

PLAYABILITY HEURISTICS EVALUATION FOR EDUCATIONAL VIDEO GAMES

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Abstract

Player Experience (PX) is one of the main aspects of the Educational Video Game (EVG), also has been used in the evaluation process of this type of video games due to their complex structure. Playability is a tool to measure and characterize PX, it is therefore necessary to evaluate the playability, to analysis, build or improve the PX. In this paper we present how to use the Playability in evaluating EVGs based on the playability attributes, and the EVG contents.

Index Terms – Playability, Player Experience PX, PX Evaluation, Educational Video Game.

I. INTRODUCTION

Playability in video game is defined as effectiveness, efficiency, flexibility, security and, satisfaction in a playable context of use [3]. EVGs is more playful and educative when they provide an appropriate fantasy, immersion, learn and challenge to capture the players interested, these aspect can be provided in different ways to create a playable and learnable environment. Playability achievement in EVG ensures fun and entertainment to the players, as well as it has a great effect on the PX. Thus players can play with enjoy instead of struggling with the game content, where implausible features of the content can easily frustrate the player and encourage him to quite the game. Recently, much effort has been put to extend playability concepts to investigate (user experience in video game) PX for improving the game design.

In this paper, we present a number of heuristics for playability evaluation that have recently been developed in many previous works. It is therefore necessary to analysis and to complement the existing heuristics. In this sense, we would like to draw the attention to the fact that it is possible to improve the PX based on playability characterization. We thus propose a set of heuristics to evaluate PX related to all EVG aspects. These heuristics cover general playability issues in the EVG (mechanics, challenge, fantasy, etc), and ensure the positive PX. Our heuristics is divided in two groups related to the optimal structure of EVG, and to the playability facets in EVG.

II. BALANCED EVG

As already stated, an EVG is a combination of education and playful, EVGs are controlled by their success as a tool to teach and entertain. EVG success is related to band of factors that balance and educative contents to ensure us getting the best EVGs. This type of video game to be success shouldn't give any content more importance than other, which both contents forms EVG structure and ensure its success or the game fail, balance must reflect as much as possible the player's state (emotional, psychological, etc.). Law [19] presents some problems of current EVG as a poor balance between playing and learning activities or between challenge and ability. Also the lack of sound instructional models, based on pedagogical standards and didactical methods, is seen as the common weaknesses of most EVGs s, leading to a separation of learning from playing. The imbalance between EVG components may lead to a game failure. Here, we can define other reasons for an EVG failure as, unentertaining and uninteresting content, the presented contents aren't suitable for players, game elements and game contents are unrelated and the match between them is arbitrary.

In this work we present our point of view of the relation between EVG components that captivate players and take into account the previous EVG characteristics during the playing time (Balanced EVG):

Dependency: The success of EVG depends on the relationship between educational content and playful content, and how we can present these contents in the game without the domination of any of the two main components to the other during the entire game, or during any game stage, as well as to keep players interested and motivated to play. EVG contents must be provided to support their objectives during all playing time, which means the game success is constrained by the interdependence and integrity between playful and educative parts during all game steps.

Continuity: Keeping the Learning-Fun Relation balanced during all game steps in a way that engages the player. Games that aren't engaging for the player can affect negatively, and time is being wasted. It is therefore necessary to present the educational content implicitly, provide an appropriate content for the predetermined learning objectives and players, keep the game's history, and to keep the contents compliant in terms of goal visualizing and achieving.

Tuning and Consistency: Another factor is keeping the consistency between games parts. It is very important in the design of EVG, and its importance appears through its role in managing Learning-Fun Relation. Here, we emphasize that EVG must contain different goals and objectives (playful and educational) throughout different levels, and the need to a well-structured and carefully-chosen content during the design and structure of game environment.

Completely New: The content should be renewed each time the player plays "different ways to present EVG contents", game must keep player immersed and give him something new, knowledge, experience....etc. This manner with good presentation of game content in simulation to the real life ensures us that EVG will make the player loose sense of time and place.

III. PLAYABILITY AND THE PLAYER EXPERIENCE (PX) IN EDUCATIONAL VIDEO GAME (EVG)

EVG is a world of a special kind, different from the target, design and the presentation manners; vary depending on the user requirements. EVG has defined as “an educational game, one designed for learning, is a subset of both play and fun, it is a melding of educational content, learning principles and computer games” [1].

Current trend in EVG highlights the role of the player in the game structure, and the role of the EVG as a means to entertain and teach players as well as to improve the user experience during playing time. Thus we can say PX is an indicator of the EVG success and that requires measuring the PX. Since learning will be presented through the play, will be important to know which elements of the game are helping or hindering the positive PX. A positive experience was defined as anything that increased their pleasure, immersion, and/or the challenge of the game. To measure the PX we will use the playability properties, which help to measure whether player have fun playing the EVG, and would maintain the player attention and motivation, where an appropriate value for playability allows the player to get a more positive game experience. It is therefore important to define the PX to identify the playability attributes and properties to ensure the optimal PX in EVG. The term PX -based on user experience definitions [17]- refers to “all aspects related to the player that are affected by and interact with the playing environment”, and these aspects representing pragmatic and hedonic features of the process of the interaction such as: sensation, feelings, emotional response, assessment and user satisfaction and the obtained experience during the playing time. PX is focused on whether a player enjoys what they do in the video game, and whether they understand their goals. This can encompass many sub-categories of PX, such as how is challenge and interest is maintained, why and where players give up, and how they understand the game.

IV. PLAYER EXPERIENCE CHARACTERIZATION

Playability has been defined as a special case of usability, or the usability of videogame “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” [2]. In another work, playability defined as “Capability to provide enjoyment for a player over an extended period of time” [18]. This could be interpreted to support a separation of playability and usability, saying that playability is related only to a game’s. EVGs have the reality of being a wonderful way to promote joyful learning, for this fact new playability definition are needed to unify the capability of the game content to provide enjoyment with the possibility to understand and control this content. In [3] playability is presented as “a set of properties that describe the PX using a specific game system whose main objective is to provide enjoyment and entertainment, by being credible and satisfying, when the player plays alone or in company”, and proposed a set of seven attributes to characterize PX, the presented properties in these attributes groups present what the player looking for when playing a game (fun, challenge and curiosity). In the case of EVGs, two fundamental pillars which must be included in the game are fun and education. This indicates the need to adapt and modify the playability attributes. We thus define playability in EVG as “the set of properties that describe the player experience in the gaming environment, the main goal of which is to provide enjoyment and learning in a playable and learnable context for the duration of play, when the player plays alone or in company”.

Thus, playability in EVGs is an extension of playability in videogames. In this way, we have used the definition proposed in video game [3] to achieve the new changes in playability and have therefore identified new attributes and properties, which are suitable for defining playability in EVGs [4]: Satisfaction: the gratification or pleasure derived from playing a complete video game or from some aspect of it. Learnability: the player's capacity to understand and master the game system and mechanics (objectives, rules, how to interact with the video game, etc.). Effectiveness: the time and resources necessary to offer players a fun and entertaining experience whilst they achieve the game's various objectives and reach the final goal. Immersion: the capacity of the video game contents to be believable, such that the player becomes directly involved in the virtual game world. Motivation: the set of game characteristics that prompt a player to realize specific actions and continue undertaking them until they are completed. Emotion: This refers to the player's involuntary impulse in response to the stimulus of the video game that induces feelings or a chain reaction of automatic behaviors. Socialization: the set of game attributes, elements and resources that promote the social dimension of the game experience in a group scenario. Supportability: the ability of an educational video game to keep the player motivated, to teach players/students effectively and encourage him or her to continue learning and achieve the learning objectives. Educative: educational characteristics of the game and the ability of the user to be aware of, understand, master and achieve the learning goals.

EVG has different perspectives that can be used to analyze its structure, this add the complex nature to the playability analyzing. To facilitate the analyzing process the Facets of Playability in video game has been proposed [3], each facet allows to identify the different attributes and properties of playability that are affected by the different elements of video game architecture. In this paper we extend these facets to include the educational playability attributes and to affect the educative part of the PX. The Facets of Playability are: Intrinsic Playability, this is the Playability inherent in the nature of the videogame itself and how it is presented to the player. Mechanical Playability this is related to the quality of the videogame as a software system. Interactive Playability we distinguish two types of interactive playability educative and ludic. Ludic is associated to the user interface design, the mechanisms of content presentation and control systems. Educative is related to supporting mechanism and how to managing the educational content presentation. Artistic Playability this facet relates to the quality of the artistic and aesthetic rendering in the game elements. Educational playability this is related to the quality of educational content that is presented in the game and how to execute it. 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. Interpersonal Playability or Social Playability, this refers to the feelings and perceptions of users, and the group awareness that arise when a game is played in company, be it in a competitive, cooperative or collaborative way.

V. PLAYER EXPERIENCE EVALUATION

The main objective of using EVG is to provide fun and enjoy playing the game, as well as to teach new knowledge and to improve the PX. Game designers created the game content and defined goals that the players must achieve, and the player needs to work towards goals. Accordingly, game should be scanned to

expose and correct as many obvious and critical issues in the game. Once complete, should be moved on to user testing to uncover any problems that the evaluator missed.

A.Heuristics

Heuristics is one of the so-called expert-based usability inspection methods, they are guidelines that evaluators could use, in order to rapidly identify common issues in game design, and they are an efficient analytical and low-cost usability method to be applied repeatedly during a development process. The first attempt at compiling a set of heuristics was done by Jacob Nielsen [6], Nielsen and Molich[7] described the HE methodology as “cheap”, “intuitive”, “requires no advance planning”, and finally, “can be used early on in the development process”.

Games heuristics started when Malone [9] presented his heuristics that mainly focused on educational game and categorized into challenge, fantasy and curiosity. Federoff [10] assessed the applicability of the heuristics to video games area compiled a list of 40 game heuristics from a case study at a game development company which partially based on Nielsen's heuristics, she categorized them into game interface, game mechanics and game play. Garzotto [20] also studied heuristic evaluation for multi players educational games which include three aspects; contents (length, integration), fun (attention, goal clarity, challenge, immersive) and social interaction (group cooperation, competition). An effectiveness evaluation should also include fun elements such as engagement, color and sounds of games, feedback [21] and experience such as cooperation and immersiveness [22]. Song and Lee [8] also compiled key factors of heuristics evaluation for game design and categorized game heuristics on four areas game play is the set of problems and challenges a user must face to win a game; game narrative includes all plot and character development; game mechanics involve the programming that provides the structure by which units interact with the environment; game interface addresses the interface and encompasses the elements the user utilizes to interact with the game.

B. Heuristic Evaluation for Playability

Malliet et al [11] classified the existing playability methods, method that focus on strictly formal aspects of game content [12] and [13], user-experience related aspects such as presence [14] and many researchers have highlighted the mechanisms of interaction between content and player by means of biometric or psychophysiological measures [15]. Desurvire has created the heuristics that are best suited to evaluate general issues in early development phase [12], which were based on the heuristics introduced by Federoff, these heuristics were categorized into four sections: game story, game play, game mechanics and game usability. In 2009 he constructed the Heuristics to Evaluate Playability (HEP) tool, consisting of 50 items that correspond to a wide range of commonly used design patterns [13]. Koivisto and Korhonen [16] presented a framework to evaluate playability of mobile game, which contains heuristics related to game play, game usability and mobility. Nacke [15] have used psychophysiological methods to evaluate the relationship between game content and play experience, his Biometric measures have been applied in the evaluation of aspects such as affective level design, and the relationship between game controls and flow. A set of heuristics conducted by the playability facets has been presented to ask the player about his experience when he playing, trying to distinguish the play elements that improve video game playability [3]

VI. PLAYABILITY EVALUATION FOR EDUCATIONAL VIDEO GAME

The evaluation of the playability through different methods is one of the major topics of PX in video games and by many seen as the optimal experience when playing games. However, EVGs have other aspect which affects the PX is the balanced structure between the EVG components (fun and learn). In that, a good balance between fun challenge and educational objective produces a positive PX. Accordingly, we introduce heuristics to evaluate the playability based on two trends: Balanced EVG Heuristics study the balance properties to present their influence on the PX and the relationship between them. Playability Facets study the playability attributes to determine the game elements that impact more on the PX.

Our evaluation methodology has taken into account the game aspect that relates directly to the proposed characteristics of EVG Balance and Playability. Besides, the proposed heuristics in these two groups have suggested based on our research group experience in the field of E-learning and video game¹.

A. The Proposed Methodology:

An educational video game with collaborative activities called Nutri-Galaxy has been used as example. This game, presents educational goals related to learning function of nutrition, has been developed to run on PC. It is designed for playing in a 2D environment.

1) Procedure: The evaluation process involve in this study will be a heuristics based set of questions that are proposed in two groups related to playability attributes and the EVG structure. The process will be developed in different steps.

- Develop heuristics that addresses the playability attributes based on the balanced EVG structure and playability facets.
- Identify suitable evaluators, real user with different levels of experience.
- Before the start of evaluation, the group of participants will sit for pre-test, which is a set of questions on the video game topic.
- Divide the evaluation process to steps.
- Keep evaluators comments and suggestion to improve the EVG.

2) Evaluators: The participant users are 40 student volunteers from the Master Software Development and other degree course students at the School of Computer and Telecommunications Engineering in Granada, Spain. Participants' ages ranged from 20 to 28 years. Game developers (designers and educators) also have participated in the evaluation process (Evaluators). Thus, we will enrich the process of EVG with various evaluators suggests and comments. According to Sekaran [23], sample size between 30 to 500 is suitable for most of the study.

We worked with different player profiles (game stakeholders) so that the results would be representative of the context of real-life video game use. To obtain the maximum information about PX we used different player profiles: "expert" (a person who is a good player, knows the game platform perfectly and is comfortable with difficult game challenges) and "casual" (a person who plays infrequently and looks for quick entertainment). For our evaluation, we required information about all game players, not only experienced ones, in order to analyze the experience for all possible player profiles.

3) Evaluation Process: The evaluation was carried out in the in a laboratory, in order to observe how people actually interact with an EVG. Players will be grouped in fours and each level must comply with

¹ <http://gedes.ugr.es>

two mini-games (challenges) "Collaborative EVG", one individual and one group in order to advance to the next stage or level. At each level presents patients with nutritional problems more complex and difficult to overcome.

To start this process, educators should explore and ensure the educational content that is presented in the evaluation process. The evaluators' role is to observe the participants players, and record their actions, problems and comments. Besides, evaluators should decide the positive PX and negative PX based on the participants' action and answer to the presented questionnaire. We define a positive PX as any aspect that increases acceptability playability attributes and properties of EVG; a negative PX is any aspect that decreases the acceptability of playability attributes and properties.

B. Balanced EVG Evaluation

The presented balanced EVG factors ensure the balance between EVG components and present the importance of PX, in that they keep the player interested and motivated. It is therefore important to present the effect of this balance on the PX. We thus present heuristic to evaluate the effect that the balanced EVG has on PX based on playability attributes and properties, the presented heuristics derived from the analysis and discuss the observations. Some of our heuristics are shown in table I.

TABLE I. SOME EXAMPLE OF HEURISTICS TO EVALUATE THE BALANCED EVG.

| Balanced Education Game Playability Heuristics |
|---|
| Dependency |
| Fun-learn are the explicit game goal. Balancing the presentation focuses on educational and playful content. The presented balance make the EVG easy to use and difficult to master. Educational objectives are related to fun challenge. Balance between reinforcement and redundancy. |
| Tuning and Consistency |
| The EVG interface elements are integrated. The relation between games elements is recognizable. Game presents efficiency in visualization the element situation. Game use perfectly the fun elements presentation to overcome the game challenges. Game provides an appropriate playful content to include the educational objective. |
| Continuity |
| The game goal should be clear in all game stages. The game doesn't lose the balance that presented early through the game. The different elements consistency is kept in all steps. Keeping the Aesthetic, Playful and Educational |

| |
|---|
| aspects. The balance changes based in the game progress without lose the game attractiveness. |
| Completely New |
| Capture the player attention during the game to specific objects. The balance presents new experience without any negative aspect. Game supports variety representing styles of EVG elements. Encourage players to integrate the obtained knowledge. The effect of being able to display mastery in the game related to something attractive. |

C.Heuristic Evaluation for Playability in EVG

To evaluate the playability in EVG we suggest using a qualitative evaluation method by using heuristics according to the playability facets. Playability facets offer different viewpoints to analyze the playability between the various elements of EVG. They offer the possibility of interactive level analysis (user interface, menus, and controls) or intrinsic (rules, goals, challenges, rewards...) or hedonic analysis (emotional, cultural factors...) [5], [3]. The presented set of heuristics is conducted by the playability facets. In this way, the player gets the valuation as soon as possible by asking the player about his experience when playing. This way gives us the possibility to know the play elements that improve the EVG playability. Some examples of the proposed heuristics are shown in table II.

TABLE II. SOME HEURISTICS TO EVALUATE THE PX IN EVG.

| Playability Facets | Evaluation Heuristics |
|-------------------------------|--|
| Intrinsic Playability | Game content is fun and interest for the player. Each level has different fun challenges and educational objectives. Game provides the player with a recognizable environment structure to play without needing any additional help. |
| Mechanical Playability | Game supports and encourages the player during the game cycle to pass a specific challenge. Game allows players to interact with various elements of the world virtual. Game provides different manners to |

| | |
|----------------------------------|--|
| | pass the game challenges. |
| Interactive Playability | Game Audio/Visual elements are consistence with the game challenges. Game story and the sequence of events during the game are fun and attractive. Game relates the educational elements to the playful ones in each level. |
| Artistic Playability | Games Audio/Visual elements are attractive and capture the player attention. Game Ensures an aesthetic consistency between playful and educational elements. Game presents the player score and his current knowledge in funny manner. |
| Educative Playability | Game provides an appropriate content for the predetermined learning objectives and players. Game presents a valid, reliable, and credible content. Game educational content is clear and suitable to the player. |
| Intrapersonal Playability | The spent time to play and to entertainment are high. The obtained knowledge and skills are high. The passed game levels are high |
| Interpersonal Playability | Game presents the same level of difficulty to all players. Game allows easy modification and adaptation depends on the players' number playing at the same time. Game provides a consistent educational content to all players. |

VII. THE RELATION BETWEEN THE TWO EVALUATION DIMENSIONS

In this paper we have suggested a new way to evaluate Playability based on two dimensions. Our first dimension is designed to interact with a balance between play elements and fun elements. Besides, the balance is a very difficult aspect of EVGs to evaluate in the traditional heuristics [11]. The balance presents different aspects of EVGs structure; the degree of immersion, satisfaction and motivation that EVGs transmits in players, as well as to present the game ability to provide content curiosity, attractiveness and correctness.

Our second dimension Playability Facets provides us with the effects of EVGs elements on the different playability attributes and properties. Thus, these two dimensions have complementary effects of each other. The first one presents how a good EVG structure ensure the quality of playability attributes and properties, while the second dimension present the effects of a good playability on improving the PX. Thus, a high evaluation degree of these two dimensions will enhance the EVGs design process and ensure the quality of the EVG content.

VIII. CONCLUSIONS

EVG is an attractive environment to provide players with new skills and knowledge. However, currently there are many researches to study the usability and playability of the EVG, which emphasize the importance role of PX evaluation to develop a success EVG. In this paper we have introduced several heuristics to evaluate the Player Experience by using the Playability based on two dimensions.

We have defined a set of very helpful and meaningful attributes and properties of Playability in EVGs that can be used to better understand and analyze the structure of EVG. Besides, we have identified diverse facets of Playability in a very intuitive and explicitly way, all of which can be served as basis for understanding and designing new and better User Experience in video games.

We present one of the most important aspects is the balancing between the leaning elements and fun elements of the game, and we analyzed how it should be. Furthermore, to evaluate the PX by using playability, we have presented two groups of heuristics the balanced educational game playability heuristics and heuristics evaluation for playability in EVG, which can play an essential role in developing "success playable and learnable" user experience in video games. Our study will provide good results, due to the fact that many evaluator types have participated in the evaluation process. Thus, we the results will provide valuable suggestions that can improve the EVG design. Besides, the proposed sets of heuristics are designed to be appropriate to EVG structure, all of which can provide new guidelines for evaluations specifically developed educational games.

Currently we are working to develop taxonomy for design patterns based on the playability in the educational framework. In this context, we have to analyze the most common challenges in EVG and propose standards which indicate what they are, how they apply and which elements of the PX positively motivated. We are also developing a set of guidelines for EVG, related to the PX and playability, and to study the effect of applying these guideline on achieving the optimum playability and PX.

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