Educational Video Game Design Based on Educational Playability: A Comprehensive and Integrated Literature Review

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Abstract—**Design techniques can have an important effect on how video games teach and players learn. The ability to harness these techniques in the design of educational video game can impact the motivation and engagement of playing and learning by creating more options for players to connect with game content as well as to other players. This article focuses on the design phase of the game development process and highlights the role of some techniques that can be used to design a successful educational video game (guidelines and design patterns). These techniques provide information on good practice and form a basis for evaluating the educational video game quality, acting as useful tools for developers to enhance video game playability. To this end, we have presented a set of guidelines and design patterns in order to provide an acceptable level of playability and, in this way, a better player experiences and learning achievement.**

Keywords- Playability; Player Experience PX; Educational Video Game EVG; Guidelines; Design Pattern.

I. INTRODUCTION

There has recently been a great deal of interest in using and designing games for education, integrating education and game design in order to grabbing the players' attention and maintaining attention over long period of time. Accordingly, we must understand the structure of games and use this in teaching, and meeting the needs and player requirements due to the different profiles of the players on the market. Designing successful Educational Video Games (EVG) requires ensuring their fun and educational aspects and the different design perspectives (artistic, ludic, social, etc), also, requires design techniques that ensures the Player Experience (PX) improvement and provides an appropriate level of fantasy, immersion, learning and challenge to engage players. A poorly designed game or a bad choice of game elements (story, challenges, puzzles, etc.) means that the player spends more time ascertaining how to play than in achieving the objectives of the content provided [3].

In this work, we aim to use guidelines and design patterns techniques, in addition to take into account the playability concept in EVG due to its capability to ensure fun and entertainment of the game, as well as the effect that playability has on PX, and its role to improve the quality of game design [33][34]. Using playability and video game guidelines are useful in order to ensure player satisfaction, and to ensure the development of an effective EVG both from educational and fun standpoints. Also, using design patterns is appropriate as an effective model to support the design and analysis of EVGs so that the video game experience and the efficiency of the learning process may be improved. Our proposal gathers together what is suitable and useful for EVG design (rules, gameplay, PX, etc.) from a set of works that relate to different video game genres, interactive systems, hypermedia systems and multimedia systems.

Following this introduction, in Section 2, we discuss some studies of EVGs design; present the different design technique of EVGs. In Section 3, we present a definition of Educational Playability, in addition to present an analysis of the relationship between playability in EVG and the presented design techniques (guidelines, design patterns), and define the importance of guidelines and design pattern in the design of EVGs. In Section 4, we present our set of playability guidelines and playability design patterns. Finally, we present our conclusions in Section 5, followed by our references.

II. EDUCATIONAL VIDEO GAME DESIGN: RELATED WORK

Many researchers have discussed the use of video games as useful educational tools to improve learning and performance, and they have attempted to provide a set of techniques for EVG design. In this section, we propose some researches that have been realized to provide norms and rules during the design process, which can be useful as a base to introduce a suitable and a high quality set of guidelines and patterns for the design of EVGs.

Malone and Lepper [68] provided that endogenous integration of educational content into games enhanced learner motivation. In a well-developed educational game experience, "some integral relationship [exists] between the instructional content and motivational embellishments". Prensky [44] outlined the principles of good game design in his book, Digital Game-Based Learning. These principles are the heart of what makes digital video games so engaging and addictive. Prensky predicts that games will be "much more realistic, experiential, and immersive" and include "more and better storytelling and characters". He has argued that video games can help provide such a context for learning. Prensky highlighted several relevant concepts that characterize video games: rules, goals, outcomes, feedback, competition, story,

challenge, opposition, problem solving, interaction, and representation.

Kasvi [29] listed the seven requirements suggested by Norman [22] for an effective learning environment (feedback, goals, motivation, challenge, satisfaction, engagement and suitability); Kasvi suggested that computer games fulfill all of the requirements and believes that they "satisfy them better than most other learning mediums". Rosenzweig and Vanderdonckt presented the benefits of using guidelines in HCI [32]. They advised that consistency be ensured among products and services in order to provide a better user experience. Guidelines should be more than one person's lightly-considered opinion, but they are not rigid standards that can form the basis of a contract or a lawsuit. Guidelines are not a comprehensive academic theory that has strong predictive value rather they should be prescriptive [59].

Pivec [43] in the book Guidelines for Game-Based Learning aimed to help all pedagogues, teachers and trainers implement their own ideas in the form of an EVG. Pivec and Kearney [42] have presented a model for game based learning, which includes some Game Flow criteria for player enjoyment in games which can be considered guidelines of the game design based on the following points: Concentration, Challenge, Player Skills, Control, Clear Goals, Feedback, Immersion and Social Interaction. Padilla Zea presented a set of guidelines for designing collaborative educational videogames, which facilitate the incorporation of collaborative processes into educational videogames [52]. Moreover, various works have presented evaluation heuristics which offer mechanisms to improve the PX [26][27], and these heuristics can be helpful to build EVG guidelines.

As previously mentioned EVG is a play and learn environment, this dual nature of EVGs makes them difficult to design and implement. Due to this complex nature of EVGs, it is important to take advantage of what is already known about best practices for each EVG components. We have therefore focused on existing guidelines found in similar works such as e-learning and videogames to build our set of guidelines [39][57].

Also Design patterns in video games have been a topic of discussion for some time now. Using patterns in EVGs allows the integration of educational content and video game design ideas, and in this way they help us to balance the game challenges and the learning objectives in EVGs. The idea of applying the design patterns approach to produce game designs was first described by a practitioner within the game industry [8] and an extensive collection has been developed for gameplay design patterns [61]. Rogers [65] provides a complete guide to video game design from ideas to characters, mechanics, and level design. Church proposed tools to help designers understand game design and to maximize the player's feeling of involvement and self [21].

Björk and Holopainen [61] defined design pattern in their book "Patterns in Game Design" as the following: "Game design patterns are semiformal interdependent descriptions of commonly reoccurring parts of the design of a game that concern gameplay". They also presented a large collection of game design patterns that were compiled by analyzing existing games, explaining the template used for the game design patterns that followed, and suggesting means for identifying patterns and applying them to the design of a game. Church introduced formal abstract design tools (FADTs) as a way to achieve a shared design vocabulary [21]. Falstein attempted to find a list of 400 rules that apply to game design by including rules that make a good game [51]. Church and Falstein have proposed the same objectives; to define a way to describe and share game design knowledge. In his book "Art of Game Design: A Book of Lenses", Schell presented a hundred ways to look at game design from a multiplicity of angles [30]. Several other books have also been written about game design [5][56]. Kiili [36] considered that the objective of patterns was to fulfill the need for a common tool to facilitate the interaction between designers and to develop high quality educational games. He defined pattern design in educational games in this way: Educational game design patterns are semiformal interdependent descriptions of commonly reoccurring parts of the design of an educational game that concern and optimize gameplay from an educational perspective focusing on the integration of engagement and learning objectives.

In this section, we have focused on existing guidelines and patterns found in the works presented above (e-learning systems, EVG requirement, and video game design). By analyzing these works we can conclude that game designers to get a 'good' EVG design, they need to focus on playability, internal structures (Game rules, Game mechanics…), and expected player experience (How games evoke emotional-intellectual responses from players...). Accordingly, educational video game design is suffering the lack of theoretical and methodological norms, and there is a misunderstanding of the game features that must be included in games and the teaching methodologies that are compatible with game playability. In this paper, we will propose a set of guidelines and design patterns that take into account the need to promote and maintain the playability of an EVG, to build and improve the PX of the game process and facilitate the game development process, these guidelines and patterns were compiled by analyzing the existing game techniques to achieve a good EVG design.

III. PLAYABILITY, GUIDELINES AND DESIGN PATTERNS: A TOOL TO IMPROVE THE PLAYER EXPERIENCE

EVGs design has been a topic of discussion for some time now. The importance of EVGs arises from the failure of e-learning systems and technology enhanced learning process to engage students and keep them motivated to study [44]. Due to the lake of motivation in e-learning systems many designers are shifting towards using interactive learning based on games, e.g., Aldrich [13] introduced more interrelated concepts covered by educational simulations.

Learning through play is currently an effective and attractive educational strategy. Games are fun, learning is hard, and forcing people to learn in games can ruin the fun. Lots of literature exits on why games should be good tools for education, but very little on how to ensure that they are. During our research we found many EVGs that appeared on

the market before their efficacy had been ensured. As a result numerous games have failed, due to the lack of game design methods to convert the objectives of players, educators and designers into reality [64], as well as the fact that analyzing methods are rarely used discuss the level of playability in EVGs in a structured way. Another problem arises from the fact that an EVG is a combination of fun and learning. Thus, a good EVG development process requires cooperation and synergy between game designers and educators in order to ensure a good player experience [53].

To this end, we have proposed a set of player centered design patterns that support EVG design, i.e., game design that places the player experience first and foremost. Björk and Holopainen [61] have mentioned several points that demonstrate the need for design patterns that do not depend on a designer's experience: Problem-Solving for Game Interaction Design; Inspiration; Creative Design Tool; Communicating with peers: Communicating with other professions.

Based on the above, we present our opinion regarding design patterns and guidelines in video game design. Design patterns and guidelines provide many benefits during the design of video games:

- Allow new perspectives for both design and analysis, and provide a network of relations between different game design concepts.
- Design patterns are formal tools used for solving known problems, i.e., they function as a design toolbox. Patterns allow different levels of abstraction in order to address a specific game design problem, and offer the best way to solve issues related to software development using a proven solution.
- Facilitate the development of highly cohesive modules, which may be used many times in different contexts and applications.
- Describe many design decisions that cannot be recorded through the use of primitive methods.
- Patterns have the ability to increase the opportunities for communication and reduce misunderstandings between educators, designers and players, leading to more efficient communication between them.
- Allow some aspect of the system structure to change independently of other aspects.

A. Playability in Educational Video Game

The majority of the presented works in this paper discuss the important role of PX in the structure of video game. The term PX -based on user experience definitions [23] – refers to "all aspects related to the player that are affected by and interact with the playing environment", These aspects represent pragmatic and hedonic features of the process of interaction such as: sensation, feelings, emotional response, assessment, user satisfaction and the experience obtained during playing time [34]. A video game with good playability provides a player with positive experiences of the aforementioned aspects.

The vocabulary of software usability centers on effectiveness, efficiency, and satisfaction (ISO 9241-11). But these aspects don't necessarily add up to 'good' EVGs due to the special feature of the experiential dimensions such as fun, motivation and emotion "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" [6]. EVGs should be learning environments that are adaptive, scalable, robust, reflexive, and feature modularity, automation and variability [38]. Thus, we suggested the use of playability to engage, activate and entertain players during the playing time.

Playability in video games is based on usability, but goes much further, it extends the User Experience characteristics with players' dimension using a broad set of characteristics such as motivation, pleasure, curiosity, emotion, and social influences [34]. Thus, Playability isn't limited to the degree of fun or entertainment experienced when playing a game. To this end, we have defined the Educational Playability [2] (Playability of EVG) as "the set of properties that describe the PX in the gaming environment, which main goal provide fun and learning in playable and learnable context, during the entire playing time".

We have previously presented 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 [2][3]. We have presented nine attributes to characterize the educational playability:

"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. Player Satisfaction can be considered as a measurement to assess EVG as a successful learning system. It is related to the presented content, the used mechanism, educational elements design, and game environmental.

"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 resources necessary to offer players a new experience (fun and learning) while they achieve the game's various objectives and reach the final goal.

"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.

"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.

"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.

"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.

"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.

"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.

B. Playability and Design Patterns in Educational Video Game

The integration of playing and learning is the main objective of an EVG. In this article, we highlight the properties of player experience which result in a successful game. Player experience is related to all aspects of interaction between the video game content and the player. As previously mentioned, the goal is to ensure an optimal player experience while blending educational objectives with fun challenges. To achieve this, we suggest a set of design patterns based on the playability attributes as a tool to reduce the complexity of EVG design, as well as to help the player improve his/her experience during playing time. A feature of game design patterns is that adding new patterns does not restrict or specialize the nature of the game, but rather expands it. This is because a pattern describes a particular aspect of playability and its effects on player experience.

We thus present a new taxonomy of design patterns, which were compiled by analyzing the existing exiting game design patterns and the current problems that face EVG designers. Each pattern in our proposed set describes a part of the possible interaction between a player and the game. These patterns are related and when used together they are able to improve player experience and effectively resolve EVG problems. Design patterns provide video game designers with the opportunity to play a powerful role in constructing and improving game playability. Design can be reactionary, responding only to current conditions, or it can be visionary, by presenting solutions to problems yet undefined.

The new set of patterns has been created so that the following points are considered: appeals to both cognition and emotion; improves upon the player's previous experience; fosters creativity and collaboration between designers in order to produce the best player experience possible; presents a game structure that is able to bridge the gap between the required experience and the player experience; facilitates the evaluation of the experience and the effectiveness of the game. Using design patterns should increase designers' experience, helping them to ascertain what is meaningful to the end user and how to present it in the best possible way.

C. Playability and Guidelines in Educational Video Game

Playability and guidelines are closely related, where playability can play the role of guidelines during the game design. Playability is a property that should have high levels in order to keep the game fun and to maintain the player motivated throughout the game. Playability is a qualitative property that can be used during both design and evaluation phase; in the design phase, playability can be considered as a set of guidelines regarding to how to implement the necessary elements to give birth to a desired sort of game play or social entertainment. Also, playability is a tool to measure whether player requirements have been achieved, and to determine the playable-learnable aspects of a game.

At the same time, Guidelines are a set of rules used during the design stages to increase the quality of the generated games, guidelines provide information on good practice and can be used as a basis for measuring the quality of an EVG. Guidelines facilitate decision making by designers and game developers when creating or using different elements in the game. The use of guidelines also ensures the design success and further development of the game, to a certain degree.

The complexity of videogame development requires certain specific guidelines in order to be educational without loss of playability. Thus, guidelines play a pivotal role in achieving the goals of a game and that they are useful in creating a highly playable game design. We can say that guidelines are, specially, to ensure high levels of playability in the game. Accordingly, we present a set of guidelines that have been obtained by analyzing the characteristics that a playable game should have. Based on the above, we define the guidelines in EVGs as the following: "a collection of principles, conventions or directives which describe the educational video game characteristics and are used by developers in all stages of game creation".

D. Guidelines and Design Pattern Importance

Having identified that games exhibit some unique playability problems, e.g., the lack of a player role in the game design or the inability to provide the player with the proposed content, we considered that there was a clear need to develop a collection of design patterns and guidelines that specifically addresses playability and player experience in video games. In this work, we emphasize the properties of player experience that are necessary to obtain a successful video game, where this experience is related to all aspects of interaction between the video game and the player. Accordingly, the solution should ensure optimal player experience and be able to blend the educational objectives with playful challenges, present the game objectives, and provide interesting choices, immediate support and assistance, and an attractive learning environment.

We consider that the design of EVGs is ideal for developing design patterns and guidelines because it is able to:

- Support an innovative approach that effectively integrates and balances fun challenges with educational objectives.
- Support the playability attributes and build an optimal experience by including a game design that motivates players.

- Patterns provide a common vocabulary between game developers and designers in this rapidly expanding field.
- Guide the test and evaluation of the game experience and the efficiency of the learning process.

IV. EDUCATIONAL VIDEO GAME DESIGN

The purpose of the design phase is to give the game designer the ability to design educational video game based on the generated requirements in the analysis phase, understand the lack points and problems of players, fix the problems and do walkthroughs of design concepts. The designer can brainstorm the game elements such as motivation and concept; narrative context and story; the goals and rules of the game, including game mechanics; and the player interface, including the feedback and modes of interactivity.

Achieving the players' needs and requirements, and the educators' objectives and requirements at design level involves the use of design pattern and guidelines techniques. In this work, we have presented a set of guidelines, which are sound and unambiguous and then they could be presented to designers without the rationale behind them. Also, we have used design patterns in educational video game as a useful way to explore suggestions for good design and to complete the rule of guidelines.

A. Educational Video Game Guidelines

In this paper, we aim to provide an integrated and comprehensive set of guidelines appropriate for EVGs to be efficient, fun and successful. The design of these guidelines is based on the playability attributes, and takes into account the need to promote and maintain playability, as well as to improve the PX during playing time. Also, we have classified the suggested guidelines into groups related to all EVG aspects. This classification aims to clarify the designers and game developers expectations, and identify how players will be evaluated for each objective more clearly, to show more knowledge of the game content as well as to improve learning content structure, consolidate all resources, activities related to the presented objective. We have classified our guidelines in groups, which have been proposed to strengthen our proposal by achieving the educational playability attributes during the design phase. We have presented the guidelines groups as follow:

1) Game Goals

This defines how the playful and educational contents can be presented in an interactive way, which is both easily understood and attractive to the player. Games should provide enticing long-term goals [25]; in addition a short-term goal will be needed to achieve the overall game goal [10]. Game goals should guide player through the game and can be presented implicitly or explicitly, goals need to be presented early and clearly stated, and should be personally meaningful, obvious, and easily generated [14][69][68]. EVG should offer a particular strength and sustain of motivating users, "if computer games are intrinsically motivational, then they can be exploited to make learning more motivating and learning will happen almost without the individual realizing it" [55]. Thus, appropriate game goals keep players immersed, interested and motivated in playing and take into accounts the prior skills and experience of the player. Also, game goals describe how to provide the player with the possibility to understand and master the game in a systematic, creative manner. These goals can be divided into two categories as the following:

a) Playful Goal: presents the general objectives of the EVG in a simple and enjoyable way that can help to captivate the players.
- Must facilitate the learning process.
- Provide players with clear knowledge about the educational content in order to make the goal easier to achieve.
- Game content must be appropriate for the predetermined learning objectives and players.
- Game allows players to be involved in challenging tasks, not trivial activities.
- Game outcome should be unexpected in order to increase the player´s curiosity.
- "A good game should be easy to learn and difficult to master" (Bushnell's Law).
- Main goal should focus on reinforcing the player's skills and improve his or her prior experience.

b) Educational Goals: describe what the educational component in EVG should be and how it should work.
- Provide analytical and critical thinking.
- Make a systematic introduction of educational content.
- Assessment and recognition of prior learning.
- The goals are divided into several sub-goals to scaffold learning: generally the sub-goals are gradually presented to lead learners to the learning objective.
- Educational content should be: Valid and Reliable, Credible, Accurate, Relevant, Balanced and free of bias.

Based on the definition of the playability attributes presented above, this set of guidelines affects on such playability attributes as: Satisfaction, Learnability, Motivation and Educability. These guidelines facilitate the learning and playing process, give players the ability to master the game, overcome the different challenges in order to keep a player immersed and motivated to play.

2) Balanceability

The balance between fun and education is a very important factor in the success of an EVG, and has a great influence during the playing time. "A key problem in the development of educational games is balancing how much of the game is a game and how much of the game is learning" [37]. Law [23] presents some problems of current EVG as a poor balance between playing and learning activities or between challenge and ability. The imbalance leads to a separation of learning from playing, which leads to an EVG failure.

- Game must include a fun factor to motivate the student to achieve the learning outcomes [42].
- Educational elements should be clear but not dominant.
- All contents should be compliant in terms of goal visualizing and achieving.
- All game steps should contain both EVG components (fun and education).
- Keep consistency during all EVG steps by ensuring efficiency in game component visualization.
- Include different ways to present EVG components.
- Balance must reflect as much as possible the player´s state (emotional, psychological, etc).

The balance between EVGs contents will make a game more active and attractive, which will ensure the player pleasure, the efficiency of the game structure and thus players can reach the game goal easily. It thus affects such playability attributes as: Satisfaction, Immersion, Effectiveness and Supportive playability.

Quest Atlantis [60] presents the balance of education, entertainment feature to support academic learning, individual development, and social transformation. In this manner, it integrates principles underlying the development of entertaining games into the design of a learning environment. Also, it entails a rich metagame context through which children perceive their participation as meaningful and engaging. This design includes a lot of the presented guidelines in this group.

3) Game Challenge

Challenges are the part of video game, which keeps players motivated to seek for knowledge in order to provide a solution and continue with the game. Challenges increase the game dynamic by presenting different levels and types of challenges, challenges should be introduced in a way that give players the opportunity to study their behavior, as well as to provide an appropriate challenges to players skills, which can be seen in the second part of Bushnell theorem that addresses the idea of providing players with challenge that scales to the abilities of the player. Games motivate when they challenge players and, at the same time, maintain the "illusion of winnability" [15][54]. Also, increasing challenge keep players engaged, reducing the potential for students to become distracted, diminishing educational engagement [17].

- The game should have different level settings to challenge all types of players, (novice or expert players).
- The challenge should be produced from the diversity of the game's tasks and from the difficulty of these tasks.
- The game has to scaffold players' skills and students' knowledge. If the game is too difficult it is frustrating, if it is too easy, it is boring [42].
- Challenges and the level of difficulty should be matched to player experience in single-player games or multiplayer ones.
- Challenges should be balanced the playful and educational aspect based on the player progress.

This group aims to challenge players' creativity, and their skills. Game challenges have always been a great way to give players' brain a good work out. Challenges and mysteries are video gaming strategies to engage players and could help them enhance cognitive skills, preparing them for weightier game challenges. It thus affects such playability attributes as: Satisfaction, Motivation, Emotion, Supportability and Educability.

Mavis Beacon [50] presents different tests and level of typing speed, each level has different challenges; Mavis Beacon will monitor players' progress as well as to introduce new challenges to help players continue improving their keyboarding skills.

4) Feedback

Players must be informed as to what they are achieving at the educational and playful levels during the game. Feedback needs to be frequent, clear, constructive and encouraging. Feedback also provides an opportunity to give explanatory information, metacognitive prompts, and clues to correct responses [68]. An appropriate feedback should be presented based on the player decision and performance, and should help players actually to learn and to reach educational and playful goals [20]. Players need to know how skills translate into strategies for playing the game [35]. This takes place through the game cycle and system feedback occurs by:

- Feedback should be presented to the player after a number of failed attempts, and to help him to understand why he has failed.
- The games should be able to stimulate the player to know more about the mechanism of the system by giving clear feedback.
- Provide different type of feedback audio/visual/visceral (music, sound effects, controller vibration, etc).
- Feedback should be immediate with the aim of achieving game goals.
- Feedback must guide the player through the environment, emphasizing key points and offering assistance along the way.
- Feedback should allow the player to monitor the mastery of skills or information.
- A successful game must first familiarize the player with the complete educational task in order to begin the learning process.
- Provide feedback message about all player actions, situations (level complete, game finished, etc.) and status (score list, winner, loser, etc.).

Achieving the presented guidelines in this set will increase player enjoyment and will assist in overcoming all challenges and improving the game´s objective assimilation. These guidelines make the game attractive to a player, keeping him or her interested and motivated to develop skills to overcome the game steps and compete with other players. It thus affects such playability attributes as: Immersion, Satisfaction, Satisfaction and Educability.

Lure of the Labyrinth [40] lacks a good and appropriate design of player feedback, when players make a mistake in a game, it just gets corrected for them without an explanation

in hopes to help players, it did not tell them why so even though it corrected them. It gets way too frustrating.

5) Interactivity

It describes how to make the players feel that they are part of a creative and dynamic community, and how to create more powerful interactive experiences and engagement by streamlining players' interaction and motivation during the game time. Swartout and van Lent [72] deemed that the best games are "highly interactive, deliberately generating tension between the degree of control the story imposes and the player's freedom of interaction". Thus, the playing experience can be boring and unchallenging in games with complete freedom of interaction, when the game progress requires too much control; the player becomes a passive observer rather than an active participant [47]. De Freitas [62] proposed that the interactivity of EVG involves applying changes on the game structure and the learning process, how games are designed, developed and used in practice upon the processes of learning and how learning activities are structured in practice. Thus, we propose the following guidelines:

- Game should have clear and simple instructions and rules.
- Game should respond in different ways to correct and incorrect actions (using sound, images, etc.).
- Permit easy reversal of actions. If a player makes a silly mistake, allow the player to reverse the action, unless it would affect the game balance adversely.
- Introduce elements of positive surprise or special events in strategic locations.
- Introduce enjoyable activities that aren't passive.
- Educational elements should be related to the playful ones in the same video game frame.

This group aims to produce interactive experience that motivate and actively engage players in the game process. Thus, players discover and reinforce their abilities and learn new skills with interactive and fun computer games, which will implicitly affect on the achievement of several playability attributes such as: Satisfaction, Learnability, Motivation, Immersion and Educability.

The ReDistricting Game [70] was designed to educate citizens around the issue of political redistricting. It present a good level of interactivity, it provides many different ways to draw the district lines that meet the basic mission requirements. It provides an active process of discovering the rules of the game, combined with the ability to get feedback on the players' map at any time allows the players to explore and try out strategies, slowly refining them as they learn more about the game.

6) Adaptation

Adaptation is a very important characteristic of EVGs. In adaptive games the level of difficulty increases or decreases depending on a player's performance. When the games are adaptive they support learner preferences for different access pathways and allow the learner to find relevant information while at the same time remaining immersed in the game [16]. Adaptation shouldn't be only as response to players' action during the game time, but should play a crucial role in the

success of the learning process by triggering the learning patterns. This means the learning outcome is related to player performance, so if a player finds a game difficult to play, he will leave it and the leaning process will fail [66]. Therefore, we present some guidelines that can be useful to adapt certain features to create a tailored experience for each player based on how they learn and why they play games. In the following we present some adaptation guidelines:

- Game should be easy to modify and adapt (difficulty level, sound level, background music, control keys, etc.).
- Educational content should consist of modules that are flexible enough to be readily utilized during the game time with minimal adaptation efforts.
- Educational content should be able to cater to diverse learning styles and motivation.
- Rationale for using a specific style of educational content should be determined by the needs of the players, game steps and game situation.
- Game contents should be adapted to the individual pace of the player.
- The player should not be overwhelmed by the information the game is provided. Provide ways to hierarchically compartmentalize information.

Introducing this group of guidelines adapts the game content (playful and educational) to the individual pace of a player, relates the educational content to players' needs, this gives players the opportunity to construct a personal profile, and encourages him or her to master the game and complete all steps of the newly customized environment. This will encourage the player to spend the maximum time playing, as well as to compete with other players. It thus affects such playability attributes as: Satisfaction, Motivation, Supportability, Socialization and Immersion.

Mavis Beacon [50] provides many personalized lessons, exercises and tests. Many entertaining typing games, also it presents a detailed progress reports assist in identifying strengths and weaknesses. It provides different level to teaching all letters typing each level teaches some letter typing.

7) Game Control

Providing player with the ability to easily control; generates a sense of belonging in the game environment. Players should feel a sense of control over their actions in the game. In fact, control has been determined to be a deciding variable when motivation has been observed to increase over time for instructional games. A controllable environment allows players to build confidence and self-esteem, as well as to extend their potential and natural abilities, earlier and to further extents. Also, the level of control the players have in their interactions can develop a sense of ownership in the game environment [7][62]. Control is defined by the number of choices available to the learner, the presence of contingency, and a feeling of power given to the learner by allowing them to produce very different outcomes [46].

- The player is not required to learn new control techniques during the game.

- The player should be the one in control. Players want to feel in charge of the game-at least in regard to control of their avatar.
- The control should be intuitive and mapped to platform control.
- Don't throw random uncontrollable events, or tedious or difficult input sequences.
- The control over the program is very crucial: the interaction should determine how the learners observe and infer the rules of the system, which are also the subject matter.

The role of this set is increase the player interactivity and integration with virtual game world. This group allows the player more control over the experience, and engages the competitive mind in a positive way, helps players to develop skills and reduce the margin of error, thus player will find the virtual world enjoyable. It thus affects such playability attributes as: Immersion, Emotion and Learnability.

Storm Tracker [67] is a game that allows player to predict the path of a storm presenting a several options that support a player to domain the storm mechanism, players are actively in control and trial and error comes into play when the final storm prediction is made. Also, learning the storm´s terminology allows players a better understanding and controlling of what is going on during the game and it also helps game play move more smoothly.

8) Ethics

This group defines that the game content should be presented within an acceptable ethical framework which has no negative impact upon the user - How appropriate are the attitudes and beliefs embedded in a game? How appropriate are the implied social attitudes and beliefs, e.g., about violence, gender, race? [4]. EVG must act as a tool to motivate the player's understanding and awareness of the content presented, establishing some basic principles of the real world, such as competition and the ability to complete tasks. Several researches show that player feel more hostile after playing violent video games, especially games that simulate real-life situations. There is also evidence that playing violent games can make people behave more aggressively immediately afterwards. In the same time several researchers have mentioned that the violence in a video game motivates and engages players, and have considered violence as part of our real life, and thus a game will lose something of its realism by hiding the violent scenes [19][71].

- Game should not teach anything that may result in dangerous situations in real-life.
- Avoid content that has an impact on physical, mental or moral development (for example, inhuman and sexist content).
- Avoid messages conveying content of an aggressively nationalistic, ethnocentric, xenophobic, racist or intolerant nature.
- Emphasis on acquiring and maintaining competence during playing time.

Introducing these guidelines and achieving them will develop a player's skills and experience, in particular the social experience. In this way, correct and real information will be presented to the players, which help them to take the responsibility to discover and achieve the game content, and thus the player skills will be developed. It thus affects such playability attributes as: Motivation, Immersion and Educability.

Storm Tracker game does not show the real world dangerous consequences or any other aspect of the storm that has negative effects on the player, i.e., dead bodies, etc. We suggest that a game will be better if it presents dead bodies as result of a storm, but these bodies shouldn´t cause to the players any visual damage.

9) Realism

Another advantage of EVG is that has the ability to simulate real-life situations in a way which can greatly facilitate the learning process. Crawford describes a computer game as "a closed formal system that represents a subset of reality" [15]. This means focusing more on the real life simulation part with rewards, customizations and clear objectives. Tashiro and Dunlap [31] have explored relationships between simulation realism and engagement in learning, they consider the impact of visual realism on learning engagement in educational games. Krcmar [41] says that as the games become more and more realistic, the positive and negative effects on children increase, because "Greater realism leads to greater immersion; greater immersion leads to greater effects". Also, Wood [58] find Players rate realistic video games more favorably than unrealistic ones.

- Make real-world situations and simulations available within the game.
- Relate educational content to real-world simulation.
- Real-world simulation should provide to help game contents to be achieved.
- Make story realistic, presenting real sequence of events throughout the game.

Realism is very associated with the playability attributes such as: Satisfaction, Immersion, Emotion, Motivation and Educability. Realism ensures the diversity of motivations and the accuracy of the information. Also, it motivates the players' understanding and awareness of the presented content, establishing some basic principles of the real world to activate their primer experience.

Storm Tracker game is real world simulator, it is a very good teaching tool about hurricanes without being too graphic or visually overwhelming. Concepts are presented in a way that allows the player to see the real world aspects involved in hurricane storm tracking as well as to present realistic outcomes of these aspects.

10) Game Reward

Any activity that people enjoy doing has some kind of reward. Rewards it is a very important way to encourage players to perform better due to the bonuses and advantages. Currently, most digital games are designed so players must actively complete quests based on a reward system [56]. Moon [56] mentioned the role of reward to induce play, and presented a learning model for video game based on the reward system. Nielsen has presented the reward as an

extrinsic motivation that players get a reward for engaging in an activity, and are not motivated by the activity by itself [63]. The intrinsic rewards arise from the process of learning or playing, and the extrinsic rewards arise from results (grades, points, winning, or approval) [9].Thus, connecting the reward system and player motivation to learning process will help each player to have a more optimal game experience.

- The reward should be appropriate and important in motivating the player.
- The reward should be appropriate to the current educational step or level.
- The reward should be related to the player´s progress in achieving the educational content
- The reward should be commensurate with the capabilities of the player.
- The reward should be presented at an appropriate time to engage the player.
- Rewards can be given several times during one game step if necessary.
- Game should present a variety of rewards.

Presenting this group of guidelines affects on the player participation during the entire playing time due it's important to hold the player attention as well as to make games funny and delighting. The rewards guidelines motivate and encourage players to play and learn. Thus, by using this group we can improve the different playability attributes such as: Motivation, Immersion, Learnability, and Educability.

Math Missions [49], the Amazing Arcade Adventure by Scholastic, players earn money for every correct answer. This money can be spent on buying arcades and they even get to run the arcade. These rewards are presented as a way to motivate the learning without really being related to the learning experience.

11) Structuring

This group is related to how the EVG content is presented in a way which motivates the player, and how to introduce challenges throughout each game level creating an imaginary learning space that is engaging and immersive. The structure of EVG should provide entertaining and interesting content, which should be suitable for players´ primer skills and knowledge. Also, game elements and content should be related and the match between them is a very important, where the aesthetic aspect of the game structure guides the player to achieve the game goals, while the learning design of games should make it possible to use them in a modular way and to organize content and sessions in such a manner as to emphasize this learning aspect (personal learning routes, "*reassembling*" of parts of the games into different training paths, etc.) [43].

- Ensure an aesthetic consistency between playful and educational elements, to guide the player through his or her tasks and objectives.
- Each item has its activity that is easy to distinguish from the activity of other items.

- Ensure that the player can quickly recognize the game environment structure without the need for additional help.
- Design the interface to offer defined tasks. The sequences of actions the player is performing should be arranged into a conceptual group of smaller subtasks. Each task completion should be punctuated with an acknowledgment, so the player knows that his or her task has been completed.
- Utilize game elements that can be easily and quickly understood without requiring any additional help.
- Storyline and the interface elements should be appropriate.
- Each player should be able to easily distinguish his or her items in multi-player environment.

The set of guidelines is related to several playability attributes such as: Effectiveness, Motivation, Emotion and Supportability. A good game structure helps players interact in a simple way, and maintains the enjoyment and curiosity of players. This group provides the ability to control and master the game and successfully overcoming all challenges in order to reach the game objectives.

WolfQuest [73] is an immersive 3D wildlife simulation game, Based on real topographic maps of Yellowstone Park and realistic graphics, which lets players join a wolf pack made up of friends in the multiplayer version or seek to perfect their hunting skills and build their own pack in the single player version. The presented design of this game is related to its story and totally captivates players during the playing time. The presented elements of each frame represent the required function as well as to be easy to understand and master.

12) Player knowledge

This can be defined as how to encourage and motivate players to activate and use their prior knowledge and skills, and intends to generate and improve the players experience by providing them with the new content during playing time. EVGs are collections of skills, knowledge, one advantage of the EVG is its ability to build on or to improve the player's current skills, which arises from the pleasure of mastering a new topic or content being learned, and the curiosity about the subject matter. Thus, a way to build the player knowledge is to engage in the game virtual world during game play [18]. Also, this group emphasizes that the quality of the presented content should be correct and effective. Prensky [45] explained how young people can create their knowledge in practice "the kids who play today's 'complex' video games… learn to think: through experimentation and what real scientists call 'enlightened trial and error,' they learn to understand and manipulate highly complicated systems". Prensky understood that "in order to 'beat' their complex games kids must learn, through complex reasoning, to create strategies for overcoming obstacles and being successful – skills that are immediately generizable". Thus, video games encourage players to achieve mastery to challenge, forcing people to adapt and devolve their thinking and strategy.

- Use the previous experience of players rather than oblige them to learn new knowledge.
- Give the player the opportunity to relate his or her knowledge to real life situations within the game environment.
- Each game level should add something new to a player's knowledge.
- The player should be encouraged to reflect upon the newly acquired information and integrate it into his or her existing body of knowledge.

These guidelines ensure that the player's skills and knowledge is increased and his or her ability to achieve the game goal is improved. These guidelines can increase player confidence during the game, and increase his or her ability to compete with other players. The emphasis on real knowledge in these guidelines will encourage the player to concentrate on achieving the game goals. It thus affects such playability attributes as: Learnability, Educability, Supportability, Emotion, Motivation and Socialization.

A Branches of Power [11] game immerses students in the workings of the three branches of government. The player has to think critically about the decisions he/she is making about what to put in bills and whether they are popular and constitutional or not. Thus, the presented content is definitely not passive learning. During the playing time player has to learn basic ideas and words about what it takes for an issue to move from an idea into a law. Players have to make choices and decisions about what values they take on and what ideas to put into bills, they must think about those same things and how they affect the real world. Thus, players must use their experience about the game content as well as to use the presented content to make their decisions.

B. Design Pattern for Educational Video Game

To achieve learning and entertainment in a gaming environment, we have presented an integrated set of patterns must be suggested to support the player experiences based on the playability attributes in EVGs [1][3].

The proposed patterns are documented in a standard format, as solutions to common design problems. We use patterns as a tool for problem-solving, to support creative and effective design, to build a repository of knowledge and encourage reuse of best practices, and as a way to share designers' experience. By using the patterns described in this section, it should be possible to develop a structure that helps build both entertaining and productive educational video games.

To facilitate the development and use of EVG patterns, we have developed a template based on the proposed elements by Christopher Alexander [12], our template consists of the following main elements: Name, Problem, Description, solution, Playability Elements Affected, and Elements of the Game Affected. Also, we have classified the patterns in relation to "Educational Playability." In this way, we associate the proposed patterns with the situations and the game elements which are closed to the player's experience during the game. We believe that this aspect is most important to develop effective and motivating learning games. In this context, we have classified the proposed patterns within a flexible interactive structure based on playability attributes and related to all aspects of EVGs (Table I), as follows:

1) *Interactive Integration:* describes those patterns that focus on EVGs as a combination of fun and educational elements. It presents the structure of EVG objects, where educational and fun aspects are given more emphasis than in other types of games.

2) *Active Support:* describes those patterns that help and support players to understand what they are doing and learning during the game's progress. This discourages the player from stopping the game, and encourages him or her to think about the decisions, actions or strategies that must be taken in the next step.

3) *Knowledge Realism:* describes those patterns that ensure the quality of the EVG content, by presenting accurate knowledge related to the real world. This gives the user confidence as it enables him or her to check the accuracy of obtained information.

TABLE I.   PLAYABILITY DESIGN PATTERNS TAXONOMY

Taxonomy	Pattern Problems	Patterns	EVG Elements
Interactive integration	Create an EVG in which all fun and educational aspects are included, Present the educational content indirectly, Produce a appropriate player interface, Generate a good player experience.	Balanced EVG, Interface Structure, Adaptive Content	Tasks, Disposition, Objective, Challenges.
Active support	Feedback, Keep the player informed about his or her status, Present the necessary information to support the game progress. Incentives to reward players	Related Support, Reward	Feedback, Score, Active Reward.
Knowledge realism	Give players new, correct knowledge, Effect of game reality on player experience.	Knowledge Correctness, Game Reality	Reward, Realism, Challenges, Rules.
Beneficial play	Use game activities to teach, Keep player motivated during playing time and progress in the game.	Incremental Learn, Motivated Play	Reward, Challenges.
Knowledge Growth	Support players to become aware of and to obtain new knowledge. Improve player experience and awareness.	Skills Improvement, Embedded Learning	Challenges, Feedback.
Social awareness	Use social aspect to improve player experience.	Shared Experience	Group challenges, Dependence among members.

4) Beneficial Play: describes those patterns that provide players with incentives (reward, fun, pleasure) to encourage them to advance in the game, and consequently, in their knowledge and skill acquisition.

5) Knowledge Growth: describes those patterns that focus on the use of EVGs to give players new knowledge and skills, and to improve and develop previous knowledge.

6) Social Awareness: describes those patterns that present and use the social features of EVGs to facilitate learning or teaching through social activities and their role in strengthening the player experience.

The previous table (Table I) presents the proposed taxonomy of design patterns, the common problems, the suggested solutions in each group, and EVG elements which are related to the discussed problem [1].

In the following we will present a brief description of the presented design patterns:

"Balanced EVG": describe how to create a game in which all fun and educational aspects are included.

"Interface Structure": present solution to produce an appropriate and attractive player interface.

"Adaptive Content": shows how the EVG actively should provide players with the proposed content.

"Related Support": describe how the EVG helps the player's progress in the virtual game world.

"Reward": describe how the EVG provides players with incentives that encourage them to explore the game world.

"Knowledge Correctness": show how to give player new, correct knowledge during playing time.

"Game Reality": present how the useful aspects of game realism can be used and managed to improve player experience.

"Incremental Learn": focus on the EVGs ability to increase the player's desire to achieve the educational content.

"Motivated Play": presents solution to keep players motivated to play and achieve the EVG contents.

"Skills Improvement": support the player to become aware of new game knowledge and obtain it.

"Embedded Learning": shows how the educational content of an EVG can be presented throughout the game.

"Shared Experience": present how the social characteristics of EVGs can affect the Player Experience.

C. Patterns and Guidelines. The Interrelated Objectives and Role

All the presented design patterns and guideline have built based on educational playability and the optimal player experience, taking the educators view point into account to ensure the educational content integration, and the educational objectives achievement. For example we have proposed a set of guidelines to design a balanced educational video game this guidelines aims to help designers to create active game from a both educational and playful standpoints. In the same time, we have presented a new pattern to treat with the problem of an imbalanced EVG, and thus this pattern provides some ways to avoid this problem during the design phase. As we have mentioned above in Section 4.1 and Section 4.2, this pattern and the related set of guidelines

affect on some playability attribute as education, effectiveness, motivation. Accordingly, ensuring a high level of playability during the game design will ensure us a good player-centered design.

In the same way, Player Knowledge guidelines have been presented with the aim of using game contents to build or develop the player experience, which has been supported by several design patterns, Skill Improvement, Knowledge Correctness and Embedded Learning, where Skill Improvement and Embedded Learning introduce solution to player previous skills and knowledge development, while Knowledge Correctness ensure the quality of the player new knowledge. Thus, these three patterns have complementary role to the Player Knowledge guidelines. In other words, these patterns provide solutions to some problems that could face players during the playing times. Achieving this group ensures that the player's skill and knowledge is increased and his or her ability to achieve the game goal improved, and thus they promote the following playability attributes: Supportability, Educative, Effectiveness, and Immersion.

Other example of the integrated role of guidelines and design patterns is Adaptation guidelines that aim to provide the game content complexity and challenges based on the level of knowledge that a player has. This set of guidelines is supported by Adaptive Content design pattern, which provide an active way to provide the different levels of difficulty of the game content based on the player performance, in order to keep the player motivated and encouraged to play. This is related to several playability attributes Satisfaction, Motivation and Immersion, and affects on the Education attributes.

V. PLAYER CENTERED DESIGN PROPOSAL FOR EDUCATIONAL VIDEO GAME

To ensure that the proposed design is player centered, we need a playable prototype, which will be tested with the set of players and educators to get the final educational video game. In educational video game prototypes have three purposes, the first is to define how they video game will work from the player interface perspective; the second how the video game content will integrate from the educators perspective; the third is to test on real players.

To create an educational video game that has the ability to provide what has been presented in the design phase we need an iterative and incremental development process, and thus, any iteration provides the possibility to reveal errors and omissions in the requirements, and to evaluate the proposed design, which help game designers and developers to build gradually an effective and high quality game design. The evaluation during any iteration gives game designers an imagination of the uncompleted objectives based on evaluation of the playability requirements, as well as to inform designers to develop or to change the applied guidelines and the patterns solution to complete the new players´ requirements and suggestions for improvements for the game that result during the evaluation step.

At the fist iterations we suggest the use of low fidelity prototypes that it can be produced quickly and does not

require much development effort, low fidelity prototype helps to start the design process immediately, to do quickly the design change, and designers' decisions are validated with players. However, players could find it difficult to take that leap from the somewhat abstract to the real thing. On the other hand, high fidelity prototype can be used after an acceptable level of designers satisfaction, high fidelity are easy to comprehend by the end user but may require a lot of costly development effort.

As the current market has a different players´ profiles that means the team of players would change their requirements many times with the progression of the game development process, this involves creating a several playable prototypes during the successive iteration in a short time, which should realize the new requirements of players, and thus we suggest the use of the low fidelity to keep the programmers efforts during these first iterations. The result of these iterations creates an acceptable game to players, and thus we can give game programmer an acceptable level of the game requirements to create a playable version as high fidelity prototype.

In this paper, we propose a brief description of a Player-Centered Video Game Development Approach, which includes the proposed design techniques and prototype. Our approach aims to introduce a player from the earliest phases of game development cycle, as well as to use the principles of Playability in EVG throughout the different phases of development in order to achieve a high level of quality in Playability, in the same way as with traditional desktop systems.

A. Analysis

Our approach should start with a game specification that includes the requirements of playability deduced from reference to the facets of playability, analyzing which attribute is affected by which specific video game elements [1].

B. Design

In the EVG design phase we have proposed the use of design patterns that support an EVG design and analysis, which are player centered; we mean game design and analysis that place PX first and foremost. We need design patterns that take into account the need to promote and maintain the playability of EVG at the game process. In addition, we focus on the guidelines for EVG design, which provide information on good practice and form a basis for evaluating the EVG quality, acting as useful tools to enhance videogame playability. Guidelines will be also necessary in order to design appropriate and playable elements according to the context of the game or player profiles.

C. Prototype

In this phase, we emphasize the design needs to prototype and to test with real users. It is therefore important to design and develop playable prototypes, and then will be tested to support the adaptation and refinement of the game with all the players as participants. Thus, we can get the playable elements.

D. Evaluation

Our approach emphasizes the use of playability test during all the development process phases to ensure the quality of playability in the final EVG. It is therefore important to evaluate PX in EVG based on the evaluation of playability. This will enhance the overall game experience by summing all values of PX across all playability attributes, as well as to determine which video game elements have more influence on the final experience throughout the development process. Thus, we will propose a specific heuristics for EVG, which will also help to decide if playability guidelines and playability design patterns are effective, as well as to cover all aspects of PX. Using Facets of Playability also helps to check Playability properties in the different phases.

Table II shows the different phases of our proposal for EVG development based on educational playability (see Figure 1).

TABLE II.   PLAYABILITY DEVELOPMENT PHASES

| Development Phases	Main Objective	Importance
Analyze	Understand the player's goals of playing an EVG to determine playability requirements.	Include playability tasks in the project plan that have the educational and playful aspects, Create player profiles, Develop a task analysis, Document player scenarios, Document player performance requirements.
Design	Achieving the proposed design based on the generated playability requirements. (Playability guidelines and playability design patterns).	Achieve the players' needs and requirements, Understanding the lack points and problems of players, and fix the problems and do walkthroughs of design concepts.
Prototype	Design and develop a playable prototype.	Present the designers´ understanding of players' requirements, and the used design techniques.
Evaluation	Evaluating playable EVG by using playability characterization. (Playability evaluation , Playability Heuristics)	EVG to be compelling and engaging, evaluation tests if playability characterization and playability requirements carried out, to ensure the success of the EVG to much extent.
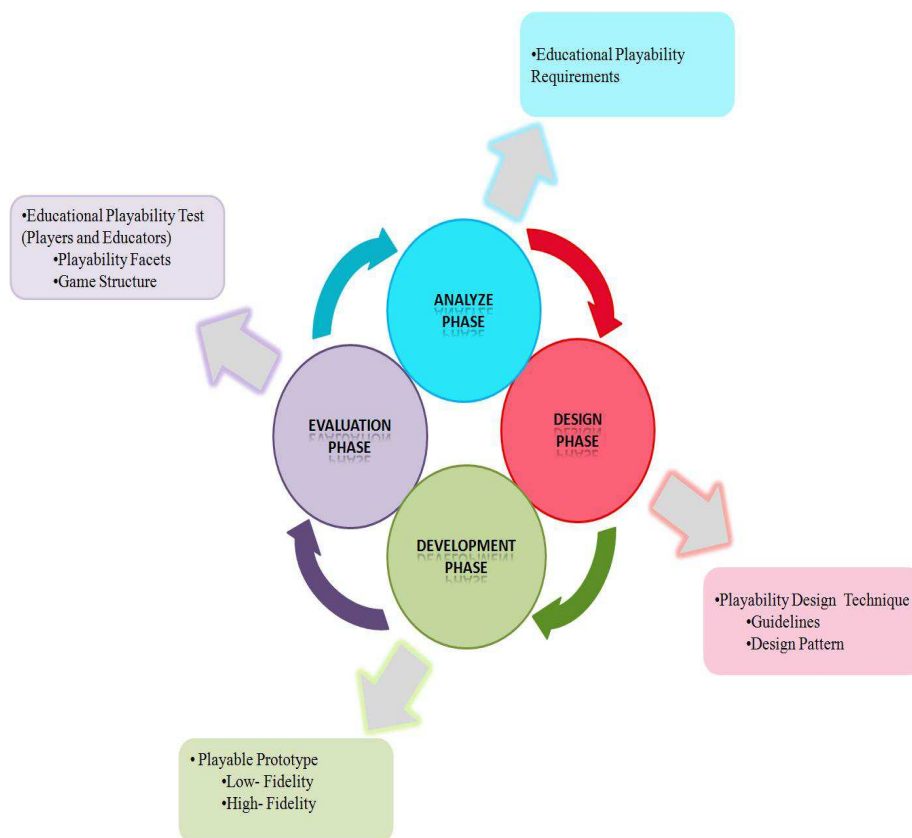
Figure 1. Playability Development Process.

VI. CONCLUSION

Designing and building process of an EVG is far from being a simple task due to the lack of methodologies that provide the necessary constructs and support for the different design tasks. During our research, we have perceived the need for a unified vocabulary and common concepts regarding EVGs and game design. Game design patterns and guidelines are powerful tools that can be used to build a real gaming future, by providing utility, flexibility and scalability of the video game design.

EVGs have the potential to offer real content (playful and educational) in an enjoyable way, which enjoy and build the PX throughout the game progress. The use of certain norms and standards are vital for an EVG to be effective. Guidelines and patterns are presented as certain parameters that make the games apt and useful for their players. Guidelines are a part of game aspects and, in order to be successful, a game must achieve them without losing the playability. Patterns also play a powerful role in constructing and improving the PX by analyzing the exiting game design problems, as well as to be effective to resolve these problems. In this paper, we have proposed some patterns and guidelines; we believe there are many more waiting to be formalized and many more to discover.

Currently, we are working to develop our approach of playability evaluation in order to build a complete catalogue of playability problems, and to develop an extended set of heuristics taking into account the different profiles of evaluators (educators, game designers, etc.). Also, we are working to develop the evaluation approach to be useful to filter the largest number of potential playability issues before making a test with users.

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