A Serious Game Proposal to Reinforce Reading Comprehension in Scholars

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Abstract. Reading comprehension is a cognitive activity, which development promotes complex and fundamental processes helpful to access learning; it is connected to the world understanding in a participatory way. Consequently, it is essential to acquire this ability at an early age. Particularly for children, the videogames motivational aspect makes them an attractive resource in reading comprehension. In this paper is presented the development process of a serious game as a support for the reading comprehension process. The videogame is oriented to strategies related to syntax through fill-in-the-blank exercises. The game tutorial is illustrative for the children to understand the game mechanics, the avatar movements and the interaction with the game elements; an exploratory study was conducted to observe its effectiveness.

Keywords: Serious games · Reading fostering · Game design · Tutorial design

1 Introduction

Decoding text is the baseline for reading. However, a single-by-single word reading is not enough to comprehend what is written. Comprehensive reading involves word decoding along with language understanding [1]. Although decoding and comprehension are highly related, a person with decoding word ability does not necessarily have also comprehensive reading skills.

Reading comprehension relays on several factors, both text and reader related. Text related are for example, the type of text or the amount of new information, and reader

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related are the reader's prior knowledge or decoding skills, which includes even affective factors such as motivation or self-perception [2].

The development of comprehensive reading is crucial for another cognitive process such as the development of thought [3]. And therefore, it is important to acquire this ability at an early stage, for the child to go successfully through the first years of the scholar stage.

People who lack the ability of reading comprehension requires to experience diverse literate practices, preferable with different strategies to build the tools to interpret and organize texts on their mind [4]. As Dubbels [4] pointed out, comprehension is transmedia, this means that it does not depend only on formal printed material. Also, other key processes for comprehending printed material are helpful in different communications and media. Dubbels [4] also stated that games represent a medium to build comprehension, because they provide interaction, feedback and demand mastery, with the incentive to reengage in the development of different skills.

Nowadays, children are digital natives. They interact with technology on an everyday basis. New trends in pedagogic reinforce the use of ICT to motivate active learning [5] because as has been established, motivation is a fundamental factor in learning. Serious games are one of these trends, these are video and computer games with other than just entertaining purposes, mainly with training or educational aims [6]. Therefore the use of videogames that comprises technology media and games represent an adequate platform to reinforce reading comprehension.

1.1 Related Work

In [3] a study was conducted with 228 children in 5th grade, with the aim to evaluate four designed strategies for reading comprehension: (1) activating prior knowledge, (2) clarifying difficult words, (3) making schematic representations, and (4) formulating the main idea of the text. Results showed that children were able to apply the comprehension strategies in different contexts. Authors summarized that by immersing children in a learning environment, based on highly interactive instructional techniques, they fostered the adoption of helpful comprehension strategies.

Regarding serious games, in [7] was presented a game prototype designed under the frame of the TERENCE European project [8], aimed to improve reading comprehension skills in primary school poor comprehends. The learning task consisted of reading a story, then play with smart games for the stimulation of inference making about the stories, and then playing with relaxing games to motivate the learner. The paper presents the design and development of the playing material.

A serious game to improve reading comprehension skills in 3rd graders was developed by [9]. They applied a User Centered Design, particularly the child-centered interaction proposed in [10]. They followed three stages for the design: (1) the design of the menus, characters, scenarios, textures, scripts, among other items, (2) the development of the actions and functionalities to interact with the game, and (3) the application of a functionality test. This serious game follows a storyline approach. A study was conducted to measure usability and acceptance with good results.

In our case, as a request from the program to promote reading "*Letras para Volar*" (Letters to Fly) from the Universidad de Guadalajara, a serious game was proposed to

encourage reading comprehension in children in the range of 7 to 9 years old. Our approach consists on completing a task in order to get a reward, that in this case are missing words of a sentence that they have to locate in the correct place. Fill-in-the-blank is a well-known technique frequently used in exercises for reading comprehension. This involves word decoding, syntaxes knowledge, and reading comprehension in order to situate the recovered words in their correct place, according to the text of the story.

In the next Sect. 2 the game design is presented, and in Sect. 3 is presented an exploratory test focused on the game tutorial effectiveness, finally, in Sect. 4 conclusions and future work are discussed.

2 Serious Game Design

BrinCuentos is the name of the proposed videogame; its name derives from the mix of two words in Spanish, jump and stories, since its principal game mechanics is jumping.

BrinCuentos is categorized as a serious game because its primary purpose is not pure entertainment, and therefore its development process is not necessarily identical to the one for entertainment games.

Mildner and Floyd Mueller [11] pointed out the design of serious games presents two particular different challenges, when compared with regular game design. First, serious games have to be both attractive and effective, requiring a balance of task difficulty and skill level; and second, they require involving domain experts. Serious games design has to be conducted holistically avoiding just inserting to the serious content in a game or vice versa. The game design takes care of the relevant aspects of the internal structure and external structure, while the game production takes care of content production and game programming.

As Abeele et al. [12] recommended on their framework for design and development of serious games, BrinCuentos followed their four pillars: (1) a player-centered design, (2) an iterative development, (3) an interdisciplinary teamwork, and (4) the integration of play and learning. Their interactive development approach consists of three main phases: *concept design, game design* and *games development.* In the concept phase stage the understanding of the players and the involved domain is acquire. In the design phase the concept is transformed into a detailed game that serves as input for the final phase. In the final phase, game development and user tests are specified, and also the risks that could represent delays or problems.

Figure 1 depicts the development process of BrinCuentos. Defining the design challenge and a review of the state of the art were part of the concept design. Then for the game design were used the next techniques: an executive script, action verbs identification, brainstorming, and paper prototyping. Finally, for the game development the digital prototyping development, test and the release version were accomplished, by following an iterative and incremental approach. These steps are next briefly described, while they are linked to BrinCuentos examples.

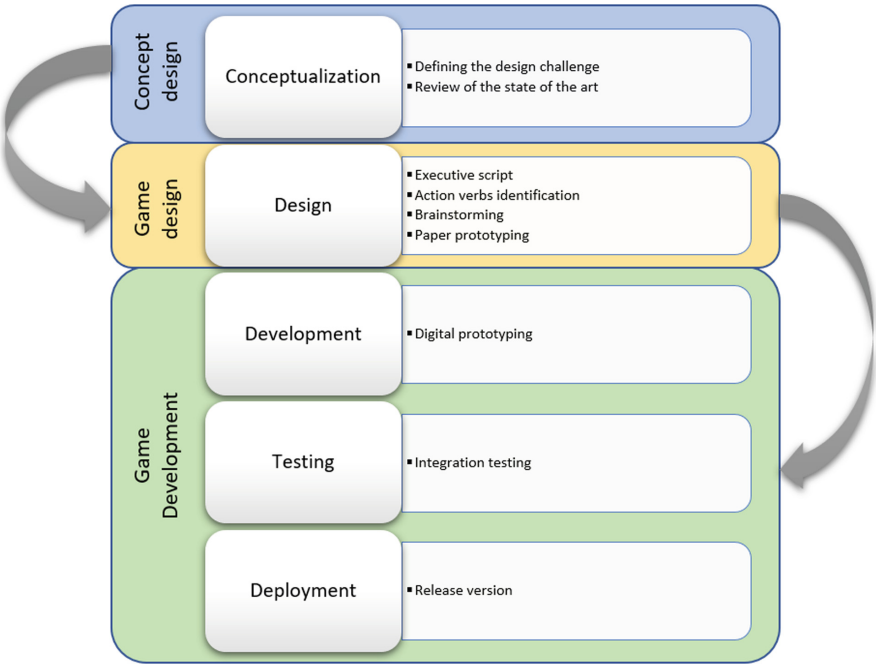

Fig. 1. Iterative cycle of the serious game development

Defining the Design Challenge. In this step, the main objective, the audience, and the platform were decided. For example, *the video game promotes reading for children in the range of 7 to 9 ages. It has to be compatible with Android-based mobile platforms.* Here was determined that BrinCuentos intended to have simple rules and to be somehow easy to master, so the player does not require investing major time to learn how to play it.

State of the Art Review. Similar products on the market, directly or indirectly tackling the design challenges were reviewed trying to identify achievements and deficiencies on each one of them. That is to say, written material, games, videogames or apps aimed to promote reading with the same target audience as BrinCuentos were reviewed.

Executive Script. This is an approach that provides a narrative context for the game mechanics design. For example, "*A monster that devours words from books arrives at the Earth. People can no longer read. Your mission will be to defeat those monsters and return the missing words to the books".*

Action Verbs Identification. Action verbs were selected from the executive script as key for the game mechanics. Taken for the previous example of the executive script: *devour* and *return.* Returning words to their place on the text, which represents a fill-in-the-blank exercise. From this step arose the question: How can we make fill-in-the-blank exercises fun?

Brainstorming. As a result of this approach, it was decided to simulate somehow the marble game that is usually played at fairs, like the one presented in Fig. 2, that consist on throwing marbles to holes with some determined value.

Fig. 2. Marble game

Then a paper prototype was designed and tested within our target audience, at the popular First Literary Festival organized by the "*Letras para Volar*" program of the Universidad de Guadalajara, which took place at the center of Guadalajara city. Figure 3 shows the paper prototype being tested at the festival.

Digital Prototype. In this stage the elements of the game's execution environment that were validated in the paper prototype were implemented. Here, the Unity™ game engine was used.

Integration Testing. The assembly between the different components as a unite was verified. Also an exploratory test presented on this paper in Sect. 3 was conducted.

Release Version. Brincuentos was decided to be distributed through the Google Play Store™.

The conceptual design took around 8 months, while the production took around fourteen months.

2.1 Videogame Mechanics

After downloading the game, a tutorial is presented. This tutorial is detailed in the next Sect. 3. The proper game starts with the user selecting a female or male avatar. A series of three sequential stories are available; the first one is "*Dany el ensuciador*" (Dany the dirty one) written by Andres López, and the second one is "*Las reglas de la manada*"

(The rules of the pack) written by María Furquet. These two short stories are property of AMCO International Education Services, LLC. The last story is Tassie, written by Alberto Ramírez Lujano. The stories were broken down in small parts with sequential sentences of the general story; they are called "pages" in the game.

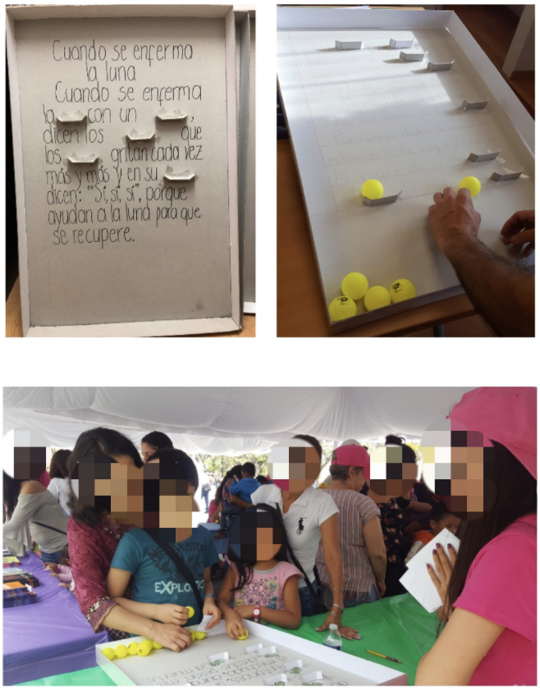

Fig. 3. The paper prototype tested with the target audience at the Literary Festival

The player has to climb by jumping on small different type of platforms (see the left image of Fig. 4); the mobile device gyroscope is used to articulate the avatar's jumping direction. On his/her way up, the player can stomp monsters and defeat them to recover the words represented by spheres (or marbles). When the player arrives at the top there is a book, as can be seen in the right image of Fig. 4.

Afterward, again using the mobile device gyroscope, the player can place the missing words on its place, avoiding obstacles like monsters, black holes or mines. If the word is misplaced, the monster eats it; otherwise, the monster is defeated by the sphere. When all the words are correctly placed, the player gets a new page of the story. The accumulated pages can be read when a new page is earned.

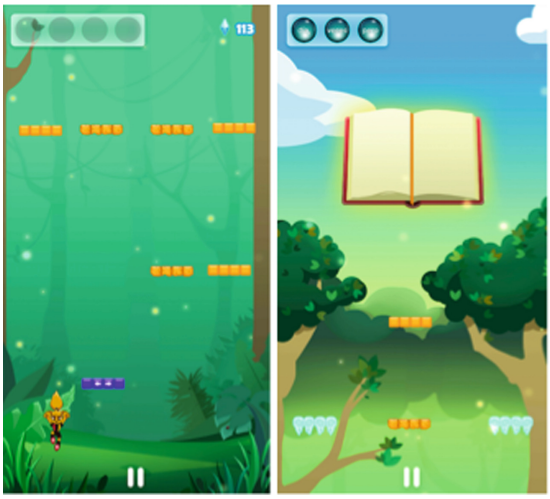

Fig. 4. Climbing stage to recover missing words

Fig. 5. Placing the words stage

On its way, the player earns points, represented by diamonds. The number of accumulated diamonds is placed at the right top corner of the game (see Figs. 4 and 5). With these diamonds, the player "pays" to unblock the next story.

3 Exploratory Test for the Game Tutorial

As mentioned, BrinCuentos design was driven by managing simple rules easy to understand and master. The game mechanics are explained in a game based tutorial, that is, instead of only written instructions, images and the user interaction conducts the tutorial.

The tutorial start with the image shown in Fig. 6, on it can be observed on the right bottom corner a mobile device figure with arrows, the mobile device figure moves to show how the device has to be manipulated to start the game. The sphere with the word "*Jugar*" (play) has to be moved, when the sphere touches the diamonds they disappear, and when it touches the monster it disappear and the sphere takes its place, then you have to touch the play sphere to continue.

Fig. 6. Starting game screen

Then the story regarding the monsters that are eating words goes on seven sequential screens, and then the game for the tutorial starts. In the first page two sentences with missing words replaced by monsters can be seen, and the word "*Jugar*" (play) in a bottom that when is touched triggers the tutorial game. Then the player has to select a male or female lion, his/her avatar. In the next screen, similar to the one shown in Fig. 7, it also appears the white figure of the mobile device figure, this time with only two arrows that show how to move it in order to jump through the platforms. The only way to get to the top is by jumping on the one placed monster, this shows the words the player wins by defeating it, on the left bottom corner.

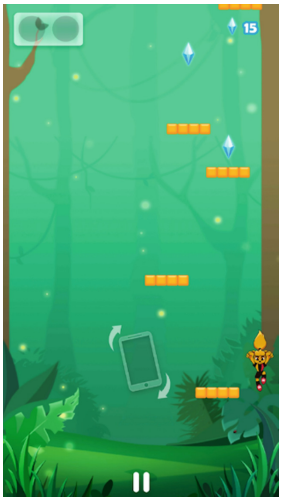

Fig. 7. Tutorial screen with a figure for instructions

Then the two earned words have to be placed in their right place to continue. Here the sentences have the instructions to place the spheres, see Fig. 8; the first sentence translation is “Hit the monster with the right word”, the word “the” is represented by a monster, and the second one translation is “The monsters eat the wrong words”, the word “eat” is also represented by a monster.

Fig. 8. Tutorial screen with instructions like game

3.1 Methods and Materials

An exploratory test was conducted with the aim to understand to what extent the tutorial helps the kids to understand the mechanics of the game. The talk aloud usability test adaptation from Doker and Reitsman [13] was selected because this test uncovers more problems than when children answer specific questions. It consists of asking the children what they are doing while they perform the application; though, children have to be encouraged to keep talking.

Five children voluntarily played the game with their parents' consent. Two male, one is 8 years old and one is 10 years old, and three female, two are 7 years old and one is 8 years old, as shown in Table 1.

Table 1. Participants data.

ID	Age	Gender
P1	8	F
P2	7	F
P3	7	F
P4	8	M
P5	10	M

The 10 years old child was included to asked him to play without performing the tutorial. The other four kids "played" the tutorial and started to play the game with the "Dany the dirty one" story for only a few minutes, however, one girl (P1) played until she got the first page.

The game was played at an Acer™ Tablet Model Iconia One7 with Android system, 7" screen, 8 GB ROM and 1 GB RAM.

Each child was taken by an adult to a room with doors open trying to avoid distractions. The children were told that they were going to be sound taped. They were instructed as follows: "*Hello, we need your help to find out if a videogame is well done and if it is fun*", then they were asked their data: name, age, and gender. Then they answered two questions: (1) "Have you ever played videogames in a cellular phone?, and (2) Have you ever played videogames in a tablet? Then they were instructed "*While you are playing comment to us about what you are doing*" when they staid quite for a while they were encouraged to comment on what they were doing. At the end they answered two more questions: (1) Did you like the game? And (2) Do you remember what was the story about?

3.2 Results

All the participants had experience playing videogames in tablets, and P1 and P3 did not have experience in smartphones, these results are shown in the second and third column of Table 2. The time to complete the tutorial varied in the range to 3:04 to 8:08 min, as shown in the fourth column of Table 2. The participant with the ID P5 is the 10-year-old child that was asked to play the game without following the tutorial, he could not found out how to manage the avatar jumping by himself, so the game was restarted for him with the tutorial.

Table 2. Participants' time to complete the tutorial.

ID	Smart phone	Tablet	Time to complete the tutorial
P1	✗	✓	3:04
P2	✓	✓	8:08
P3	✗	✓	3:18
P4	✓	✓	5:29
P5	✓	✓	5:20

As was observed during the test, the moving figure with the mobile device and the arrows, was a helpful tool to show the children how to manipulate the table to direct their avatars' jumps. They understood at the very moment what they had to do.

Regarding the instructions for the spheres, only two children (P1 and P3) explained out loud how they had to choose what sphere was on what place. The other three children seem to solve the task by a trial and error approach, however, this was not confirmed by a direct question.

Only P3 asked questions, like "how do I play this?", "what do I have to do?", or "how do I move this?", the questions were answered with questions to guide her to found out by herself how to play. The other participants just commented on what they were doing.

The five children expressed that they like the game, and they remembered the introduction story of the tutorial game. They also expressed that they only need more practice to master the game.

This exploratory test helped us to understand the extent to which the children comprehend the tutorial instructions. We believe, that even if they do not read the instructions for the spheres in the tutorial, during the game they will figure out the convenience of understanding where the spheres should go on the first place, instead of using a trial and error approach, however, this has to be tested.

P1 was the only that finished the first page of the game. It took her around half an hour to complete it. This can be seen as a drawback in the game, but we consider that as any game, with practice the player get better scores, and the difficulties him/her to stay interested in it. Although, this requires more inquiry, especially regarding the support for reading comprehension main target of the game.

4 Conclusions and Future Work

Because of the motivational nature of videogames, particularly in children from this technology era, a serious game was designed with the aim to support reading comprehension in children of the ages of 7 to 9 years old. The steps for its design are here described. Game design elements such as rewards and narrative are part of this serious game proposal.

An important factor of the design was to keep the game fun for the users while improving their comprehension reading abilities and avoiding the sense of being in a traditional learning scenario.

An exploratory test on the tutorial as a game was conducted. Results showed that the game as tutorial was helpful for the children to understand some mechanics of the game, although, it seems that others could be reinforced.

For future work, we will compare this serious game results regarding reading comprehension on a long-term approach.

The game is available at Google Play Store™ and to this day it has around 500 downloads.

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References

1. Gough, P.B., Tunmer, W.E.: Decoding, reading, and reading disability. Remed. Spec. Educ. **7**, 6–10 (1986). https://doi.org/10.1177/074193258600700104
2. De Corte, E., Verschaffel, L., Van De Ven, A.: Improving text comprehension strategies in upper primary school children: a design experiment. Br. J. Educ. Psychol. **71**(4), 531–559 (2001). https://doi.org/10.1348/000709901158668
3. Bravo Valdivieso, L.: El aprendizaje del lenguaje escrito y las ciencias de la lectura. Un límite entre la psicología cognitiva, las neurociencias y la educación. Límite **11**(36), 50–59 (2016)
4. Dubbles, B.: Video games, reading, and transmedial comprehension. In: Handbook of Research on Effective Electronic Gaming in Education, pp. 251–276. IGI Global (2009). https://doi.org/10.4018/978-1-59904-808-6.ch015
5. Kiryakova, G., Angelova, N., Yordanova, L.: Gamification in education. In: Proceedings of 9th International Balkan Education and Science Conference (2014)
6. He, L., Hu, X., Wei, D.: The case analysis of Serious Game in community vocational education. In: Proceedings of 2011 International Conference on Computer Science and Network Technology, vol. 3, pp. 1863–1866. IEEE (2011). https://doi.org/10.1109/iccsnt.2011.6182333
7. De la Prieta, F., Di Mascio, T., Gennari, R., Marenzi, I., Vittorini, P.: Playing for improving the reading comprehension skills of primary school poor comprehenders. In: Proceedings of the PDSG 2012 Workshop. CEUR-WS (2012)
8. TERENCEProjectWebSite. http://www.terenceproject.eu/. Accessed 20 Feb 2019
9. Gaytán-Lugo, L.S., Santana-Mancilla, P.C., Santarrosa-García, A., Medina-Anguiano, A., Gallardo, S.C.H., García-Ruíz, M.Á.: Developing a serious game to improve reading comprehension skills in third graders. Res. Comput. Sci. **89**, 71–79 (2015)
10. Tan, J., Goh, D., Ang, R., Huan, V.: Child-centered interaction in the design of a game for social skills intervention. ACM Comput. Entertain. **9**, 2 (2011). https://doi.org/10.1145/1953005.1953007
11. Mildner, P., Floyd Mueller, F.: Design of serious games. In: Dörner, R., Göbel, S., Effelsberg, W., Wiemeyer, J. (eds.) Serious Games, pp. 57–82. Springer, Cham (2016). https://doi.org/10.1007/978-3-319-40612-1_3
12. Vanden Abeele, V., et al.: P-III: a player-centered, iterative, interdisciplinary and integrated framework for serious game design and development. In: De Wannemacker, S., Vandercruysse, S., Clarebout, G. (eds.) ITEC/CIP/T 2011. CCIS, vol. 280, pp. 82–86. Springer, Heidelberg (2012). https://doi.org/10.1007/978-3-642-33814-4_14
13. Donker, A., Reitsma, P.: Usability testing with young children. In: Proceedings of the 2004 Conference on Interaction Design and Children: Building a Community, pp. 43–48. ACM, June 2004. https://doi.org/10.1145/1017833.1017839