the current teaching strategy that does not capture the student’s attention, leading to a lack of motivation and engagement during classes. Due to this, many scholars seek to innovate the current teaching method finding greater motivation and student’s engagement. Among the leading innovations used, there are sounds, practical classes, and even games. Video games have been in our lives for over 50 years, making it one of the most important forms of entertainment. They have several advantages that can collaborate to improve the current teaching method. However, despite these advantages, games are often omitted from the classroom; among the main reasons are the fear of addicting the student and the difficulty of creating educational games. Based on this, this work aims to present some concepts that can help in the creation of games for educational purposes.

**Index Terms**—Games, Educational games, Teaching, Learning, Education

## I. INTRODUCTION

Going to school to study every day can become a tedious situation. Many scholars argue that educators are increasingly looking for innovative learning strategies that combine pleasure with education [1]. Trying to make learning enjoyable can be a great help for students who need to study a subject. Games are one of the main forms of fun, they are increasingly popular among people; it is possible to find them being used in many different areas, such as entertainment, medicine, and education. They are interactive, lively, and stimulating, which makes them an excellent opportunity to make students remember what was taught. Based on this, the use of games in education seeks to make teaching more interactive, enjoyable, and practical [2].

Playing can be a penetrating and powerful method of learning; in fact, many psychologists agree that playing is a method by which ideas and new skills are created [3]. On the other hand, Squire states that studies show that, while playing a particular game, people are involved in more complex and challenging learning activities than most school tasks [4]. Also, there are several advantages in using games as a teaching method, such as immediate feedback, real scenarios, learning from mistakes, increased motivation, and student’s engagement.

Despite all the advantages of using games as a teaching method, some problems prevent this strategy from being applied, such as the difficulty of teaching through games, the

fear of addicting students, and the complexity of creating a game being the main problems [5, 6].

Games as a teaching method has already been demonstrated as a good idea. However, as previously mentioned, one of the difficulties is their creation. When starting the development, many difficulties arise, such as ensuring its quality, what type of game to use, how to design it, among other problems faced [7]. Based on these difficulties in creating educational games, this work intends to demonstrate some concepts that should be considered before constructing a game with an educational purpose. The remainder of this article is presented as follows: Section II introduces the concept of using games as educational method, Section III describes the main concepts that must be taken into account before developing an educational game, and Section IV concludes the paper with some final remarks.

## II. GAME-BASED LEARNING

Games can be defined as systems that simulate fun and recreational activities in which users participate in an artificial conflict, limited by freely accepted rules, which end in a quantifiable result, within a virtual world [8, 9]. They have a series of characteristics that make them so well accepted and used in society, among which: they are interactive, have an uncertain ending, quantifiable, regulated by rules, provide rewards, and are one of the primary sources of entertainment today [8].

Games have functions beyond entertainment as mentioned before. They can serve various purposes such as training, to assist in physiotherapy, or even the transmission of educational content that is the focus of this work. This branch of games has a different name, which is called serious games. These have a goal that aims to achieve some effect in the real world, offering an opportunity to try new approaches to solving problems in a safe, inexpensive, and without consequences manner. The branch of serious games with educational purposes is called Game-Based Learning (GBL) and are games to convey an educational message to assist in learning [9, 10].

The learning provided by educational games is based on three steps that form the learning cycle [11, 12]. The first step is the **input**, composed of the body of knowledge of the subject to be taught and the mechanisms/characteristics (rules, challenges, difficulties, progressivity, feedback) used in the game, such as rules levels, feedback, etc. Next is the **game cycle**

that is the principles into practice (i.e., increase motivation, fun, autonomy, and authenticity, and experimentation for the student). Finally, the **output** is generated, making the student learn and remember what was taught in the classroom. Figure 1 demonstrates the GBL model that presents each of these steps.

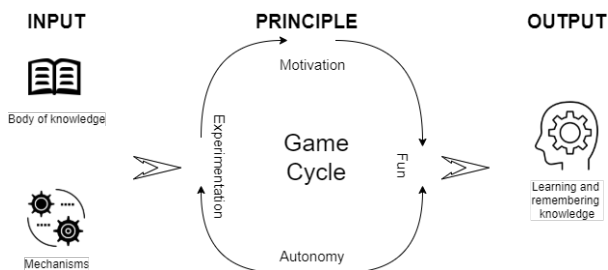


Fig. 1. GBL model based on the models of Pivet et al. [11] and Perrotta et al. [12].

### III. CONCEPTS FOR CREATING EDUCATIONAL GAMES

This section aims to present some concepts, aspects, theories, and concerns that must be considered before creating an educational game.

#### A. Should I use games to teach my discipline?

Scholars often wonder if games make teaching easier. There is strong evidence that games are capable of being useful in education, often reaching more effectiveness than the current teaching method. However, games are like any other educational solution. They need to be created carefully, that is, poorly designed games, like poorly designed classes, produce poor learning results [13]. In general, games can help in any discipline. However, they need to be planned very carefully, knowing how to choose the type, mechanics, challenges, rewards, and the various other elements that the game has to provide.

#### B. Purpose of the game

In educational games, it is crucial to keep in mind that the rules and actions that will be imposed to the user must be carefully thought out so that they do not affect the learning experience [13].

Depending on the purpose of the game to be created, some mechanics (actions and rules) are better suited to the context. If the goal is to recall information learned in the classroom, quiz and matching games are recommended. If the purpose is to force the student to think and analyze a situation, games like puzzle, RPG, and strategy are more suitable. If the goal is to understand the content without prior knowledge, it is advisable to use games that contain a story for the player, such as storytelling. For games with a slightly more practical approach, it is advisable to use simulators or construction games to encourage student’s creativity. It is worth remembering that these types of games are not exclusive to one purpose. They can have more than one, that is, a storytelling game can also be used to encourage the student

to remember something. However, it is more recommended to present content without the need for having prior knowledge [13].

#### C. Game Design

There are several ways to organize ideas for building a game, such as using UML, flow models, gameplay, and features. Two well-known models in the gaming area are MDA [14] and OCR [15].

**MDA** is an approach to understanding games that tries to describe their characteristics through three components[14]: **Mechanics**, which are the essential components of a game, such as actions and rules; **Dynamics** that describe the behavior of mechanics, acting on data inputs and outputs and; **Aesthetics** that define the desired emotional responses invoked in the player when he/she interacts with the game.

**OCR** model is known as the basic structure of a game. This model is divided into three parts [15]: **Objectives**, which are the purposes to be achieved; **Challenges** that are the steps to be faced to reach the goals, and; **Rewards** that are the prizes that are won.

The above models can be used together to help developers better organize ideas before starting game development. Based on this, Figure 2 was created with an execution order in mind for the creation process. All activities are sub-processes since this process is only an abstraction of the order of execution of the two methods. However, each activity has much greater complexity.

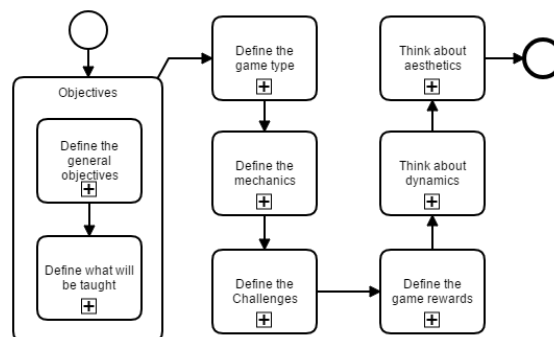


Fig. 2. OCR [15] and MDA [14] models used together.

The combination of the elements that define the models above can give rise to two other terms that are called Gameplay and Flow experience. The flow describes a state of complete absorption or involvement in the activity and refers to the ideal experience. It can be understood as the junction of all the previous elements and the triggering of this combination, giving rise to the player’s experience. Gameplay is the core of the game. It is directly linked to the mechanics, dynamics, and challenges of the games, representing the actions that the player can take to overcome the challenges of the game [16].

Two other very important concepts when creating a game are stories and narratives. Although these concepts are quite similar, they have differentiations. The story is the game’s

subject, the plot, while the narrative of the game is the events that are happening throughout the game. These two concepts allow the player to feel the game’s experiences [17].

Finally, a document called Game Design Document (GDD) should be constructed using the elements described above. It is a text document explaining each of the elements of the game, such as aesthetics, history, mechanics, etc., having the function of communicating and guiding the various involved in developing the game [18].

It is worth remembering the extreme importance of good writing and structuring of the GDD because it is responsible for guiding the entire creation of the game and communicating between the different teams that are involved in building a game, such as requirements engineer, designer, animator, programmer, sound and video editor, modeler, tester, among others.

#### D. How can I guarantee that my game can teach?

When talking about the guarantee of teaching, it is necessary to emphasize that the game must teach precisely what it was planned to teach, because all games teach something indirectly, even the non-productive ones.

The first way to ensure that a game fulfills the purpose for which it was designed is through GDD analysis, where the game must be following all specifications of the document [18].

Another way to try to ensure that the game follows its purpose is through tests and evaluations. There are several ways to test a game. However, most methods revolve around the use of a questionnaire with the practice of the game. Some of these methods differentiate a little from the others by using more than one questionnaire, one before and another after playing the game; some use control groups, where one group learns something without the game and another learns through by using the game; some make divisions and categorizations in the questionnaire questions, among other approaches [19, 20].

#### E. Do I need to create from scratch?

Several areas, such as manufacturing, machinists, and engineering, have characteristics of creating artifacts from others. In computing, this also usually happens, and this area is called Software Reuse, where new programs are built from pre-reusable components [21]. In game development these components are called assets, and can be of the most diverse types such as sprites, sound effects, mechanics, or even other games. The use of these assets greatly assists the development of games, giving speed for development [22].

The first mistake that many new game designers can make is trying to create their game from scratch. Most games are built from derivations of others with minor modifications to the elements that were mentioned earlier [17].

A derivation of a game is a variation of the same game where modifications were applied to the constituent elements. There are different types of changes that can be made to games, among which the following stand out [23, 24]: **Add-ons** are extensions to the game, such as introducing new maps;

**Mutators** are limited modifications, such as changing game speed, or a small change in the rules; **Mods** can be understood as a union of the two above, building extensions and mutations in the game. It is worth remembering that a mod can also be defined as any form of non-commercial alteration of a proprietary digital game; **Total** are games that modify the rules system and mechanisms, thus creating a similar game but the user has the feeling of playing something completely new.

Several games are built from modifications of others, for example, on the website moddb.com, it is possible to find more than 21000 modified projects (accessed on July 10, 2020) [23]. From that, these modifiers can also be used to build educational games. It would be enough to apply the modifiers, change the teaching context, and validate the quality of teaching provided by the game.

Despite the demonstration of the modifiers and assets, no well-defined tool or method was found to assist in creating games from an existing one. However, abstracting this idea of creating games from others through the insertion of modifiers, it is possible to think of a branching tree where each edge would be a modifier to be applied, and each node would be a potential new game or would be closer to one. This idea of tree and generation of new products is similar to a research area within the field of Software Reuse called Product Line. This research area aims to create similar products based on their configurations, for example, a car can have a combination of settings such as air conditioning, disc brake, rear camera, among other, that is, there is a product where a particular configuration or modification is applied and becomes another product [25]. Following this same line of reasoning, there may be a game X, and when using a modifier Z, it will generate a game XZ, applying a modifier Y, the game XY will be created, and applying a modifier W, the game XYW will be created. Figure 3 demonstrates this idea.

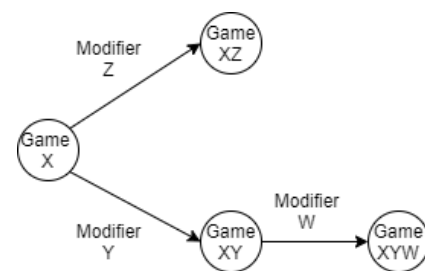


Fig. 3. Game branch tree example.

## IV. FINAL REMARKS

Going to school to study every day can become a tedious situation. Due to this problem, scholars are looking for other innovative learning strategies that combine pleasure with education. Thus, a possible way to improve current teaching is to use games as an educational method, taking into account that they are entertainment and pleasure sources.

However, the construction of a game is not an easy task. When discussing educational games, this problem increases.

Moreover, having problems related to the type of game, guaranteeing the teaching quality, which mechanics to use, among other problems. Due to these problems, this article tried to present some concepts that must be taken into account before creating an educational game.

Throughout the paper, concepts that can help the reader to think and elaborate games were presented. It is worth remembering that, as has been discussed, most of the current games are created based on others with some modifications. Therefore, it is intended as future work to expand the idea of a game derivation tree through strategies, tools, and techniques to contribute to the creation of games from an existing one by applying concepts related to the field of Software Reuse, such as Product Line.

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