PROTOTYPING AND FEEDBACK DESIGN IN A SERIOUS GAME CONTEXT

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ABSTRACT
Serious gaming is on the rise, which results in a lot of discussion on how to effectively design serious games. A recently developed serious game (the Game of Games), allows students to learn and create a game while playing a game. In this paper tests and validates the game's second phase where students will learn about prototyping and feedback design. A considerable amount of literature is written on prototyping and feedback; however, within the context of serious gaming these subjects are relatively untouched grounds. Firstly a literature review was conducted and based on the findings we constructed a theoretical model which grasps these two concepts. This model was tested by a qualitative approach in a total of three cases. It showed the importance of involving feedback design in the prototype process, as it sped up the total development time and resulted in more in-depth games. The three cases in this paper gave promising results. It was discovered that the game can be improved by reducing the prototype cycle time. There was also an indication that a good integration between feedback design and prototyping can lead to more behavioral change, the ultimate serious game outcome.

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1. INTRODUCTION

Organizations have discovered the importance and opportunities that serious games offer, making serious gaming a fast growing sector within the gaming industry (Susi et al. 2007). Serious games are being used in a lot of different settings, ranging from healthcare to education. These games give us opportunities to simulate scenarios that are simply not possible to experience in the real world for the reasons of cost, time, safety, etc. (Susi et al, 2007; Corti, 2006). Serious games have already proven to be effective: Hamari et al. (2014) recently did a literature review of empirical studies on the subject, indicating multiple positive effects of serious games. As Dominiguez et al. (2013) have stated, serious games are a great tool to increase students' motivation to learn. However, there is a thin line between a game that is fun, but has a little educative value, and a game that is educative but not fun. Balancing these two values is vital in developing a useful serious game. One of the necessities to create this balance, is the feedback the player receives from the game. In order to increase the quality of serious games, this research hopes to detect the correct way of implementing feedback in a game. After all, learning should be made more fun, which is exactly the goal of this research.

1.1 Research problem

"The Game of Games" (from now on GoG) is a game in which players learn the different components of serious games by creating a serious game and undergoing the development processes themselves. The GoG is developed in the style of a board game and is based on existing game design theories. However, the choices of the creator still need to be scientifically proven. This is one of the problems tackled in this research.

Currently, the game has been put into practice by students in two different timeframes, over the period of one week, and over a period of ten weeks. The results are promising, but there is still room for improvement. One of the problems that was discovered was the absence of prototyping and feedback in the early stages of the game (Spil & Bruinsma, 2016).

Previous serious game projects showed us the importance of designing feedback for the players within the game (in prototyping). Feedback is considered one of the core mechanics of a game (Erhel, 2013). However, designing player feedback correctly the first time is difficult. When feedback is implemented incorrectly, for example, when the player receives the feedback too late, it affects the playability of a game. Even though playability is a main concern for business clients. Achieving balance between prototyping, feedback and playability, or flow, can be quite challenging.

1.2 Research Question

Combining a model, composed of prototyping- and feedback models from various peer-reviewed articles, and case study research, this research intents to answer the following research questions:

Main Research question:

How can we validate prototyping and feedback as a part of the Game of Games?

Sub Questions:

- *What is Serious gaming?*
- *What is the Game of Games and as what can it be classified?*
- *What is feedback in relation to game design?*
- *How are game prototypes developed?*
- *How can we relate feedback and prototyping to each other?*
- *How can feedback design be incorporated into the prototyping process?*

2. LITERATURE REVIEW

2.1 Serious gaming and the Game of Games

A brief description of the GoG is already given in the problem statement. If the underlying assumptions of the game are to be validated, a deeper understanding of the GoG is necessary. The amount of literature on games is vastly increasing and multiple different fields are emerging. There are multiple different definitions of serious games to be found in the literature. One that is often used is the one from Michael & Chen (2005): "Games that do not have entertainment, enjoyment, or fun as their primary purpose". It is important to mention here that serious games do not only exist in digital forms: they can also be presented in the form of, for instance, a classical board game.

Bringing up the second sub-question; how can GoG be classified? Does it classify as a serious game, or a gamified process? Gamification is an upcoming term in the last years, it has only been used since 2008 (Paharia, 2010). Gamification can be seen as enhancing of services to create "gameful experiences", something to be seen as a game, and further behavioral outcomes (Huotari & Hamai, 2012). As an elaboration of this definition, Hamari et al. (2014) conceptualized gamification as a three part concept with: "*Motivation affordance, Psychological outcomes and Behavioral outcomes*". However, the definition that is most accepted in the literature is the one of Detering (2012): "*Gamification is the use of game design elements in non-game contexts*". Detering (2012) also tried to map out the different forms and terms in game literature, as can be seen in Figure 1 below.

Since the GoG is a fully developed concept, unlike the partialities of gamification, it can be concluded that the GoG is a serious game.

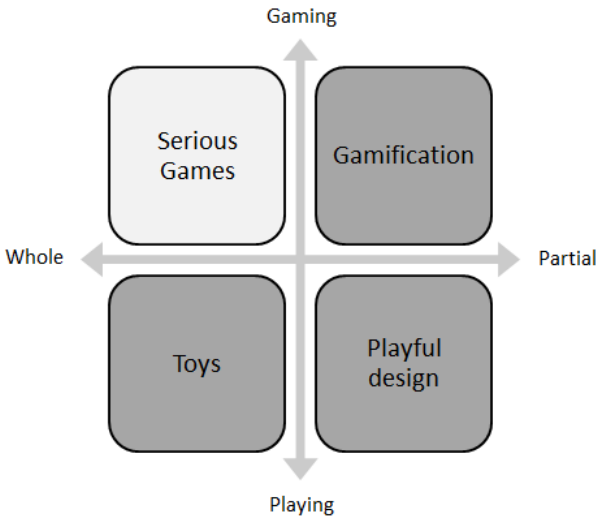

Figure 1 – Serious games between game and play, whole and parts (Detering, 2012)

2.2 Feedback in game design

Feedback is one of the key components of a game. According to Reeves and Read (2009), it is one of the "Ten ingredients of great games", giving a good indication of its importance. But what exactly is feedback? And how can we use it to increase engagement?

Feedback is generally conceptualized as 'the information the player receives from the game by preforming certain actions'. Feedback allows the player to monitor his progress towards a desired goal (Garris, 2002). In most games, feedback is present in the form of a continuous feedback loop.

When designing serious games, feedback loops can be used to the developers advantage. Butler (1995) argued the positive effect of feedback on learning. In his research, a distinction between immediate feedback and cognitive feedback was made. Immediate feedback ensures that the player keeps focused. Cognitive feedback has the aim to stimulate the player to reflect on his choices and actions in order to improve his own models and strategies (Butler, 1955). In other words, cognitive feedback increases the player's motivation for learning objectives. Another addition to this was made by Kiili (2012): "*If the player has to wait long before he can realize what effect his actions cause, he will become distracted and loose the focus on the task*".

Feedback can have multiple variables. However, some scholars differ on the amount of variables and their definitions. In Table 1, a comparison is drawn among different articles and the variables they mention.

Author	Type	Content	Format	Frequency/ Timing	Amount/ Complexity
Dunwell (2011)	+	+	+	+	
Shute (2008)	+			+	+
Kiili (2012)				+	
Fu (2009)		+		+	
Bellotti (2013)				+	
Erhel (2013)	+			+	+
Mory (2004)	+			+	+

Table 1 – Feedback characteristics from literature

Especially the Frequency or Timing of the feedback is often discussed, regularly characterized as immediate or delayed feedback. Also the content of the feedback is similar to the amount/complexity variable. The term content is preferred, while this also incorporates the desirability of the feedback in relation to the learning objective.

As shown in the Table, Dunwell's (2011) article includes the most complete definition. This definition of feedback, involving its four categories, has been used in the latter part of this paper, to create the theoretical model.

2.3 Prototyping in game design

Prototyping is a well know practice which is commonly used in product development. However, when searching literature that covered both prototyping as well as feedbacking, it was discovered this is still relatively untouched ground. Some scholars have discussed the subject of prototyping in game design, often by applying software development practices (Ollila, 2008, Eladhari, 2012). Fullerton (2014) underlines the importance of prototyping in his book about game design: he argues that prototyping is the creation of a working model of the idea that allows testing of the feasibility and improvement of the game. The focus of a prototype is to get the fundamental mechanics right, not perfecting the aesthetics or optimizing technology (Fullerton, 2014).

The prototyping process can be split down into different steps. These steps or phases, as argued by different scholars, can be seen in the Table 2. When we look at these different steps we can see a lot of similarities between studies. The core steps in prototyping include a design phase, followed by a creation phase, and lastly, a test phase. However, Olilia (2008) also discussed a kind of preliminary phase where needs of end users are sought out or identified. Furthermore, Manker (2011) wrote about an extra step in the prototyping process where multiple simple prototypes are combined into a larger and more technological advanced prototype. Vega (2009) also discussed the implementation phase, but this will not be used in the model, since it lies outside the scope of this paper.

Author	Identification	Design	Create	Test	Combine
Manker (2011)		+	+	+	+
Olilia (2008)	+	+	+	+	
Reuter (2014)		+	+	+	
Vega (2009)	+	+	+	+	

Table 2 – Prototype Phases from literature

All of the four papers above mention that the cycle time in the process is optimal when kept as short as possible and repeated frequently. Other papers not mentioned in Table 2, like Naumann (1982), do not mention this, probably because of the year of the publications. Nowadays, it is commonly accepted that the agile development method works (Ollila, 2008).

The paper by Ollila (2008) is also useful in determining which prototype method should be applied. This is based on the type of the game that is being developed. Whereas the phases of the prototype process remain the same, the choice between a physical or software prototype can be difficult. Table 3 shows the appropriate prototyping method based on the game type.

Game type	Prototyping method
Context-aware	Easier to implement as software prototype
Discrete (events occur in a predicTable manner)	Physical- as well as software prototypes
Continuous (e.g., events are functions of location and other sensor inputs)	Software prototype is useful
Technically innovative	Software and/or hardware should be used early to test technical aspects
Social novelty	Real users should be involved in realistic situations. Both software and physical

	prototypes can be used.
Complex interaction between gaming platforms	Can be difficult to demonstrate with physical prototypes
Persistent, long-term	Software prototypes or prototypes with software components are good. Testing with physical prototypes is difficult but can be useful in testing core mechanics
Player-to-game interaction: dexterity-based games	If manipulating game objects physically is central in the game, software prototype is needed.

Table 3 – Best suited prototype methods by Ollila (2008)

We saw that prototyping can be done in various ways and using multiple techniques. Combining the steps of the prototype process results in an approach using five phases. We defined these phases as follows in a chronological order: Identification, Design, Development, Evaluate, Combine. We discovered that these steps are independent to the prototype method. However, the prototype method is important for a successful prototype and this depends on the type of game that is being created.

2.4 Implementation of feedback into the prototype process

Feedback is one of the most important aspects of a serious game (Kiili, 2012). However, as discovered earlier, feedback as a concept is hard to grasp and consists of multiple layers (Dunwell, 2011). By structurally implementing the components of feedback design in the prototype this research hopes to improve the effectiveness of the process. In order to test this, a theoretical model needs to be composed, as shown in Table 4.

Protoype phase	Type	Content	Format	Timing
Identification	+			
Design	+	+	+	
Development		+	+	+
Test				+
Combine	+	+	+	+

Table 4 – Feedback design within the prototype phases

Table 4 was constructed, based upon the findings of the literature. The goal was to link the four categories of feedback design to specific prototype stages.

The identification stage is about learning the desires of the end users. There is no need to think about the content, format of timing yet. However, in order to decide what role the feedback should be playing in the game (type), it is necessary to discover the demands of the end users.

When entering the next phase of prototyping, the design process, feedback design plays a bigger part. In this stage, the learning objectives of the game should have already been established, or just in need of fine-tuning. So, the next logical step is to design feedback loops in relation to these objectives; the content of the feedback. The format also needs to be thought about, as this is how the feedback will be given to the player (e.g. by images or text).

The development stage, when the actual prototype is being produced, should still include the content and format. However, the timing starts to play a role now as well. Timing is all about giving the feedback to the player at the correct moment. The type, content and format, on the other hand, should already have been designed at this point.

The test phase should be primarily about testing the timing of the feedback. Because this is a hard category to design, the best results come because of extensive testing.

The combination of multiple prototypes will require the developer to think about all the feedback categories in order to eliminate redundancy.

3. METHODS

For this study, a combination of qualitative research methods was used.

First, a literature review on the ground of feedback design and prototyping in relation to serious gaming was conducted. Articles of Scopus were used, since Scopus uses a proper search engine and contains a large pool of good quality and peer-reviewed articles. The search of papers incorporating both feedback design and prototyping in relation to serious gaming led to no results. However, a relation between these two concepts was still expected. Therefore, it was decided to look into prototype as well as feedback literature in order to construct a new conceptual model.

In search of literature about feedback, there was searched for the words: “feedback AND gam*”. By using “gam*” as term we can include both game and gaming. Furthermore, the results were limited to papers from the computer science field, published between 2000 and now. This gave a total of 2855 paper, so it had to be narrowed down to another search query. Only papers with the keyword combination of 'feedback and any other form of gaming related keyword were allowed. This resulted in 49 papers, but after reading them, only found 8 out of the 49 proved to be useful for the research.

For the prototype literature the same technique was adopted, using “prototype* AND gam*” as term. The field and date restriction were kept the same. Again, a combination of key words was sought after, between prototype related and game related keywords. This eventually resulted in 59 papers, of which a total of 4 papers were suitable for the research.

The papers are compared in pivot tables and selected in order to come up with a conceptual model.

For the second part of the study, a case study method was chosen. The use of case studies gives this research the advantage of examining the data within the context of its use (Yin, 2013). This makes it perfect for testing our developed theory, because it can be tested within its own environment (Zainal, 2007).

There are a total of three cases and all of these include a group of persons who developed or are developing a serious game. Reviewing the development process of these groups gave an insight into their interpretation of feedback design, and how they made their own prototypes.

In order to answer the research questions proposed in the introduction it is also necessary to discover the underlying thoughts of the game creators. For the primary data collection method, the choice was made to conduct interviews with these game developers. As a secondary data collection method, data about their games was reviewed. These reviews of their games and reports written about the game creation process, combined with the interviews should be enough to draw sound conclusions about the hypotheses.

For the first case, interviews with three group members were conducted. This resulted in a lot of redundant information and

was thus not necessary. Therefore only one interview for case 2 and 3 was conducted.

As for the analysis method, the processes as distinguished by Miles and Huberman (1994) is used. They talk about three processes in the analysis: data reduction, data display and conclusion. For the data reduction and data display a table to look at the similarities between answers and the conceptual feedback prototype model was created. As for the final process, a cross-case analysis was used. Miles and Huberman (1994) claim that cross-case analysis can be of good value when comparing units as "*It enhances generalizability as well as deepening the understanding and explanation of a phenomenon*" (Miles and Huberman, 1994).

4. RESULTS

This section contains the results of the three case studies. The cases will be put into perspective, based on the subsections of this paper's theoretical background, as stated; feedback design, prototyping, and the combination of the two.

4.1 Case 1 – Start-up game

The first case is a serious game made by five students of the University of Twente. It was part of a ten week course about serious game creation. They were handed tools by their supervisor in order to apply theoretical knowledge about serious games and game design. The development process was stimulated by using the scrum project management method. They created a game with the learning goal to create a better understanding of start-ups in the form of a board game.

4.1.1 Feedback design

In the first stages of the development process the group focused primarily on the timing of feedback they were using and the purposes of the feedback. They tried to apply proven game mechanics and their associated feedback design to their game. Also the format of the feedback was easy to design because the game is a board game. However, the group put in little effort on which type of feedback they wanted to use because of their little scientific knowledge about feedback design. The content of the feedback was addressed in later stages of the development, but it was a result of testing. They figured out that some parts were too complicated for the players. A good example of this was mentioned by one of the creators in the interview: "*We had little cards with too much information written in a small red font. This resulted in players getting confused because of the large amount of unnecessary information*."

4.1.2 Prototype process

The first prototype was ready in week four of the ten week program. After this first paper prototype the group made a new improved version every week. The first prototypes were tested by the group themselves and were later on tested by other players. Functionality was their prime objective and the visual aspects were developed later. The testing of the learning objectives proved a bit more difficult because the targeted group of players was poorly formulated.

4.1.3 Implementation of feedback design in the porotype process

The group was not entirely aware of the importance of implementing feedback design in the prototype process. Therefore many decisions regarding the change of feedback principles occurred too late in the game development process. This became apparent during the interview as they evaluated their own performance, by saying: "A lot of mistakes in feedback design could have been avoided".

4.2 Case 2 – Kidney game

The second case is also about a serious game created by students, however, this case has been created in a different setting than the previous one. It was created by a group of four students of different universities in a summer school setting. The total development time was ten days, which came with a lot of challenges. The game was designed for people in need of a donor kidney.

4.2.1 Feedback design

A fundamental of this game's feedback design was the importance of the storyline of the game. The type of feedback was therefore quite clear from the start. The overall goal was to create a simple game. When asked about the thought process behind this choice the response was:

"*This was a deliberate choice, as the group wanted to develop a game that has a low threshold to start playing, and of which the rules are easy and quick to understand. This to avoid that people would spend time on reading a long manual of discussing uncertainties about the rules*."

This gives a clear indication that the format and context were carefully considered. The timing aspect was introduced in later parts of the development process.

4.2.2 Prototype process

The first three days of the development process contained brainstorming and some education about serious games. After this brainstorming, multiple paper prototypes were constructed and the most promising would be developed into a game.

4.2.3 Implementation of feedback design in the prototype process

The implementation of feedback design in the prototype process was direct, as the supervisors aided the students a lot in designing the appropriate feedback. This enabled the group to deliver a full working prototype in a short period of time.

4.3 Case 3 –Childcare workers game

With the third case, there was the ability to look inside of the creation process of a serious game instead of only doing a review after the game was finished. The game itself is created for childcare workers. The goal of the game is to share knowledge and best practices between employees from different municipalities. The game is developed by two scholars from the University of Twente, both serious gaming experts.

4.3.1 Feedback design

The game is designed around the game Ludo and Trivial Pursuit, a basic board game played with a dice and pawns. However, in order to achieve the learning goal of the game, several tiles were added. When a player encounters one of these tiles they have to share their best practices and write them down, this to enable the players to discuss best practices and thus share knowledge between organizations. The player wins if all best practices are obtained.

4.3.2 Prototype process

The brainstorming process was conducted with potential players. Social workers thought about what they would like to learn and played several games which eventually are going to show their values. Based on these findings a first prototype was created. This prototype was tested with the same group of people, resulting in useful feedback. The game is still in development and will therefore be tested further in the future.

4.3.3 Implementation of feedback design in the prototype process

Within the prototype process the creators of the game took a lot of feedback principles into account. This resulted in a short development time. First, they looked at the desired type and content of feedback. Due to this the game was fundamentally well designed and still simple in play.

4.4 Cross case analysis

The cases will be compared using the same subsections of the previous chapters.

4.4.1 Feedback design

In case 1 and 2 students were aware of feedback design, but they did not have enough knowledge on the subject. This resulted in a trial and error approach in the prototype phases. Nonetheless, by using feedback design elements from existing game elements, they still managed to deliver a good playable game. This is in contrast to case 3, where the game is being made by experts on the subject. This resulted in a much better first prototype thanks to the well-considered feedback design. The type, content and format were good. However, the timing still needed adjusting. This was also a result of our interviews: "*To get the timing correct, one has to guess instead of apply exact science*" this was supported by two out of three creators interviewed.

Feedback design	**Case 1**	**Case 2**	**Case 3**
Type complexity	Low	High	Low
Content Amount	High	Low	Low
Format Style	Multiple	Multiple	single
Timing	Immediate	Dynamic	Immediate

Table 5 – Feedback design per case

Especially case 2 had a well-balanced game, where a combination of well thought game design and simplicity is key. case 3 is also simple and good at achieving its goal. However, due to the low complexity it can become boring quite easily.

4.4.2 Prototype process

In the first two cases the prototype process was a cycle that was repeated frequently, resulting in an improved version every time the cycle was completed. After interviewing participants from these cases we noticed the importance of short prototype cycles. A lot of small steps are better than a large step, as this eliminates unnecessary work and keeps the game developing consistently. Small prototypes can eventually be combined into a new version of the game. This was also acknowledged during the interview with an expert from case 3: keeping the prototype cycle short improves the quality of the outcome. This can be clearly seen by the results of case 2. The pressure of delivering a full functioning game within a week resulted in a good game; it is arguably better than the other games. So by adding this "pressure cooker effect" into the GoG the outcome could be improved.

4.4.3 Implementation of feedback design in the prototype process

In Table 6 a visualization of the prototype path followed by the cases was made. The grey cells represent the path as was described in our model and each number corresponds with the case numbers.

Prototype Phase	Type	Content	Format	Timing
Identification	23	1		
Design	2	23	123	
Develoment		23	123	2
Test		1		123

Table 6 – Prototype feedback model with the addition of the cases

In case 2 and 3 there was some amount of implementation of feedback in the prototype process. In case 1, on the other hand, there was little to none. This can also be seen in the end product of case 1. The game is fun and flows well but the feedback design is quite shallow and it is mostly based around direct feedback. Case 2 is already an improvement when compared to case 1; it has a more in-depth feedback design resulting in a more complex game, thus doing a much better job at achieving its learning goals. Case 3 is the best example of the effect of implementing feedback design: the feedback was designed with the learning goals in mind. The resulting game achieves its ultimate goals.

5. CONCLUSION AND DISCUSSION

The main goal for this research was to discover how to validate feedback and prototyping as a part of the Game of Games. By conducting a literature review in the first part of this paper it was found how these concepts of feedback and prototyping were embedded in the literature. Based on these findings a theoretical model was constructed to grasp these two concepts into a single model. This model (of introducing certain parts of feedback design into specific phases of the prototype process) was also supported by our qualitative research.

Can feedback and prototyping be validated as a part of the Game of Games? Yes, with a high amount of certainty. Both the literature review and case studies have shown the importance of the two. Even though the Game of Games is a game about educating players on serious gaming, it should thus contain a part about feedback and prototyping.

The right combination of feedback and prototyping could arguably lead to a better behavioral outcome; well-designed games are better at achieving their learning goals while still remaining fun for multiple use.

However, looking at the relation between prototyping and feedback, it gets a little less certain. The model in this paper was created by combining existing models of feedback and prototyping. The three cases indicated that this model could be correct. Nevertheless, three cases are not enough to validate this model and further research should be conducted.

One of the findings was the effect of the length of the prototype cycle. Longer prototype cycles did not result in better games. Testing is massively important and should happen as early and as often as possible.

Also, knowledge about feedback design and serious games in general will speed up the creation process as it eliminates most of the trial and error part of designing feedback. This is not the case with the timing of the feedback. Correct timing is immensely challenging to achieve in the first prototype and should thus be improved in next prototype cycles.

Another thing to mention is the fact that none of the games described in our cases have ever hit the market, as none of them are completely finished. Topics of future research could consist of researching how to fully develop games.

6. REFERENCES

Bellotti, F., Kapralos, B., Lee, K., Moreno-Ger, P., & Berta, R. (2013). Assessment in and of serious games: an overview. *Advances in Human-Computer Interaction*, *2013*, 1.

Butler, D. L., & Winne, P. H. (1995). Feedback and self-regulated learning: A theoretical synthesis. *Review of educational research*, *65*(3), 245-281.

Corti, K. (2006). Games-based Learning; a serious business application.*Informe de PixelLearning*, *34*(6), 1-20.

Deterding, S., Dixon, D., Khaled, R., & Nacke, L. (2011, September). From game design elements to gamefulness: defining gamification. In *Proceedings of the 15th international academic MindTrek conference: Envisioning future media environments* (pp. 9-15). ACM.

DomíNguez, A., Saenz-De-Navarrete, J., De-Marcos, L., FernáNdez-Sanz, L., PagéS, C., & MartíNez-HerráIz, J. J. (2013). Gamifying learning experiences: Practical implications and outcomes. *Computers & Education*, *63*, 380-392.

Dunwell, I., De Freitas, S., & Jarvis, S. (2011). Four-dimensional consideration of feedback in serious games. *Digital games and learning*, 42-62.

Eladhari, M. P., & Ollila, E. M. (2012). Design for research results experimental prototyping and play testing. *Simulation & Gaming*, *43*(3), 391-412.

Erhel, S., & Jamet, E. (2013). Digital game-based learning: Impact of instructions and feedback on motivation and learning effectiveness. *Computers & Education*, *67*, 156-167.

Fullerton, T. (2014). *Game design workshop: a playcentric approach to creating innovative games*. CRC press.

Fu, F. L., Su, R. C., & Yu, S. C. (2009). EGameFlow: A scale to measure learners' enjoyment of e-learning games. *Computers & Education*, *52*(1), 101-112.

Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, motivation, and learning: A research and practice model. *Simulation & gaming*, *33*(4), 441-467.

Hamari, J., Koivisto, J., & Sarsa, H. (2014, January). Does gamification work?--a literature review of empirical studies on gamification. In *System Sciences (HICSS), 2014 47th Hawaii International Conference on* (pp. 3025-3034). IEEE

Huotari, K., & Hamari, J. (2012, October). Defining gamification: a service marketing perspective. In *Proceeding of the 16th International Academic MindTrek Conference* (pp. 17-22). ACM.

Kiili, K., de Freitas, S., Arnab, S., & Lainema, T. (2012). The design principles for flow experience in educational games. *Procedia Computer Science*, *15*, 78-91.

Manker, J., & Arvola, M. (2011, July). Prototyping in game design: Externalization and internalization of game ideas. In *Proceedings of the 25th BCS Conference on Human-Computer Interaction* (pp. 279-288). British Computer Society.

Michael, D. R., & Chen, S. L. (2005). *Serious games: Games that educate, train, and inform*. Muska & Lipman/Premier-Trade.

Mory, E. H. (2004). Feedback research revisited. *Handbook of research on educational communications and technology*, *2*, 745-783.

Naumann, J. D., & Jenkins, A. M. (1982). Prototyping: the new paradigm for systems development. *Mis Quarterly*, 29-44.

Ollila, E. M., Suomela, R., & Holopainen, J. (2008). Using prototypes in early pervasive game development. *Computers in Entertainment (CIE)*, *6*(2), 17.

Paharia, R. (2010). Who coined the term "gamification". *línea] Quora.< http://goo. gl/CvcMs> [Consulta: 15/11/12]*.

Shute, V. J. (2008). Focus on formative feedback. *Review of educational research*, *78*(1), 153-189.

Susi, T., Johannesson, M., & Backlund, P. (2007). Serious games: An overview.

Spil, T. A., Bruinsma, G. (2016). Designing Serious Games with the Game of Games.

Reeves, B., & Read, J. L. (2009). Total engagement. *Using Games and Virtual Worlds to change the way people work and businesses compete*, 132-133.

Reuter, C., Tregel, T., Mehm, F., Göbel, S., & Steinmetz, R. (2014, October). Rapid Prototyping for Multiplayer Serious Games. In *European Conference on Games Based Learning* (Vol. 2, p. 478). Academic Conferences International Limited.

Vega, K., Pereira, A., Carvalho, G., Raposo, A., & Fuks, H. (2009, October). Prototyping games for training and education in Second Life: Time2Play and TREG. In *2009 VIII Brazilian Symposium on Games and Digital Entertainment*.

Wolfswinkel, J. F., Furtmueller, E., & Wilderom, C. P. (2013). Using grounded theory as a method for rigorously reviewing literature. *European Journal of Information Systems*, *22*(1), 45-55.

Yin, R. K. (2013). *Case study research: Design and methods*. Sage publications.

Zainal, Z. (2007). Case study as a research method. *Jurnal Kemanusiaan*, *9*.