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USING PLAYABILITY HEURISTICS TO EVALUATE PLAYER EXPERIENCE IN EDUCATIONAL VIDEO GAMES

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ABSTRACT

Educational video games (EVG) provide a rich platform to improve the Player Experience (PX), and constitute some of the main edutainment applications currently in the market. However, the evaluation of video games as educational tools is very difficult due to their dual nature (fun and education). In some cases, PX (as an usability measure) is a very important aspect of the EVGs and is a good measure of the level of fun and education presented to players. Educational Playability (playability in EVG) attributes are a suitable and effective tool to analyze and measure the experience obtained by a player during a game. To this end, it is necessary to evaluate the playability to determine the degree of improvement in PX. Playability evaluation through different methods is one of the major topics of PX in video games. In this paper, we present a new approach to evaluate the PX by using the educational playability.

Keywords—*Heuristics, Player Experience PX, Playability, Educational Video Game EVG.*

1. INTRODUCTION

Playability in video games is defined as effectiveness, efficiency, flexibility, security and, satisfaction in a playable context of use (González Sánchez, 2011). EVGs are more playful and educative when they provide an appropriate fantasy, immersion, learn and challenge to capture the players interested. These aspects can be provided in different ways to create a playable and learnable environment. Since a long time, efforts started to investigate augmented EVG that are bridging the gap between video game and E-learning systems. This new type of hybrid games opens a wide variety of possible entertainment and edutainment systems. Recently, much effort has been put to extend playability concepts to investigate PX to improve the game design. Thus, the need to evaluate the playability and PX of the designed EVGs increases. PX is a very important aspect of the EVG. Evaluating this experience is a great challenge due to the complex structure of EVG. Playability attributes is a suitable and effective tool to analyze and measure the experience obtained by a player during a game. Although a number of heuristics have been developed in many related works,

In this article 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. In this paper we present how to evaluate the PX by using the Playability based on two dimensions, the playability attribute, the balance between the EVG contents (fun and learn). We will analysis all aspects of these dimensions to know their effects on the PX.

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2. PLAYABILITY HEURISTICS IN VIDEO GAMES

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. Heuristics are one of the so-called expert-based usability inspection methods; they are guidelines that evaluators can use in order to rapidly identify common issues in game design. The first attempt at compiling a set of heuristics was done by Jacob Nielsen (Nielsen, 1994). He described the heuristic methodology as "cheap", "intuitive", "requires no advance planning", and finally, "can be used early on in the development process".

Games heuristics started when Malone (1982) presented his heuristics that were mainly focused on educational game and categorized into challenge, fantasy and curiosity. He aimed to develop an enjoyable interface.

Garzotto (2007) also studied heuristic evaluation for multi players educational games that include three aspects; contents (length, integration), fun (attention, goal clarity, challenge, immersive) and social interaction (group cooperation, competition) (Paavilainen et al, 2018).

Currently, many of heuristics have been developed specifically for video game analysis. Livingston et al (2010) grouped current heuristics into three categories: (1) usability, (2) playability, (3) a combination of both. In contrast to Nielsen's heuristics, which were developed for user interface analysis, game usability heuristics apply to the usability of the gameplay.

Heuristic Evaluation for Playability (HEP) applies to the dramatic and formal elements of games. Playability heuristics might be applied to problems with the game narrative or to player fatigue. Playability heuristics are based on the current literature and they have been reviewed by several playability experts and game designers. Malliet et al (2010) classified the existing

evolution playability methods, methods that focus on strictly formal aspects of game content, methods that present user-experience related aspects such as presence, and methods that highlight the mechanisms of interaction between content and player by means of biometric or psychophysiological measures (Nacke, 2009).

Federoff (2002), in her research of game heuristics, listed issues related to game interface, game mechanics, game mechanics and game play. Federoff's heuristics are quite broad, but they are not comprehensive, not described in detail, and none of them refers to the social aspects of video games. We are specifically interested in problems pertaining to playability in EVGs.

Desurvire et al (2004) created the heuristics that are best suited to evaluate general issues in early development phase, discussed four game heuristic categories: game play, game story, game mechanics, and game usability. In 2009 Desurvire presented heuristics that place a strong emphasis on engagement, with limited coverage of usability issues, which were based on the heuristics introduced by Federoff. We consider that heuristics proposed by Federoff and Desurvire are relatively vague, difficult to be implemented in the game design process, very general, and strongly oriented around engagement and fun, without much considering of playability in much detail.

Pinelle et al (2009) presented usability heuristics for video games that focus on Game usability which "does not address issues of entertainment, engagement, and storyline, which are strongly tied to both artistic… and technical issues". These heuristics were validated by evaluating single and multiplayer PC games and the multiplayer heuristics were compared against groupware heuristics in a user study. This model only addresses usability issues, which involves considering other models for evaluating engagement and fun.

Koeffel et al (2009) attempted to create a comprehensive list of heuristics from those found in literature, to assess the collection's effectiveness using a comparison to video game reviews, and implemented 10 additional heuristics from earlier study concerning advanced table top games.

Livingston et al (2010) have presented preliminary work into a novel game evaluation technique, which uses usability data mined from game reviews and the genre of the game being evaluated to weight the severity of problems identified during a usability evaluation.

Nacke (2009) 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.

Nacke also proposed a practice- oriented model that focused on describing play testing in game development, presenting three types of game

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usability evaluation: evaluations of technology (i.e., system quality), evaluations of player (i.e., gameplay quality), and evaluations of community (i.e., social quality).

As we have highlighted in this section, most of the previous works don't cover all the aspect of video game as a tool for fun and entertainment. The following table (Table 1) has been developed to summarize the different works of heuristics.

Table 1. Heuristics Evaluation in Computer Game

Author / Year	Description
Malone, 1982	Developed a set of guidelines to design enjoyable interfaces based on the study of educational games
Clanton, 1998	Developed a set of game design principles. He conducted an informal inspection of several games and his principles were based on that. Clanton's design principles focus on how computer games can be designed to engage users.
Federoff, 2002	Studied on three areas of computer games; game interface, game mechanics and game playability and compiled a list of game heuristics that consist the three areas.
Desurvire, 2004	Developed Heuristics for Evaluating Playability (HEP).
Korhonen, 2006	Developed playability heuristics for mobile games, based on the demand and popularity usage of mobile games. His heuristics focuses on three areas; game usability, mobility and game play.
Song and Lee, 2007	Compiled key factors of heuristics evaluation for game design and categorized game heuristics on four areas; game interface, game play, game narrative and game mechanic.
Schaffer, 2007	Released a white paper introducing a new version of heuristics. He provides a set of detailed heuristics with graphical examples for each heuristic.
Pinelle, 2008	Developed heuristics evaluation for video game design that adapts usability inspections for games. His heuristics are specifically focused on game usability and it was based on a structured analysis of usability problem from a large number of games.
Nacke, 2009	Developed methodologies and tools for evaluating player emotion and cognitive processing in real-time.
Koeffel et al. , 2010	Created a list of heuristics, and assessed the collection effectiveness using a comparison to video game reviews.
González Sánchez, 2011	Presented heuristics conducted by the playability facets to ask players about their experience when they are playing, trying to distinguish the play elements that improve video game playability.

3. EDUCATIONAL VIDEO GAME EVALUATION

The evaluation of the playability through different methods is one of the major topics of PX in video games, and is useful to achieve the optimal experience when playing games "the phrase 'user experience' might be a broader, more accessible term that could serve as an umbrella to describe all three areas of game usability (game interface, game mechanics, and game play)" (Federoff, 2002).

EVG evaluation involves others aspects that affect the PX such as the balance between the educational and playful contents, which positively effects on PX; and the success of the implemented learning process that improves player skills and knowledge. Accordingly, it is clear that the evaluating of EVGs is more difficult than normal video games due to its complex structure, which involves taking into account evaluating EVGs as a video game, as well as to evaluate them as learning tools. Thus, we will evaluate an EVG as a game that looks for entertaining and teaching players, which involves the participation of designers, educators, playability experts, and players. To evaluate EVGs we will use a set of heuristics related to the playability facets and the balance structure of EVGs. As well as to present a learning process questionnaire that evaluates the learning process aspects and their role to develop PX.

In addition to the previous techniques we will use pre-test (Identify appropriate players to participate in the evaluation), and post-test (identify the gained experience of game content, objectives and tasks), these tests determine the percentage of the player knowledge development. Also we will use a cognitive walkthrough which is an inspection; its emphasis is on tasks. The idea is basically to identify users' goals, how they attempt them in the interface, then meticulously identify problems users would have as they learn to use an interface. The method was also introduced at the same conference as Heuristic Evaluation. In other words

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a cognitive walkthrough is a formalized way of imagining people's thoughts and actions when they use an interface for the first time.

As we have mentioned, the evaluation of EVGs is very difficult due to their dual nature (fun and education). Thus, we need different profiles of evaluators to evaluate an EVG (educators, game designers, playability specialist, players). The lack of good reviews of current EVGs leads us to let reviewers examining and analyzing some EVGs based on the suggested characteristics of EVGs and playability attributes (Ibrahim et al, 2012). Also, we will give evaluators the possibility to define some playability problem during the evaluation process, and to relate them to playability attributes.

In this work we will present some EVGs problems as shown in Table 2. These problems have been found by analyzing some EVGs (WolfQuest[1], Mavis Beacon[2], Storm Tracker[3], Math Missions[4]). We have relate these problems to the main dimensions of our methodology and to playability attributes.

Table 2. Playability problems categorization and description

Problem Category	Subcategory	Problem Description	Playability Attribute
Playability Facets	Educative Playability	Bad presentation of the educational content;	Effectiveness
	Artistic Playability	Educational objective are unrelated to the playful elements.	Supportability
	Interactive Playability	Doesn't provide a suitable content based on the player profile.	Educability
	Mechanical Playability	Repeat the same game elements in different levels.	Supportability
	Intrinsic Playability	Provide the same challenge with high level of difficulty.	Immersion
	Intrapersonal Playability	The proposed levels of motivation don't encourage players to learn and play for a long time.	Satisfaction
	Interpersonal Playability	Weak interaction when players are playing in groups.	Socialization
Balanced EVG	Interdependency	The educational goal is un clear to players.	Educability
	Consistency	Game content is hard to achieve by players.	Learnability
	Completely New	The same player´s profile plays the same level many times with the same game elements.	Motivation

[1] http://www.wolfquest.org/
[2] http://www.mavisbeacon.com/
[3] http://www.jason.org/public/whatis/start.aspx
[4] http://www.superkids.com/aweb/pages/reviews/math/03/arcade35/merge.shtml

3.1. Heuristics of balanced EVG

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, taking both engagement and learning into account. 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 et al (2008) indicate 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. Accordingly, we can consider success of an EVG is related to its success as a tool to teach and entertain. We believe the success of an EVG is related to a number of factors that balance the playful content and educational content.

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To characterize the relationship between EVG components we have presented new aspects (Ibrahim et al, 2012 and Ibrahim, 2017):

- Interdependency: Managing the EVG contents (educational and playful) without either one dominating at different stages. It also depends on keeping players interested and motivated to play. 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.
- Continuity and Consistency: Introducing an appropriate contents, and different objectives and challenges throughout the different levels. Keeping the Learning-Fun Relation balanced during all game steps in a way that engages the player. EVGs that are not engaging can negatively affect players as their time will not be utilized effectively. 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. "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"
- Completely New: using different ways to present the EVG contents. EVG contents should be changeable 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 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 describe how to present and to manage the relationship between the educational content and the playful content throughout the different levels, as well as to manage the suitability between the prior knowledge of the player and the knowledge presented by the challenges in the game. 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.

To evaluate the balanced structure of EVG we have developed heuristics that take into account the problem proposed in Table 2, educational playability attributes, and the characteristics of the EVG (Ibrahim et al, 2012). Also, theses heuristics are derived from analyzing and discussing the observations, and the presented work of EVG design (Guidelines, Design Patterns…) (Pivec & Kearney, 2008 and Kiili, 2009); these works have discussed video games as learning tools and presented the problems that have faced game developers and designers from different perspectives. Some of our proposed heuristics to evaluate the balanced structure of EVGs are shown in Table 3.

Table 3. Some of the heuristics to evaluate the balanced EVG

Balanced EVG Properties	Balanced EVG Heuristics
Interdependency	Fun-learn are the explicit goal of EVGs. Balancing the presentation of EVG elements focuses on educational and playful contents. The presented balance makes the EVG easy to use and difficult to master. Should relate the educational objectives to the fun challenge. The balance between reinforcement and redundancy shouldn't hinder players to reach the target goal.
Tuning and Consistency	The EVG elements are integrated in the player interface. The educational elements should be designed in a way the educational challenges satisfy the expectations of the player and the context of the game. Game presents efficiency in the visualization of 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 supported by the entirety of the game. The game doesn't lose the balance

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	that presented early, throughout the game. The consistency between different elements is kept throughout the different game stages. Keeping the Aesthetic, Playful and Educational aspects that make the game comfortable to play. The balance changes based on the game progress without losing the game attractiveness and challenges.
Completely New	Capture the player attention during the game to specific objects. The balance presents new experience without any negative aspect. Game supports several representation styles of the EVG elements. Encourage players to use and integrate the obtained knowledge during the previous levels to overcome the game challenges. The effect of being able to display mastery in the game related to something attractive.

3.2. Heuristics of playability facets

We have previously explained that educational playability isn't limited to the fun objectives, but also takes into account the educational objectives to reinforce the player skills and improve his/her current experience (González Sánchez et al, 2011and Ibrahim et al, 2012). We have presented nine attributes to characterize the educational playability: Supportability, Educability, Satisfaction, Learnability, Effectiveness, Immersion, Motivation, Emotion, and Socialization.

EVGs and playability analysis is complex enough to warrant being examined from different perspectives. Accordingly, we have proposed the Facets of Playability in order to facilitate the analyzing process (Ibrahim, 2012 and Ibrahim et al, 2012 and González Sánchez, 2011). Each facet allows the identification of the different attributes of playability that are affected by the different elements of the video game architecture. Furthermore, we present these facets as a logical subdivision of the overall playability in a little more specific playabilities, which together identify the overall playability of the video game.

The proposed set of facets is related to video game elements (game core, game engine, and game interface), and ensures the video game aspects: aesthetic, interactivity, social…etc. These facets cover the educational aspects and they are able to analyze and manage the educational content though the game structure.

Playability facets offer different viewpoints to analyze the playability of 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 aspects (emotional, cultural factors…). These facets are:

- Intrinsic Playability: is related to the rules, objectives, pace and game mechanics.
- Mechanical Playability: is related to the fluidity of the scenes, the correct lighting, sound, graphics, movements, behavior of the game characters and environment.
- Interactive Playability: We distinguish two types of interactive playability. Educative: is related to the supporting mechanism and managing the presentation of educational content; Playful: is associated with the user interface design, the mechanisms of content presentation and control systems
- Artistic Playability: is related to the graphic and visual quality, sound effects, story and narrative form.
- Educative playability: is related to the educational content correctness and suitability to the game objectives, player profile, game reality, and accuracy.
- Intrapersonal Playability: is related to the individual outlook, perceptions and feelings of each player
- Interpersonal Playability: is related to the feelings and perceptions of users in a competitive, cooperative or collaborative way.

To evaluate EVGs we suggest a qualitative evaluation method by using heuristics according to the playability facets. Playability facets offer different viewpoints to analyze the playability of the various EVGs elements. They offer the possibility of interactive level analysis (user interface, menus, and controls), intrinsic (rules, goals, challenges, rewards...) and hedonic analysis (emotional, cultural factors…).

Our proposed heuristics are related to the problems in Table 2, and based on the educational playability attributes (Ibrahim et al, 2012, Ibrahim 2017). These heuristics are harvested from analyzing and qualifying the presented playability heuristics in first Section. The proposed heuristics are divided into groups:

- The first group will be realized by evaluators in phase 1, and by evaluators and players in phase 2 (phase 1, 2 are explained in section

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7.4). This group aims to evaluate the educational playability in general (playful and educational playability attributes) to determine whether a game is fun and learnable or not from the playful standpoint (table 4).

- The second group will be realized by educators to evaluate the educational playability ability to integrate the educational content and provides a good EVG from the educators´ point of view (table 5).

Table 4. Some of our heuristics to evaluate the educational playability in EVG by evaluators

Playability Facets	Evaluation Heuristics
Intrinsic Playability	Game content is fun and interesting 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 personal 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 and to execute the relative action by themselves. Game doesn't provide repetitive and boring 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 way.
Educative Playability	Game provides an appropriate content to the predetermined learning objectives and to players' skills. Game presents a valid, reliable, and credible educational content. Game provides the players by educational Feedback and Feedthrough when appropriate.
Intrapersonal	The played time with fun is high.
Playability	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. Communication and interaction ways between players should be supported by the entirety of the game.

Table 5. Some of our heuristics to evaluate the educational playability in EVG by educators

Playability Facets	Evaluation Heuristics
Intrinsic Playability	Have specific educational goals Adequacy of learning elements Recognizable educational elements
Mechanical Playability	Inserting and managing alternative learning paths Managing users' profiles Modality of fruition of an educational content
Interactive Playability	Mechanisms exist to prevent usage errors Personalization of the educational content Educational rewards based on educational content achievement
Artistic Playability	Graphic layout (educational graphic) Organization of an educational content Adaptation of the graphical aspect to the playful context of use is provided
Educative Playability	Educational feedback in the different game levels Educational content suitability to the player age Support for flexible content organization
Intrapersonal Playability	Player able to integrate the provided educational content in the game Modality of fruition of an educational content Insert assessment tests in various forms and different levels
Interpersonal Playability	Presence of communication mechanism Usage of communication mechanism Mechanism exists to present the educational content to all players

3.3. Learning Process Evaluation

Learning process has an important impact on game design as it allows the game developers to know exactly how it will bring positive results to

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the game. The importance of learning process evaluation to the EVGs has been evident, but what is becoming increasingly clear is that those who are expected to use evaluation process recommendations for improving performance should participate in the different steps of evaluation process.

Learning process assessment is related to players and educators who will be participated and be responsible to ensure the quality and efficiency of this process. However, the performance of learning will be enhanced by the degree to which players will be entrusted with the implemented learning process, and thus they become the motivated learners, and are able to translate into action what they have learned throughout game progress. To be effective, our evaluation processes need to respond to this requirement.

Learning process in EVGs and E-learning systems are similar to some degree, which both aims to teach players/learners, improve current skills, development players/learners knowledge, and meet players/learners needs. In the following we will criticize and indicate the possibility of using some factors to evaluate the learning process in EVGs.

- Result: main objective of EVGs as edutainment systems is improving, rebuilding players' prior skills, knowledge and information. Result is a reflection of higher level of player satisfaction and interaction in the learning process, which is an important component for promoting and sustaining motivation in the learning process.
- Performance: the primary purpose of learning process in EVGs is to improve results by having its players learn new skills and knowledge and then actually applying them to during the game levels to pass the different educational challenges. Since performance measurements must take place when they are playing, the measurement will typically involve educators, and observers who are involved with the players.
- Learning strategy: the success of learning process in EVG is related to some extent to players' knowledge improvement, skill development, and attitudes changing. Measuring the learning content that is implemented is important in order to validate the learning objectives. We can relate this factor to the required learning to be implemented, the acquired knowledge and skills enhanced.
- Motivation: is a critical component to evaluate learning process. Motivation is important in getting players to engage in learning process activities. It is also important in determining how much players will learn from the activities they perform or the information to which they will be exposed to. Players who are motivated to learn something use higher cognitive processes in learning about it. Motivation to do something can come about in many ways.

4. THE METHODOLOGICAL APPROACH OF EVALUATION

In this section, we give an overview of the several steps of the proposed evaluation methodology. Our methodology consists of three phases (figure 1):

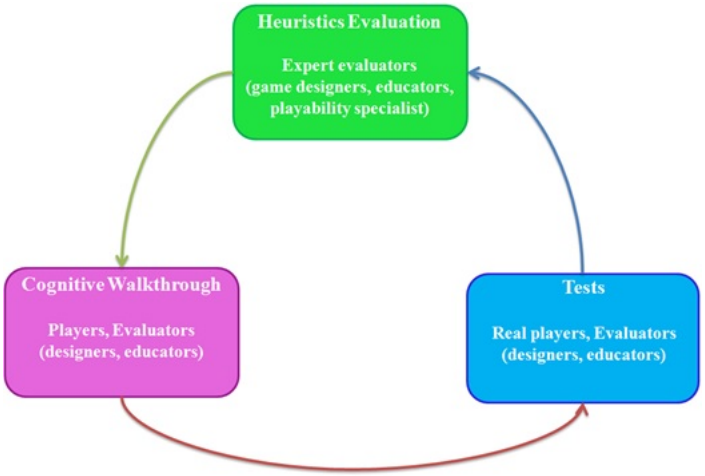

Figure 1: Phase of the evaluation methodology

- Phase 1: Heuristics evaluation of the defined playability problems. This phase will be useful to filter the largest number of potential playability issues before making a test with players. This phase will be done by expert evaluators (game designers, educators) to discuss these playability problems from playful and educational perspectives.
- Phase 2: A cognitive walkthrough. After the filtration of the maximum number of the defined problems in phase 1 player will participate in this phase. Phase2 is mainly based on player participation and observation by evaluators (educators, designers, and expert players). This phase aims to produce playable prototype with the minimum number of playability problem, and thus reaching a high level of player satisfaction of the proposed game.

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- Phase 3: Tests. Real users will be participated in this phase. This phase aims to ensure high quality playable game. The objective of this phase is to evaluate the different tasks of the game by real user under the observation of the evaluators.

4.1. Procedure

The evaluation process involves in this study will be questionnaire, heuristics and tests based on a set of questions, which are related to the three phases that form our methodology. We have mentioned above to the players role in this methodology. Thus it is important to identify the player profile (gender, age, and education. Also we need information about the experience of playing, amount of time of playing, quantity of games, platform of games and type of games played).

4.2. Evaluators

We select ten Game evaluators, who must be experienced in the area of EVG, playability and PX (five of them should be educators). Designers, educators, and playability specialists should participate in the evaluation process; educators' participation is vital to evaluate EVGs from educational perspective. These different backgrounds of evaluators is useful to the dual nature of EVGs (fun, education).Thus, the process of EVG evaluation will be enriched with various evaluators suggests and comments.

The participant users are 30 player volunteers, those have a good background of video game, and they have played different genre of the current video games. The participants must be females and males to avoid gender-specific ambiguities. We work with different player profiles (game stakeholders) so that the results would be representative of the context of the EVG use. To obtain the maximum information about PX we used different player profiles: 'Hardcore' (a person who is a good player, knows the game platform perfectly and is comfortable with difficult game challenges), 'Casual' (a person who plays infrequently and looks for quick entertainment) and 'Mid-core' (person how is between casual and hardcore player). The proposed evaluation procedure will require information of all game players, not only experienced ones, in order to analyze the experience for all possible players' profiles

4.3. Evaluation process

The evaluation should be carried out in a laboratory, in order to observe how players actually interact with EVGs. To start this process, players will be selected based on the required skills for each phase of the evaluation method. The proposed heuristics in phase1will be presented and explained to the evaluators by an expert evaluator. Educators will observe participants playing the game, as well as to do the pre-test and post-test to know the obtained knowledge by players after playing the game. Due to the high number of participants in this evaluation methodology we must to state, that generalization of the result will be possible.

The evaluation process starts with the verbal introduction, which helps participants understand the game and the heuristics goals better. Evaluation will be done individually by the evaluators at the same time. After playing the game, evaluators should explore and ensure the educational content that is presented in the evaluation process, each evaluator will obtain a sheet of paper that shows the heuristics (Table 6, and table 7; and must fill Table 6. Evaluators should present and comment all problems that they will find that are related to the heuristics categories. In addition, the evaluators have the possibility to add further problems to the list. Also, the evaluators' suggestions for improvements for the game will be collected to improve the design phase.

The evaluators' role is giving severity to the game problems, relating each problem to playability attributes; determine the frequency and the impact of each problem, also they must mention in their reports to the usefulness or the difficulty of using the proposed heuristics. Besides, evaluators should decide the positive PX and negative PX based on the presented questions. We define a positive PX as any aspect that increases acceptability of playability attributes and properties of EVG; a negative PX is any aspect that decreases the acceptability of playability attributes and properties.

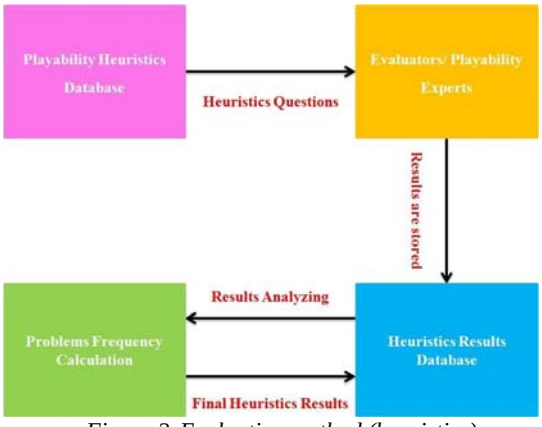

Figure 2: Evaluation method (heuristics)

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Following this step, to obtain meaningful result, evaluators will answer and discuss the given result of the proposed heuristics to eliminate any miss understanding during the process. Then, for each playability attribute we will count the number of problems that will be found using each heuristic, and we will calculate the severity ratings that will assign to each problem (figure 2).

To register all the previous aspects of the evaluation process we will use the following tables (table 6).

Table 6. Playability problems registered by evaluators

Heuristics Dimension	The Affected Playability Attribute	Problem Description	Frequency	Severity Rate
Playability Facets				
Balanced EVG				

This table will be filled by each evaluator, and is designed to meet the parameters and possible values for the answer to each question. The first column show the heuristics dimension (balanced structure, pliability facets), the second is the related attribute to each problem, third column is to describe problem, then impact and frequency columns, and the severity rate of each problem. To present the final report of the evaluation process we propose Table 7.

Table 7. Final report of playability problems

Problem	Playability Attribute	Total Problem	Severity Rate

This table is to present the result of all evaluators. The first column shows the playability problems, the second is the related playability attribute, the third column presents the total number of each problem, and the forth shows the mean severity.

5. 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 EVGs, which emphasize the importance role of PX evaluation to develop a success EVG.

In this paper we have introduced several heuristics to evaluate the PX. We have presented one of the most important aspects of EVGs the balance between the educational and playful elements of EVGs. To evaluate the PX by using playability, we have presented two groups of heuristics based on the balanced structure of EVGs and the playability facets, which can play an essential role in developing "success playable and learnable" user experience in EVGs. To propose this set of heuristics, we present and analyze a number of research proposals related to the evaluation techniques of the playability, the heuristics that have been developed recently, and how to avoid their weaknesses.

Our study will provide good results, due to the fact that expert game designers and playability evaluator are participating in the evaluation process. Thus, the evolution result will provide valuable suggestions that can improve the EVG design. Also, the proposed sets of heuristics are designed to be appropriate to EVG structure, all of which can provide new guidelines for evaluations specifically developed for EVGs.

Currently we are working to analyze the result of applying the method on several EVGs to build a complete catalogue of playability problems, which will help us to develop an extended set of heuristics taking into account the different profiles of evaluators (educators, game designers…). Also, we are working to develop our proposed method not only to be an evaluation methodology but also to be a good tool to filter the largest number of potential playability issues before making a test with users.

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