

Adaptation of Rapid Prototyping Model for Serious Games Development

El Aachak Lotfi¹, Belahbib Amine² and BOUHORMA Mohammed³

Abstract

Serious games are a very effective and highly interactive instruction tool. When combined with lecture-based training, they can increase participant interest and make the training process more enjoyable, memorable and effective. To create such a game we need a design process that combines both educational and entertaining aspects, and also allows saving cost and time of development. In this paper we will present a game design methodology dedicated for the beginners and the non experts in game design, the proposed design methodology is the result of the adaptation of the rapid prototyped method usually used in instructional design, to develop serious games. An evaluation of how our proposed methodology proved successful along with an outlook on future research concludes this paper.

Keywords: Serious games, Game Design, Rapid Prototyping Model, E-learning, E-training

I. Introduction

The transfer of knowledge since the teacher to the learners requires the use of different types of mass media, which are intended to reach a wide audience through the mass communication. Among the media that known a big success this last decade and increasingly used in education, there are video games.

¹ Computer science, systems and telecommunication Laboratory (LIST), Faculty of sciences and technologies, University Abdelmalek Essaadi Tangier, Morocco. E-mail: lotfi1002@gmail.com.

² Computer science, systems and telecommunication Laboratory (LIST), Faculty of sciences and technologies, University Abdelmalek Essaadi Tangier, Morocco. E-mail: amine.belahbib@gmail.com.

³ Computer science, systems and telecommunication Laboratory (LIST), Faculty of sciences and technologies, University Abdelmalek Essaadi Tangier, Morocco. E-mail: bouhorma@gmail.com.

The strong points of video games are the influence and targeting of the large margin of young people, this is due to their interactive environment and the unforgettable experience that can offer to the players. The video games that have the educational purpose are known as serious games, such games can combine both educational and entertaining aspects to create the desire into the learner to play and learn during the game progression. The education can benefit from using serious games because they are an increasing popular and important part of the entertainment industry. The industry estimates range from \$2 to \$10 billion in revenue for the serious games space, depending on how much of the market for games, simulations and virtual worlds is included in the calculation [1]. Unfortunately the design process of serious games is a complex task; it needs a lot of resources, time, and money. Each phase of the process requires the intervention of experienced actors, and in addition, there is no specific protocol has yet been developed resulting in the use of methods designed for video games or educational systems that are patched up in an effort to adapt them to the needs of serious games [2]. For these reasons we propose in this paper a design methodology of serious games based on the rapid prototyping model [3, 4 and 5] often used in instructional design, this methodology will help game designers especially the beginners to create their own serious games easily.

II. Our Proposal

After several researches to find a game design process with clear steps and that allows saving cost and time of realization, we have found the rapid prototyping model, a model dedicated for instructional design; then we have modified it to be adapted to design serious games, the proposed design model is composed of five major phases "Need analysis, Design, Prototype & Development, Validation and Evaluation" represented in Figure 1.

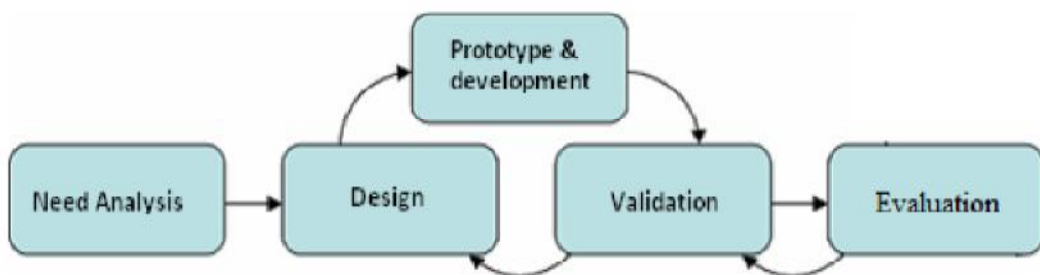


Figure 1: The Design Methodology for the Serious Games

1. Need Analysis

During this phase the game designer has to describe the need that leads to the creation of the video game, and define the set of pedagogical objectives that the learner must acquire when he completes all levels of the game. Description of need: The description of need is a general description of the serious game that will be developed; it includes features, general objectives and skills that the learner must acquire during the sequence of the serious game. Pedagogical objectives: The pedagogical objectives are statements of intent teaching, they are intended to describe the outcomes of the serious game, in general, the pedagogical objectives are extracted since the description of need and through different questions posed to the experts of domain, those objectives describe the aim, skills, and expected results that will be acquired during the game progression.

2. Design

Design is the phase where the tow aspects educational and entertaining will be combined to create a serious game that attracts the attention of the learner to play more, and learn as he plays. This phase is composed of different steps: Developing the game story, Establishment of flowchart of scenario, Characters description and Levels description. Developing the game story: The game story is the art of presenting a story in a compact and intriguing manner to create a desire to the player to play more. In this step the game designer can imagine different chronological events that happen to the main personage to achieve the objective of the story, in order to attract the attention of the player, the game designer should introduce same techniques that attract learners attention e.g." challenges, puzzles, suspense, etc..". Establishment of flowchart of scenario: The scenario can be established by using a flowchart [6] in order to have a clear and global view of the story, for this reason we present in this section an easy flowchart of scenario "Figure 2" composed of three different components "Non Play, Mission and Immersion", each component of the flowchart has a specific role described below: Non Play: This component describes an animation or a video introduction to begin or introduce the mission or the immersion. Mission: It's the main component, where the player does different tasks and avoids obstacles to achieve the pedagogical objective of the mission; this component is composed of five subparts describes bellow:

- Objective: In this part the designer defines the main goal of the mission that will be achieved by the hero or the protagonist of the story.
- Obstacles: in this part the designer describes the different things, objects or events that prevent the hero to achieve the main objective of the mission e.g. (enemies, traps, etc.).
- Rules: In general the rule is a relationship between actions "verbs" and challenges.
- Rewards: Description of recompense given to the hero if he achieved the objective of the mission or the immersion e.g. (win the points, win coins, etc.).
- Punishments: Description of the penalty that will undergo the player if he didn't achieve the objective of the mission or the immersion e.g. (loss of the points, etc.).

Immersion: This component is the same as a mission, but with entertaining objectives, the component is also composed of five subparts "Objectives, Obstacles, Rules, Rewards and Punishments".

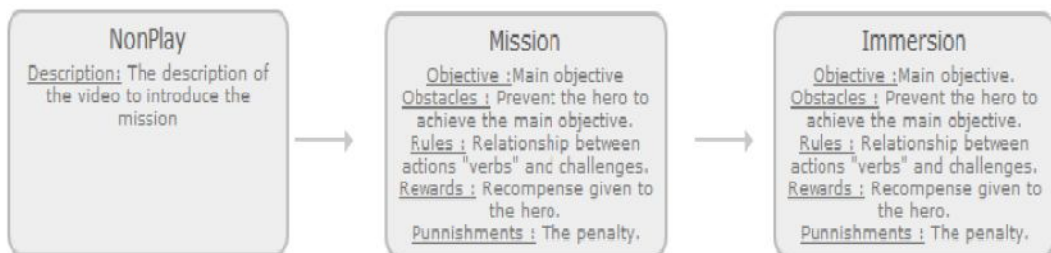


Figure 2: The Flowchart of the Scenario

Characters description: The characters that have been described in the game story will be detailed "Table II" in this section; in general, there are three kinds of characters exploited in the most games. Main character: the main character is the protagonist or the hero of the game story.

Non playable character: the non play character or non-person character is any character not controlled by a player. In electronic games, this usually means a character controlled by the computer through artificial intelligence.

Enemies: the enemies are the characters who try to prevent the hero or the main character to achieve his objectives. In general each game can have one or different kind of enemies controlled through artificial intelligence.

Table I: Character Description

Age	26
Height	170cm
Race/Nationality	American
Job Title	Soldier
Abilities	Has the ability to Double Jump, Has an Assault Cannon.
Purpose	destroy the enimey .

Levels description:

The most of video games have one or more levels, during this step the game designer has to develop the map associated in each level of the video game or each specific area that belong to the level; in addition he has to define the gameplay[10], the dialog, and the technical details that belong to each level by drawing a map with a legend "Figure 3" that represents the places of different components of level like "start point, Cheek points, Pickups System, Objects System..." and also the flow of path game progress.

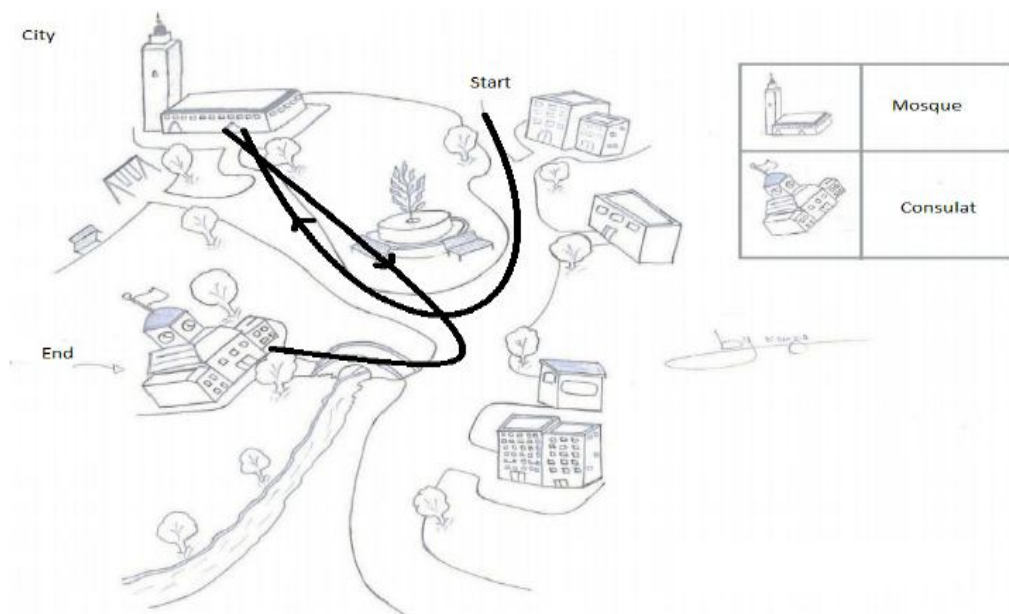


Figure 3: Map of the level with a Legend

3. Prototype & Development

In order to create a prototype of the serious game, we made several studies about methods and technologies of making games, and then we ended up with some requirements that our game should respect. In fact the tools and the game engine should be:

- Cross platform.
- Scalable / Extensible.

Among the game engines that we have used for the development of different video games to test the proposed model there are libgdx [7] and cooperlicht [8]. The two game engines are free, open source and cross platform. In this phase the game programmers can start working on the specification and conception using UML [9] in order to construct the basic layer that uses the basic functionalities of game engine ‘‘Figure 4’’, this layer will make use of all the coming development.

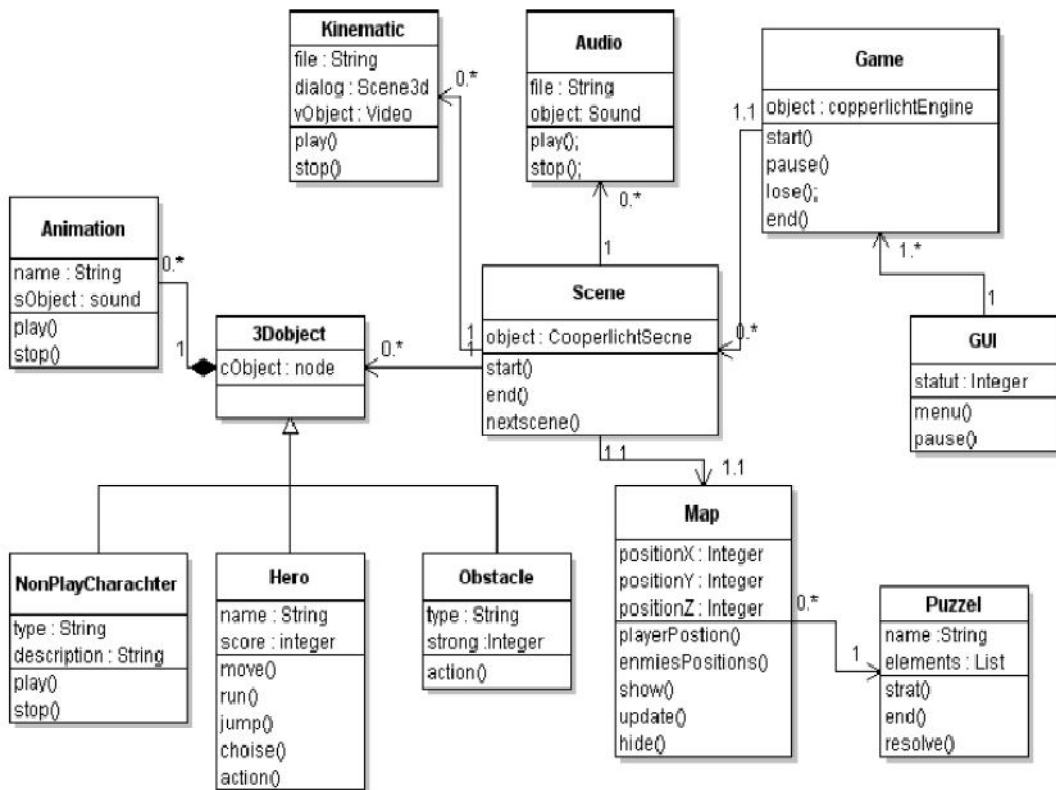


Figure 4: UML Class Diagram of Game Objects

4. Validation

The validation phase begins when the development of the first prototype has done, during this phase the game designer has to verify if all the pedagogical objectives mentioned in the need analysis phase, were implemented in the game in a proper way, The verification can be done by using a check-list Table II of all pedagogical objectives mentioned before. The advantage of the prototyping is that the users don't have to imagine what those specifications really mean in term of working system. They can actually experience it, and thus find the problems or enhancements that they may not have considered otherwise and also verify if the pedagogical objectives were respected. This phase play an important role in design process because it saves time and cost of process; because the pedagogical objectives will be validated before the development phase. In addition, during this phase several tests should be done by the game designer or by the test team to find 'bugs' in the programming code or graphic layers.

Table II: Cheek-List of Pedagogical Objectives

Pedagogical objective	Status	Description
Pedagogical objective ₁	OK	
Pedagogical objective ₂	KO	

5. Evaluation

The phase of evaluate is the final phase in the proposed model, in this phase game designer and the end developers will evaluate, continue the tests that was begun in the validation phase and confirm the final version of serious game developed by the development team. Among the criteria that have to be evaluated during this phase there are Reliability, Portability, Efficiency, and Maintainability. Accessing reliability, efficiency, and maintainability requires checks of at least the following software engineering best practices and technical attributes:

- For reliability there are Coding Practices, Complexity of algorithms, etc.
- For the performance efficiency there are Memory, network and disk space management, Coding Practices, etc.
- For the maintainability there are Code readability, Coupling ratio, Coupling ratio, Documentation, etc.

III. Results

By flowing the design process proposed in this paper, we have succeed to create some serious games "Figure 5, Figure 6 and Figure 7" related to different fields like religion, nursing training and humanitarian immunology. In general, the feedback of the learners who have used these video games was positive, and they have learned and in the same time enjoyed the experience.



Figure 5: Screenshot of Serious Game that Teaches Islamic Prayer



Figure 6: Screenshot of Serious Game that Teaches Immunological Technique

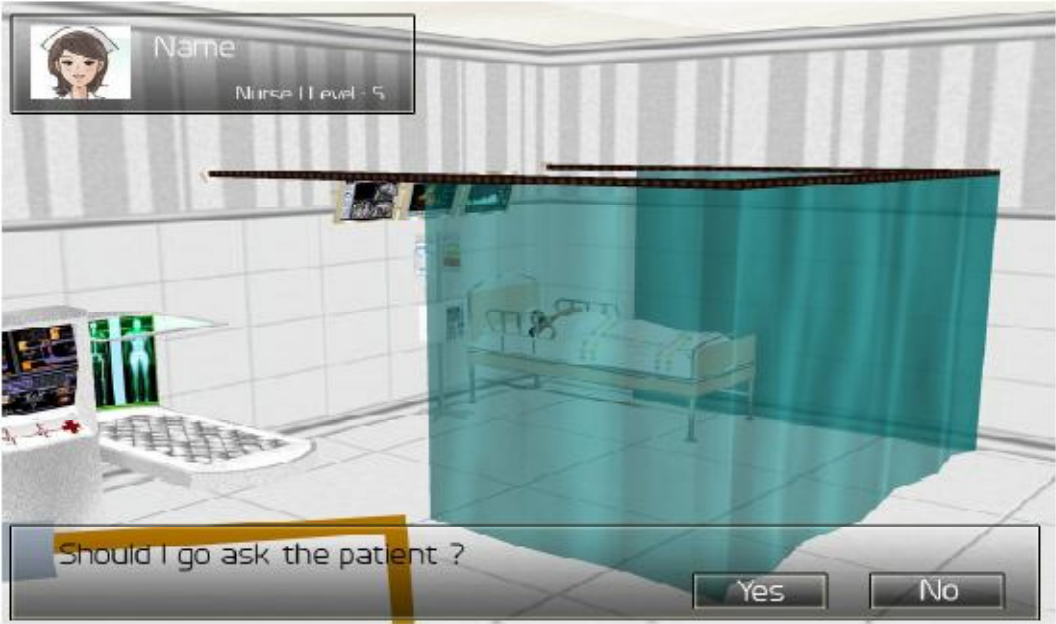


Figure 7: Screenshot of Serious Game for Nursing Education

As an example the video game that teaches Islamic Prayer was tested by 60 learners, including 20 children, 30 bachelor students and 10 master students, the statistical study Figure 8 was about learner satisfaction.

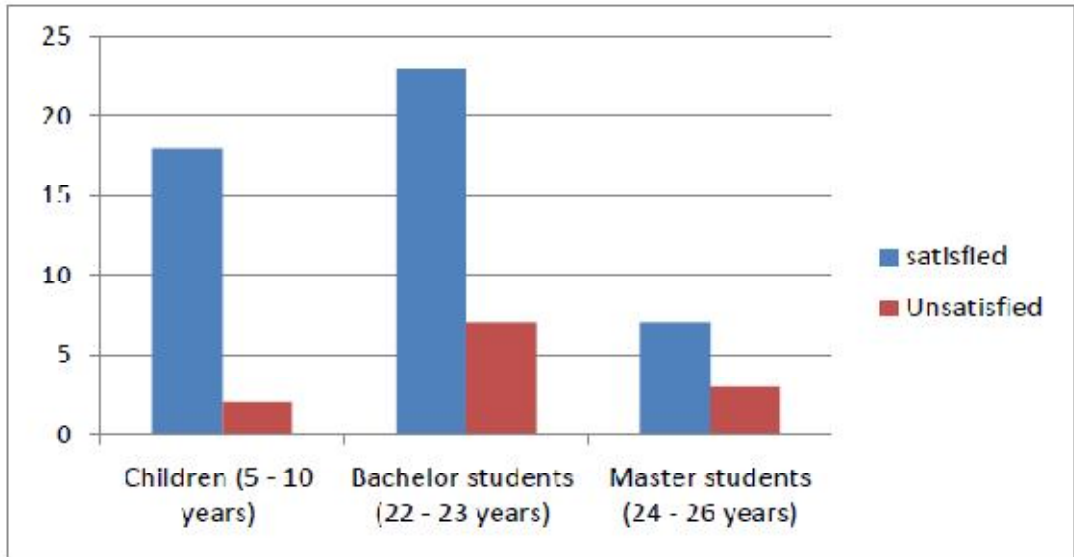


Figure 8: Graph Presentation of Learner Satisfaction

IV. Conclusion

To conclude, the proposed design model has proved successful by creating different video games in different fields, this methodology has fixed the majority of the issues met during the creation of serious games. Among the issues fixed there is complexity of the design process, the different phases of the proposed design methodology are clear, easy to establish and do not need the interaction of several experimented actors. Among the perspectives considered there is the development of a game generator dedicated for the non-experts "Instructors and Trainers" that allows the generation of different serious games without the interaction of game programmers or artistic team.

Acknowledgments

We gratefully acknowledge the support of the students and all other participants.

References

- Press Release, Serious games now \$2 to \$10 billion industry. [Online] Available: www.hypergridbusiness.com/2012/08/serious-games-now-a-multi-billion-dollar-industry/, (Aug. 23, 2012).
- I. Marfisi-schottman , A. Sghaier, S. George, F. Tarpin-bernard, P. Prévôt, "Towards industrialized conception and production of serious games, ICTE International Conference on Technology and Education" ,Paris,France,pp.1016-1020, 2009.
- Tripp, Steven and Bichelmeyer, Barbara. (1990) Rapid prototyping: An alternative instructional design strategy. *Educational Technology Research and Development*, 38, 1, Pages 31-44.
- D. Scott, Greenhalgh, Rapid prototyping in design education: A comparative study of rapid prototyping and traditional model construction, Utah State University, Jan.5, 2009.
- W. Scacchi, Process models in software engineering, Institute for Software Research, University of California, Irvine February 2001 Revised Version, May 2001, October 2001. Final Version to appear in, J.J. Marciniak (ed.), *Encyclopedia of Software Engineering*, 2nd Edition.
- Joiner Associates Staff. 2002. *Flowcharts: Plain & Simple. Learning and Application Guide*. Madison, WI: Oriel Inc. ISBN 1884731031
- Libgdx. Desktop/Android/iOS/HTML5 Java game development framework. [Online] Available: libgdx.badlogicgames.com/ (Jul.8,2013).
- Ambiera. Copperlicht WebGL javascript 3D engine with world editor. [Online] Available: ambiera.com/copperlicht (Jul.8,2013).
- Object Management Group, "Unified Modeling Language". [Online] Available: www.uml.org (Jul.8,2013).
- D.Djaouti,, J.Alvarez and J.P.Jessel. "Classifying serious games: The G/P/S Model." *Handbook of research on improving learning and motivation through educational games: multidisciplinary approaches*. IGI Global, 2011.