Educational Playability
Analyzing Player Experiences in Educational Video Games

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Abstract—**Educational video games constitute some of the main edutainment applications currently on the market. However, the development of video games as educational tools is very difficult due to their multidisciplinary nature (fun and education). Player Experience is a good measure of the level of fun and education presented to players and determines, to some extent, the success of an educational video game. This paper examines the importance of the role of Player Experience in motivating and enhancing the concept of learning through play, and highlights the role of Educational Playability attributes as suitable and effective tools to analyze and measure the experience obtained by a player during a game. The paper also discusses the role of a balanced Educational Video Game that provides a good level of motivation and engagement in order to improve player experience.**

Keywords- Playability; Player Experience; Educational Video Game.

I. INTRODUCTION

Videogames are complex environments that offer the kind of entertainment and challenges that appeal to a growing number of people. The objective of videogames is to engage players in a fun activity which provides distraction from their daily lives, and which captures their attention for hours. We define Educational Video Games (EVG) as video games with special characteristics to teach, build and strengthen skills while the player has fun. Their focus on motivation, curiosity, emotion, socialization, entertainment and education distinguishes them from other types of video games. Play is fun, and information that is learned in an enjoyable way is less likely to be forgotten [23]. A very important aspect of the success of an EVG is how much it motivates players, as motivation guides learning activities during playing time. The inclusion of educational content often leads to a loss of the game's entertainment value, which decreases its efficiency as an educational tool [33].

In this paper, we examine the problem that many EVGs do not provide motivation to play, and thus do not improve the Player Experience PX (user experience in a video game). However, do all EVGs demonstrate this problem? Where exactly does the problem lie? How can we detect it? What does player motivation depend on? How can we determine whether a game provides the necessary level of fun and motivation?

We believe this last question depends largely on the property of playability, which assesses and measures indirectly how much fun the game is and how much it attracts and captivates the player. To assess the level of playability, we must analyze the experience obtained by a player in an EVG. However, is the current structure of playability in video games sufficient to analyze the PX in EVGs? Is it necessary to qualify this structure? In this paper we answer these questions using a theoretical approach.

We aim to present educational playability (playability in EVGs) as a synthesis of all the playability studies analyzed throughout this work, and analyze the PX in order to obtain a measure of the fun and education experienced by a player with an EVG.

The subject of this paper overlaps many current topics in the games world, such as: User Experience, Video Game, Education and Human Computer Interaction.

Following this introduction, in Section 2, we discuss some studies of EVGs, present the characteristics of EVGs, and analyze the attributes of a balanced EVG. In Section 3 we present an analysis of the PX, a definition of Educational Playability, the attributes and facets which characterize and measure PX in EVGs, and define the correlation between playability attributes. Finally, we present our conclusions in Section 4, followed by our references.

II. EDUCATIONAL VIDEO GAMES

Many researchers have discussed the use of video games as useful educational tools to improve learning and performance. This is due to the many benefits video games have with regard to the attention and motivation of players, leading to greater academic success, better cognitive skills, and improved concentration. Entertainment is used in combination with education in order to create a motivating and successful environment for learning. [1] [24].

Gee [9] emphasizes the use of games as a medium to promote experiential learning. Gee discusses the opportunities that video games provide for simultaneous learning, by presenting three components for active learning: *"experiencing the world in new ways, forming new affiliations, and preparation for future learning"*. He asserts that video games teach very effectively through an environment that is demanding yet attractive, and that they

help keep a player positively engaged and motivated to continue learning. The concept of the EVG has a long history [19][34]; several attempts have been made to incorporate education into video games, such as Edutainment, Serious Games and Commercial off-the-shelf (COTS) [8][26], which effectively created games as a teaching tool specifically in the domain of computer science .

Nowadays, there are many EVGs. However, are all EVGs successful and do they always keep the player motivated to play? Good EVGs hook their users and maintain higher levels of motivation for longer. Robertson [25] highlights the value of educational games in promoting traditional literacy skills, including narrative structure and creativity, while providing significant benefits in terms of motivation, team work and self esteem. Moreover, the positive experience felt from self-initiated activities can lead to a greater sense of self-efficacy, which in turn increases a student's motivation to learn.

A. Characterization of Educational Video Games

EVGs are a combination of playing and learning, however, it can be difficult to give a precise definition of an EVG since there are many kinds, all very different from one another (simulator, social game, etc.). Not only is it necessary to identify the features that make EVGs different from other videogames, but a structure capable of achieving the objectives of EVGs is also required. There are several works in the literature that incorporate new features for building playful and attractive EVGs. Many researchers find that motivation to play is a very important feature of EVGs, based on game rules, goals, and rewards. They argue that competence, autonomy, and relatedness are factors that affect motivation [5]. Dicky and Waraich [6][30] mainly focus on the game narrative. They believe that a narrative context that promotes "*challenge, fantasy, and curiosity*" and provides feedback for players is one that promotes intrinsic motivation to play. Other works provide the social aspects of EVGs by developing skills and encouraging collaboration, cooperation and communication, so that players communicate with each other and work together to achieve common objectives. Bailey [2] suggests communication may be built or reinforced by video games through their capacity to offer a more social approach to learning and collaboration.

Malone and Lepper [19] identify four key characteristics which make an EVG enjoyable: challenge, curiosity, control and fantasy Thiagarajan [28] also presents the following characteristics: conflict, control, closure, contrivance and competency. Jenkins [14], identifies several characteristics of successful educational games such as: EVGs are made to fit specific learning contexts; successful EVGs supplement classroom teaching rather than replace it; using play as learning strategy; every element of the game design is meaningful; success is social, rather than individual; the game must be fun. Gee [10] proposes seven features of the videogame design that are important for effective learning: Interactivity, Customization, Strong identities, Well-sequenced problems, A pleasant level of frustration, A cycle of expertise, 'Deep' and 'fair'.

Based on the above works, we here highlight the main characteristics that should be included in EVGs:

- Accelerate learning times and focus on reinforcement of players' skills and experience.
- Increase player motivational levels by using accurate, richly detailed, predictable content.
- Increase players' retention levels.
- Make players feel that they are part of a creative and dynamic community.
- Give players great scope for personalization according to learning style and preferences.
- Present suitable and effective content for players of all levels.
- EVG is an active virtual world, which provides an active support system and feedback and reacts to players' actions in a consistent, immediate, challenging and exciting way.
- Use collaborative learning and improve collaboration and interactivity among players.
- Transmit different stimuli to activate and engage players during playing time.

These characteristics represent the important role that EVGs play as interactive tools to motivate, teach and entertain players. Games that do not captivate and engage players will not motivate them to play, meaning that their time will not be utilized effectively.

B. Balanced EVGs

Balancing fun and engagement with educational content and learning is one of the most important challenges that EVG designers face. "*We want the game, as much as possible, to be time spent learning*", "*You have to take both engagement and learning into account*" [36]. Thus, an EVG is controlled by its success as a tool to teach and entertain. The success of an EVG is related to a number of factors that balance the playful content and educational content.

One kind of content should not be given more importance than the other, since both form the structure of the EVG and ensure its success or failure. Law [17] indicates that one of the problems of current EVGs is the poor balance between playful and educational activities, or between challenges and ability. Moreover, the lack of sound instructional models, based on pedagogical standards and didactical methods, is seen as the common weakness of most EVGs, leading to a separation of learning from playing. The imbalance between EVG components may lead to the failure of an EVG to achieve its objectives. Other reasons for the failure of EVGs can be identified as: uninteresting content, the fact that presented contents are not appropriate for the prior skill and knowledge level of players, and game elements and game contents are unrelated.

In this work, present new factors which characterize the relationship between EVG components, based on the characteristics previously mentioned:

1) Interdependency: The success of an EVG depends on the relationship between educational content and playful content, and how these contents are presented without either one dominating at different stages It also depends on

keeping players interested and motivated to play. Morenoger notes that the different designs found in this field have aims that seem to be biased towards either fun or educational content [21]. The proposed content must support the achievement of the game objectives, which means that EVG success is constrained by the interdependence and integrity between playful and educational components during all game steps, as well as the continuity of the game story and the compliance of game contents in terms of the visualization and achievement of goals. Prensky states that effective educational game design must achieve a balance between fun and educational values [23].

2) Continuity and consistency: Keeping the Learning-Fun Relationship balanced during all game steps in a way that engages players. EVGs that are not engaging can negatively affect players as their time will not be utilized effectively. We therefore emphasize that an EVG must contain different goals and objectives (playful and educational) throughout the different levels, and well-structured and carefully-chosen content during the design step of the game environment. It is necessary to provide appropriate content for the predetermined learning objectives and player skills. *"The best way to learn is when the learner is having fun at the same time. Having fun gives your kid motivation to keep on practicing, which is the only way to learn skills"* [37].

3) Completely New: In addition to the previous factors, the EVG content should be renewed each time the player plays (i.e., use different ways to present the EVG contents), the game must keep the player immersed and provide new knowledge, experience, etc. This, along with a good, realistic presentation of game content, means that the player loses his or her sense of time and place. Mavis Beacon [38] provides typing tests with different kinds of presentation (graphics, sounds, etc.) throughout the game in order to capture a player's attention and encourage him or her to pass the tests.

These factors indicate that to develop a playable EVG and improve the overall PX it is important to understand the changes that have occurred in the video game structure due to the merging of educational and fun components. Due to its effect on the learning progress, we need to characterize PX in EVGs in order to know which elements of the video game are helping or hindering its success.

III. PLAYABILITY: A MEASURE OF A PLAYER EXPERIENCE IN EDUCATIONAL VIDEO GAMES

Above, we have mentioned the different aspects of EVGs (hedonics, motivation and the narrative structure) which help to improve PX by teaching higher order thinking skills such as strategic thinking, interpretative analysis, problem solving, plan formulation and execution, adaptation to rapid change, and offer opportunities for players to cooperate within the game and within the larger community through websites and online forums [26].

However, measuring experiential dimensions such as fun, motivation and emotion is more elusive than measuring traditional performance metrics such as time spent playing,

or number of tasks completed in each step. "It is difficult to obtain knowledge about what players did when playing the game, and how meeting different game design elements affected their experience of interacting with the game" [29]. Thus, to measure the PX, we propose the use of playability attributes and properties that allow us to measure whether a player is having fun playing an EVG based on the pragmatic and hedonic properties. Playability attributes characterize PX by analyzing all aspects of player behavior and feelings when he or she is playing, An adequate value of playability allows the player to have a more positive game experience, resulting in a greater predisposition to assimilate the educational and playful concepts underlying the game dynamics. Accordingly, we need to define the PX and identify the playability attributes and properties in the EVG context to ensure an optimal PX.

The Player Experience PX is a simulation of User Experience UX in software application used to perform daily tasks. UX is defined as how a person feels when interacting with a system in terms of ease of use, perception of the value of the system, utility, and efficiency in performing tasks etc [27]. PX may be much more extensive than the UX; PX helps to improve the player interface design, the level of challenges, the pace, game mechanics and game story. We can say that PX extends the UX in EVGs, where UX is focused more on the subjective part of the interaction process and goes beyond the traditional study of skills and cognitive processes of users and their rational behavior when interacting with computers [18].

The term PX, based on definitions of user experience [18], refers to "all aspects related to the player that are affected by and interact with the playing environment". These aspects represent the different features of the interaction process, such as: sensation, feelings, emotional response, assessment, user satisfaction and the experience obtained throughout the entire playing time [13]. A player experiences these aspects positively in a videogame with good playability, where the playability attributes and properties are measures of PX. Canossa [3] emphasizes the emotion and narrative aspects of the game in the design of a UX. Canossa describes how specific game environments and certain game features can offer players personal styles of play. To analyze the quality of a video game we must discuss the non-functional values, which define specific properties of game and affect its quality [12]. Playability has been studied from different perspectives and with different objectives without consensus on its definition or the elements that characterize it. In this context, Playability is a term used in the design and analysis of video games that describes the quality of a video game in terms of its rules, mechanics, goals, and design. It refers to all experiences that a player may feel when interacting with a video game system. Playability is affected by the quality of the storyline, responsiveness, pace, control, intensity of interaction, intricacy, and strategy, as well as the degree of realism and the quality of graphics and sound [32][35].

There are few studies focused on defining Playability formally, the exceptions being the work of Fabricator and Järvien[7][15]. However, these do not specifically refer to

Playability attributes or the properties which characterize it. Järvinen has defined playability as an evaluation tool which consists of four components: functional, structural, audiovisual, and social playability [15]. Fabricatore has defined playability in action games as the possibility of understanding and controlling gameplay [7].

Playability has been defined as "*the instantiation of the general concept of usability when applied to videogames and it is determined by the possibility of understanding or controlling the gameplay*" [7]. This may be interpreted as supporting a separation of playability and usability if we consider that playability is related only to video games, "*capability to provide enjoyment for a player over an extended period of time*" [16]. Thus Playability is based on Usability but, in the context of video games, it goes much further. Furthermore, Playability in video games is not limited to the degree of fun or entertainment experienced when playing a game; it also extends the UX characteristics with player dimensions using a broad set of characteristics such as motivation, pleasure, curiosity, emotion, and social influences that contribute significantly to user satisfaction with the product

A. Educational Playability

The main concepts studied in works that focus on playability experiences are: flow [4], immersion [22], emotions [20], and fun [31]. Are these aspects sufficient to characterize playability in EVGs? EVGs are composed of two dimensions: educational and playful. Thus, Playability in EVGs is not limited to playful objectives but must take into account educational objectives, such as learning while having fun, improving the abilities of students to solve complex problems, reinforcing players' skills and improving player experience.

EVG must maintain fun as a subjective concept and include educational goals. Thus, Educational Playability in EVGs is an extension of playability in videogames. We propose the definition of playability in EVGs to be "*the set of properties that describe the PX in the gaming environment, whose main goal is to provide fun and learning in a playable and learnable context during the entire playing time*". Educational Playability describes how to make an EVG playable and learnable at the same time, and it includes two aspects: learning to play and playing to learn. Thus, it contains new characteristics related to the educational component.

Characterizing Educational Playability (i.e., the playability of the playful and educational contents in EVGs) requires a specific study related to the different aspects of an EVG (analyzing several EVGs and their characteristics). Moreover, characterizing Educational Playability can result in improved player motivation and satisfaction, the establishment of rules of engagement, the introduction of educational content that is implicit and relevant to the narrative story line, improved quality of educational content, the provision of interactive feedback and an emphasis on the correctness, accuracy and reality of educational content.

To characterize Educational Playability we have used a tested and verified characterization proposed by González

Sánchez [11][12] to achieve the new changes in the playability structure. We have therefore identified and qualified new attributes and properties which are suitable for defining playability in EVGs.

Fig. 1 shows the educational playability attributes divided into educational attributes (the newly proposed attributes) and playful attributes.

B. Educational Playability Attributes

We will now discuss in more detail the new playability attributes for characterizing the educational component of PX (educational attributes), taking into account the educational aspects proposed in this paper. We have already mentioned the effects of the educational content on all other playability attributes (playful attributes), and have presented some of the possible ways that each attribute can be measured. Thus, Educational Playability is characterized by:

1) Satisfaction: The gratification or pleasure derived from playing a complete video game or some aspect of it. Satisfaction is an attribute with a high degree of subjectivity. Not only is it difficult to measure, but it also influences player preferences. Satisfaction is linked to the degree of balance and harmony in the game. This is defined by the following properties: Game Fun, Contents Disappointment and Attractiveness. A high degree of each one of these properties will lead to an increase in player satisfaction.

We can measure this attibute by the percentage of game objectives discovered and achieved during the playing time and by the percentage of useful playing time (amount of time a player feels pleasure while playing).

2) Learnability: The player's capacity to understand and master the game system and mechanics (objectives, rules, how to interact with the video game, etc). It has the following properties: Game Knowledge, Player Skill, Game Difficulty, Player Frustration, Speed of Learning and Discovery Techniques. A high level of player knowledge and skills will reduce the degree of learning, and a high level of difficulty and frustration will directly decrease the playability of the game. However, rapid presentation of game concepts and the ability to discover these concepts will positively affect the degree of learning. This attribute introduces learning to play, but playing to learn is also a very important characteristic of EVGs. EVGs involve a complex learning process, and the importance of this means that we have added a new attribute related to educational aspects of the video game.

To measure Learnability we can use player performance and the playing time, which are related to mastering the game controls and mechnics.

3) Effectiveness: The resources necessary to offer players a new experience (fun and learning) while they achieve the game's various objectives and reach the final goal. To ensure enjoyment and hide the educational component in EVGs in a homogeneous way, we must include elements from a playful point of view. This will reduce the effectiveness of the educational process and it may seem that time is being wasted in playing, but we are in fact increasing the motivation to learn. Effectiveness has the

following properties: Game Completion and the Structuring of Game Resources. An EVG is more effective if the percentage of Completion and Structuring is high.

To measure this attribute we can use the percentage of unachieved objectives, and also analyze the gap between the prior knowledge of the player and the knowledge presented by the challenges in the game.

4) Immersion: The capacity of the EVG contents to be believable, such that the player becomes directly involved in the virtual game world. At an educational level, this property is used to measure the ability of an EVG to present the educational aspects implicitly. It has the following properties: Conscious Awareness, Absorption in game, Game Realism, Control Dexterity and Socio-Cultural Proximity with the game. We can keep a player immersed while playing by focusing on a high degree of these properties.

This attribute can be measured by the playing time, time per challenges, the level of player awareness, and the quality of the actions performed.

5) Motivation: The set of game characteristics that prompt a player to perform specific actions and continue undertaking them until they are completed. At an educational level, motivation to play indirectly produces positive motivation to learn. It can be defined by: Encouragement Techniques, Curiosity about the game, Player Self-Improvement and Diversity of game resources. These properties evaluate the player's perseverance to overcome the game challenges.

Motivation can be measured using the educational level obtained during the game, the time and number of attempts a player makes in order to overcome a game challenge, and the objectives achieved.

6) Emotion: This refers to the player's involuntary impulses in response to the EVG stimuli that induce feelings or a chain reaction of automatic behaviors. The educational content in EVGs may provoke rejection by the player, which reduces the motivation for the player to explore the game and thus achieve the educational goals. Emotion contains the following properties: Player Reaction, Game Conduct and Sensory Appeal for game elements. These properties are able to generate a set of emotions in the player during the playing time which are very difficult to achieve in the real world.

We can measure this attribute by analyzing the pleasure gained, and by studying the emotional reaction and educational development of the player when facing and overcoming the different challenges.

7) Socialization: The set of game attributes, elements and resources that promote the social dimension of the game experience in a group scenario. From an educational

perspective, socialization is the ability to support students learning from one another. Socialization relates to the following properties: Social Perception, Group Awareness, Personal Implication, the Sharing of Social Resources, Communication Techniques and Interaction Rules of the game. We can use these properties to present new challenges that help players become immersed in the virtual game world and feel satisfied with the game dynamic, and that help create collective emotions among players. Thus each player is self-stimulated and is encouraged by other players to face and overcome the proposed game challenges.

The Socialization attribute can be measured through an analysis of the social elements, rules, effects, mechanisms, and the percentage of objectives that have been achieved in a group situation.

The preceding attributes of Educational Playability are used to measure playful aspects, although they have been adapted to the special case of EVGs. The following two attributes are used specifically for measuring aspects of learning and its relationship to the playing process.

8) Supportability: we define this as the ability of EVGs to engage and teach players correctly, and encourage them to continue learning and achieve the learning objectives causing playability as motivational element. We propose the following properties to characterize Supportability:

a) Embedded learning: This is the capacity of the game to implicitly introduce the educational content and encourage players to learn it while playing. This property aims to ensure that the level of pleasure and fun is unaffected by the educational content.

b) Interdependence: This refers to the relation (interdependence) between educational content and the game elements, and is related to game activities, challenges and game objects that represent the objectives presented to a player during the game.

c) Integrity: The game must ensure that the relationship between playful and educational content is well managed, so that new elements presented for both contents are compatible with each other. Integrity gives players an idea of the learning process and how they can achieve the presented game content.

d) Challenges: Refers to the different levels of difficulty and complexity of challenges, and how to suit these to learners' skills, as well as how to relate these challenges to the presented content, so that flow experience is possible. A game with a high degree of complexity may cause the player to lose interest.
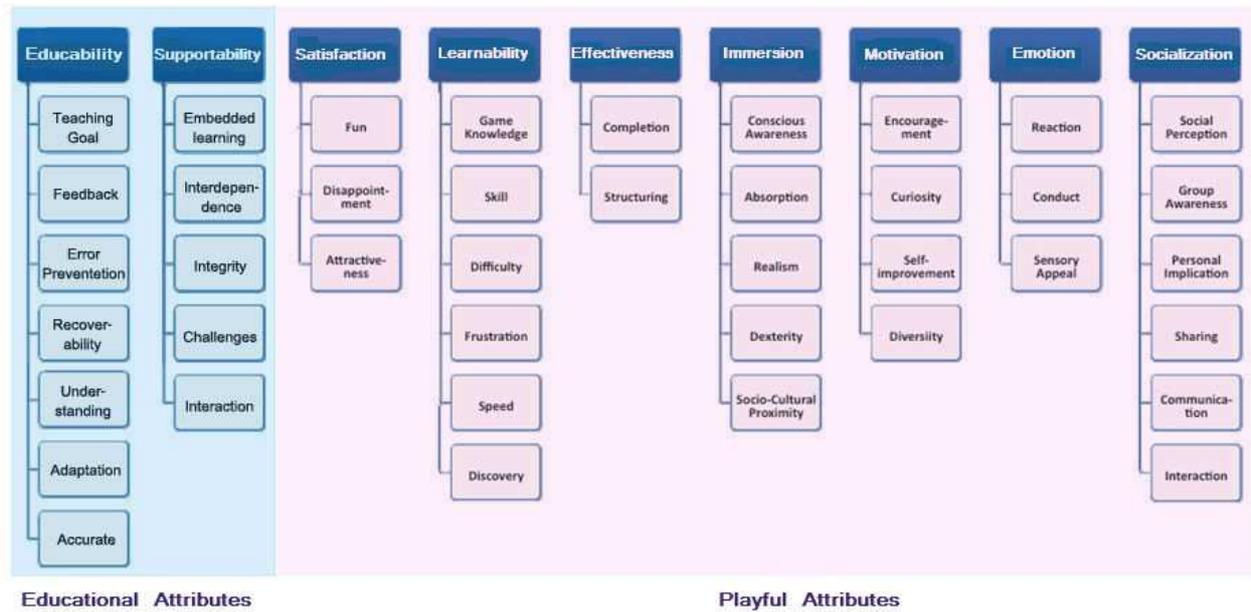
Figure 1.   Educational playability Attributes.

e) Interaction: This refers to the ability of the game to increase players' motivation to learn by encouraging them to interact with the educational content through quizzes and multimedia, stimulating them to practice skills, demonstrate their knowledge, discover information, and reinforce learning.

This attribute can be measured by determining the development of player knowledge and the percentage of educational elements provided in the game, and by analyzing the percentage of educational goals achieved.

9) Educability: We define this attribute as: the educational characteristics of video games that support the user´s ability to be aware, understand and master learning goals. We propose the following properties to characterize Educability:

a) Learning goal: the degree to which the educational content teaches and increases player skills, and the ability to use these skills. This property must motivate the learner to achieve the goals and learning experiences. Thus, an EVG that does not improve player knowledge does not teach players.

b) Feedback: Games must present appropriate educative feedback that improves the behavior, experience, and performance of players based on their progress and whether their decisions have positive or negative effects. This property aims to help players to be aware of and to achieve the educational content in the shortest possible time.

c) Error prevention: EVGs should ensure that a user's skills develop correctly, never allowing a player to use incorrect information during the learning process or when

trying to solve tasks. Error prevention is defined by the degree to which the educational elements help players avoid making errors and achieve the content correctly. This increases a player's efficiency and increases the achievement of educational goals. It also reduces the level of frustration and encourages players to play by making the game more acceptable to them.

d) Recoverability: The degree to which the EVG allows players to check the correctness of the content provided knowledge and change incorrectly and unintentionally acquired knowledge and skills. Players frequently choose incorrect options or actions and are likely to find themselves with incorrect knowledge in an error state from which they must recover.

e) Understanding: The degree to which the player is able to understand the game goals, determine the educational content in the game environment during playing time, and understand the difficulties at each game level. *Understanding* helps to define the user profile and determine the required feedback.

f) Adaptation: Games must be able to bridge the gap between a player´s prior knowledge and that which is presented at different game levels, encourage the player to use this knowledge to pass each level, and enhance the player experience in order to achieve the EVG´s objectives. the improvement of user experience and the success a player has at each game level will enable the player to more effectively achieve the target goals.

g) Accuracy: The degree to which correct and real content helps players to focus on the content provided and obtain new knowledge from the virtual world.

To measure this attribute we can use the amount of assistance (e.g., hints and tutorials) provided throughout the game and analyze player actions, performance and skills based on the knowledge gained during the game.

C. Correlation among Playability Attributes

In this section we examine the correlation among educational playability attributes. For example, if an attribute has a positive value, it will generate a positive experience in all other attributes. This is due to the fact that the attributes are focused within the experience. Thus, the model we present characterizes the player's experience. By studying and analyzing each attribute, the relationship between attributes and the effects that attributes have on one another can be clarified.

1) Satisfaction: This is an indicator of the improvement in player skills and knowledge, indicating the degree to which a player is immersed in the learning and playing process. Satisfaction is related to how well game convinces the player to learn the content presented during the game, and his or her ability to control and master this content. If a player has high level of satisfaction this indicates that he or she does not find the educational content difficult to achieve.

2) Learnability: A low level of learnability means the player finds the game mechanics and game rules easy master. The player therefore plays with high level of satisfaction and is motivated to overcome the game challenges, discover the game objectives and interact with educational content.

3) Effectiveness: An EVG has a high level of effectiveness if the player has discovered and achieved a high number of playful and educational goals, which means the player is satisfied playing a game. It also indicates that the game has provided the learning mechanism correctly in the virtual game world, meaning that a player requires only a low level of educational support to be able to master the dynamics of the learning process.

4) Immersion: An EVG with a high degree of immersion means that the player is easily captivated by the virtual game world, increasing the success of the game and enhancing a player's ability to discover and achieve the educational goals. It also stimulates players to interact with, and thus understand, most of the game content.

5) Motivation: A high level of motivation encourages players to discover new objectives presented in the game. This has an important effect on enriching a player's skills and knowledge, and indicates how well the game manages the relationship between different elements of the game. A high level of motivation also refers to effective mechanisms for supporting players to face and overcome game challenges, and helps to introduce the educational content during the game without players becoming frustrated (embedded learning).

6) Emotion: A high level of emotion provides players with different sensations (e.g., pleasure, boredom, frustration, challenge) that lead them to interact with different game elements. This interaction keeps maintains a player´s motivation to achieve the game objectives. If an EVG has a high level of emotion the player feels more immersed in the virtual world, which helps to introduce the educational content implicitly and provides greater encouragement, motivating the player to overcome a particular educational challenge.

7) Socialization: An EVG with a high level of socialization in a multiplayer environment contains many different educational playability attributes such as: increase the player's ability to achieve the game goals, increase motivation to play and interact with different game elements, help to discover the educational content implicitly presented, reduce the need for game feedback, decrease the probability of recoverability, and facilitate a player's mastering of the learning process.

8) Supportability: A high level of supportability means that the EVG has managed the balance between educational elements and playful elements perfectly. These elements transmit different types of emotions that guide player interaction with the game. It also encourages players to achieve the educational objectives by motivating them to perform specific actions in the virtual game world and helping them to complete as much of the game as possible. High supportability involves a high level of socialization, because an EVG increases collaboration and interaction among players when it helps them to achieve the game goals.

9) Educability: A low level of Educability relates to minimal effort required by players in order to understand the educational content. This means that the game controls, mechanics and rules are clear enough that the player can master them easily, thus ensuring a high level of satisfaction. A low level of Educability helps players to discover the different game resources, and thus increases the effectiveness of the game. It also helps players to control all characteristics of the virtual world, increasing player immersion and motivation. This is due to the fact that players do not need to learn how to play and thus have more confidence to face game challenges. The level of Socialization will be high if the required level of Educability is low in a multiplayer game, because the player does not need to learn the dynamics of a multiplayer game.

D. Revolution, A Case Study of Educational Attributes

In this section our intention is to analyze the video game on American history "Revolution" [39], by using the educational playability attributes proposed in this paper. However, the limitation of this work means we will analyze the game at the educational level using only the educational attributes (Supportability, Educability) "Fig.1".

Revolution is a multi-player game about the American Revolution. The game was designed to teach 18th century social and historical events of the USA, with players taking roles as farmers, slaves, politicians or merchants living in the colonial town of Williamsburg.

1) Supportability: "Revolution" the American history is one of the most captivating educational video games currently on the market. At each level the game presents wonderful graphics, music and narration. The game storyline draws students in, and players do not consciously realize that they are learning a great deal about American history and what colonial life was like in the 1700s.

Revolution uses the relationship between EVG contents to captivate players. As previously mentioned, at each level it presents different elements of the playful content (narrative, graphics, sound and visual effects) along with the historical content (Educational Content).

There is a high level of interaction in "Revolution", whereby every interaction with a character includes an impressive graphical representation of that person in cartoon form. Players have the opportunity to interact with characters by choosing responses at the bottom of the screen.

2) Educational: "Revolution" incorporates the historical content into the game play in an embedded way in order to encourage better retention of the information. Whenever players click on an object, they are provided with important historical information and facts.

"Revolution" includes important historic terms representing facts that students should learn about American history. The game encourages students to click on these terms, read the definitions and "collect" these "smart words". In this way, it ensures the quality of the learning process. "Revolution" helps players to master and understand the historical content by producing a catalog of accessible, fun to play titles that give players some sense of the actual history of a given period, not the myths that have developed around them.

Revolution provides players with an experience of history that includes passionate rhetoric and heroic battle, but also economic frustration, political indifference, and the mundane affairs of everyday life.

Revolution does not directly support Recoverability and error prevention, but does so indirectly through feedback and the information presented to players during the game. Revolution does not adapt the presented content to a player´s skills; it presents a series of easily understood actions and events relating to the social, economic, and political aspects of daily life.

E. Educational Playability Facets

Educational video game and playability analysis is complex enough to warrant being examined from different perspectives. Facets of Playability in video games have been proposed in order to facilitate the analyzing process [11]. Each facet allows the identification of the different attributes and properties of playability that are affected by the different elements of the video game architecture. This means it is possible to manage the process of analysis by taking into account the different video game elements presented in the game.

Playability facets offer different ways of analyzing the playability among the various elements of an EVG. They offer the possibility of interactive level analysis (user interface, menus, and controls), intrinsic analysis (rules, goals, challenges, rewards) or hedonic analysis (emotional, cultural factors). Furthermore, the facets act as a logical subdivision of global playability into more specific playabilities, which together identify the global playability of a videogame. The proposed set of facets is related to video game elements (game core, game engine, and game interface), and ensures the following video game aspects: aesthetic, interactivity, and social.

If we consider playability at the educational facet of an EVG, our analysis will show the main purpose of the game to be educational, with all incorporated elements designed to promote learning. Grouping all educational aspects logically in one facet helps to facilitate the analysis of the educational values presented, and thus facilitate the analysis and design of EVGs.

The overall Educational Playability of a game comes from the value of each attribute in the different playability facets presented. It should be adequate enough that a player's experiences and feelings when playing are the best possible and the most appropriate to the nature of the game. It is therefore necessary to qualify the facets so that they include the educational attributes of playability affecting the educational component of the PX. The Facets of Educational Playability are:

1) Intrinsic Playability: This is the playability inherent in the nature of the videogame itself and how it is presented to the player. It is related to the rules, objectives, pace and game mechanics.

2) Mechanical Playability: This is related to the quality of the videogame as a software system. This facet emphasizes features such as the fluidity of the scenes, the correct lighting, sound, graphics, movements, behavior of the game characters and environment.

3) Interactive Playability: We distinguish two types of interactive playability: educative and playful. Playful is associated with the user interface design, the mechanisms of content presentation and control systems. Educative is related to the supporting mechanism and managing the presentation of educational content.

4) Artistic Playability: This facet relates to the quality of the artistic and aesthetic rendering of the game elements. It is related to the graphic and visual quality, sound effects, story and narrative form and the environment created by all these elements within the game.

5) Educative playability: This is related to the quality of the educational content that is presented in the game and how to execute it. This facet relates to educational content properties such as correctness and suitability to the EVG objectives, player profile, game reality, and accuracy.

6) Intrapersonal Playability or Personal Playability: This refers to the individual outlook, perceptions and feelings that the videogame produces in each player and as such has a high subjective value.

7) Interpersonal Playability or Social Playability: This refers to the feelings and perceptions of users, and the group

awareness that arises when a game is played in a group context, be it in a competitive, cooperative or collaborative way.

IV. CONCLUSION AND FUTURE WORK

EVGs are a pervasive cultural phenomenon. The inclusion of computer games within formal learning is a necessity and should be commonplace.

In this paper, we have analyzed the characteristics that make an EVG useful, in order to analyze its level of effectiveness. We have also demonstrated how we believe the success of an EVG can be assured, based on the Balance, Player Experience and Educational Playability, and drawing on our experience in this field to discuss these three points. We have presented the balance between the educational elements and fun elements as one of the most important aspects of an EVG to affect the PX, and have analyzed what this balance should be. We have also examined the vital role that PX has in video game development, discussing its importance in building successful and effective EVGs. To measure the PX we have used Educational Playability attributes and properties (playability in EVGs). Accordingly, we have defined a set of helpful attributes and properties of Educational Playability that can be used to better understand and analyze the EVG structure.

To facilitate the analysis of Playability, and to guarantee a high level of quality in Educational Playability and improve the PX we have intuitively and explicitly identified the Facets of Playability. These facets can serve as basis for understanding and designing new and better PX in video games. They are also helpful in identifying the elements needed to achieve good overall Educational Playability in EVGs by studying every property in each attribute.

We are currently working to present a catalogue of Design Patterns that includes as many common EVG problems as possible, and propose a new way of benchmarking the efficiency of design patterns by analyzing the role of these patterns to improve and strengthen the PX. We are also working to propose mechanisms for evaluating the PX in EVGs based on the evaluation of Playability. Accordingly, we will be working on specific heuristics and evaluation tools for the field of EVGs.

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