

A contextual study and usability testing of videogames to inform the design of a serious game to improve reading comprehension

Laura S. Gaytán-Lugo¹, Sara C. Henández¹, Pedro C. Santana-Mancilla², Miguel A. García-Ruíz³

¹CEUGEA, University of Guadalajara, Mexico

²School of Telematics, University of Colima, México

³Department of Computer Science and M., Algoma University, Canada

laura.gaytan@cucea.udg.mx, shernand@cencar.udg.mx, psantana@ucol.mx, miguel.garcia@algonau.ca

Abstract—The results of different evaluations on reading comprehension in Mexico are not good. In recent years the use of video games in this country has increased, showing that this technology is already popular in Mexico. This paper shows the development and results of a contextual study, and subsequently, of usability testing in four videogames conducted in groups of third graders from different urban public schools in Armería, Colima, México. Results on the willingness of third graders about the use of video games as well as their reading, and other technology use habits are showed.

Keywords— *Serious games, reading comprehension, third graders, contextual study, usability*

I. INTRODUCTION

According to [1], reading abilities are important for a young person to be able to pursue their personal goals when embarking on adult life. The successful acquisition of reading skills during childhood is therefore fundamental. [2] explains that reading comprehension is an act that takes time to develop, so it is impossible to prove a lack of reading comprehension in children when they still do not learn to read accurately and fluid enough. Consequently, past research on reading comprehension reports that children at the age of 8 and older are the ones that start suffering the lack of such activity. [3] mentions that reading difficulties have important implications for children's emotional development. Reading may represent a painful process that demands a great effort and is extremely frustrating, which explains a bad academic achievement, low self-esteem and seriously compromises the prognosis of any therapeutic intervention.

According to a report written by [4], 41% of Mexican students do not reach basic skills level in reading comprehension; while the Organization for Economic Co-operation and Development (OECD) average score is 496, Mexican students have an average of 424. The OECD estimates that Mexico would take 65 years to reach the current OECD's average. Meanwhile, in Spanish language in reading comprehension and reflection on language at a national level, one fourth graders is on the "Under basic" level, while the 56% is on the "Basic" level and, 17% and 2% on the "Medium" level and "Advanced" level respectively.

On the other hand, it has been widely publicized that we can leverage upon the engaging and motivational aspects of video games for transforming the way people learn and make learning more enjoyable [5]. [6] explains that he observed that children who are heavily involved with computer games often show an exceptional degree of sophistication in their ways of thinking and talking about learning. [7] mentions that a serious game is a mental contest which is executed on a computer and contained specific rules and uses entertainment for supporting government or corporate training, education, health, and strategic communication objectives. The quality of serious games is characterized by the degree to which purpose has been fulfilled [5].

Nowadays, serious games are receiving interest from researchers because of their educational advantages [8]. Some Mexican researchers [9]-[12] have noticed this, so they have started to take advantages of the goodness of serious games for different purposes.

Mexico has a niche of opportunity since [13] explain that according to PricewaterhouseCoopers (PwC), the video game industry in Mexico had an average annual growth of 18.7% during 2004-2010. In 2010, the Mexican market was worth US 757 million, placing the country among the top 15 video game markets worldwide, being the first in Latin America (See Figure 1). This shows that video games are already popular in Mexico.

Therefore, the challenge is to create a serious game to improve reading comprehension skills of third graders. Nevertheless, at a first step, it needs to design a suitable solution that should be centered on the needs and requirements of such students, so their personal, cultural and contextual characteristics must be taken into account.

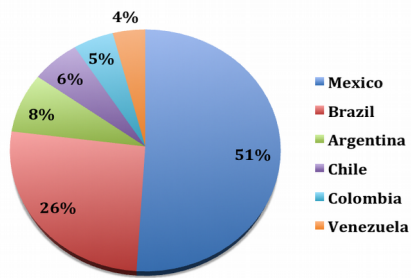


Figure 1. Distribution of the video game market in Latin America 2009-2013.

II. METHOD

The User Centered Design (UCD) paradigm was used in our project, which involves the implementation of several techniques and methodologies in order to know the user and their needs, tastes and desires [14], thus, ensuring the participation of the user, in this case third graders, in the first part of the project which is the development of a contextual study.

Designing for children is different from designing for adults, because it brings different demands and challenges, as children have different perceptions and make sense of the world around them differently. What children expect and how they make meaning in the computer applications may not be aligned to the designers' assumptions. They interact differently to technological systems due to their varied cognitive and emotional developmental needs, skills, and knowledge [15].

A. Participants

76 children enrolled to four different urban public schools from Armería City, Mexico. After obtained the necessary consent, children were surveyed. Forty-one of the children were girls and thirty-five were boys. The range of ages was from 8 to 13 years ($M = 8.44$ years, $SD = 0.78$).

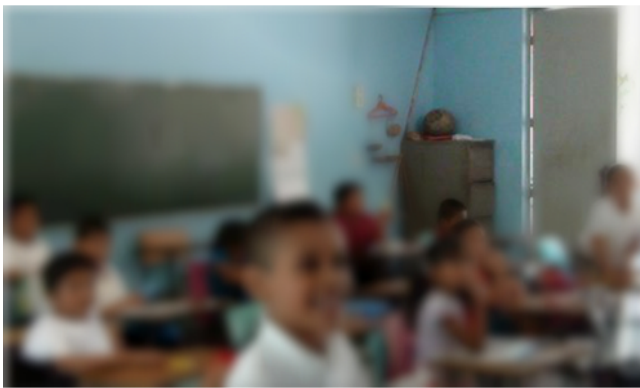


Figure 2. Children participating in the survey.

B. Experimental design

The experiment was divided into four parts: a feasibility analysis from the selected schools, a general survey, a review

of the individual surveys, and finally, usability testing of four video games.

The feasibility study consisted of verifying the infrastructure and the conditions of the computer lab in each school. We verified that all the computers were in good working order. Why is this important? [16] explained during their presentation the problems they got because they develop a serious game without taking into account the types of computers where they were going to execute their game; their original game was in 3D, nevertheless they had to change everything to 2D. It is important to mention that in all the schools that we included in our studies, computers were about 7 years old, and teachers and students use them for only 2 or 3 hours per week.

The next step was to observe students in their natural learning environment, that is, a classroom. This made possible to begin to identify and understand the interaction that children have among themselves, with teachers, with some parents and other relevant people.

A survey was conducted in order to know their likes and habits at home and at school related with technology, which included the use of computers, game consoles, cell phones and television sets. The following are most of the questions that we asked to the students:

- Have you ever used a computer?
- Do you have computer at home?
- How much time do you spend on your computer?
- What are the activities you do on the computer?
- How much time do you spend watching TV?
- What kind of shows do you like to watch?
- Do you like to play video games?
- What kind of video games do you like to play?
- Do you prefer to play video games in a console or in a computer?

After we analyzed the surveys, we proceeded to talk to each child in person, since some of the surveys were incomplete or unreadable. This helped to know the answers more accurately. It also created an atmosphere of trust and affection, which made the conversation more enriching, since some of the children shared or gave more detailed information during our interviews.

Finally, after talking to each child and, with the intention to test the interaction of them with some video games of interest to this project, we chose 12 children who were considered the most extroverted. This was very important not only because these children were able to tell how they were feeling at that moment, but also because at the end, children had to answer different questions related with the usability of video games. Four different video games of different genres (Role-Playing Game, Action/Adventure, Platform and Strategy) were tested. It is important to mention that these video games were recommended by [17]. Some of the questions asked during the interview were: Do you like the story of the video game? Do you think it is easy to play this

game? Do you like the game? Do you think this video game is fun? What would you change about this video game? Of course, some questions arose depending on the role that the child was having on the game and her/his answers.

III. RESULTS

C. Survey

Results given by the survey were very interesting because we could appreciate how children interact with technology. These are some of the highlights of the survey:

- The computer was the most used technological tool : 78 children knew what a computer is; 73 children have used a computer; 31 children have computers at home; while only 23 have Internet access from their computers.
- Narrative stories were the most frequently mentioned texts to read, while fantasy was the most favorite genre.
- The time children spent at a computer was on average 51 minutes per day.
- The average reading per day was 24 minutes. 66 children have used a cell phone to play a game, but only 22 mentioned having access to a cell phone from a family member.

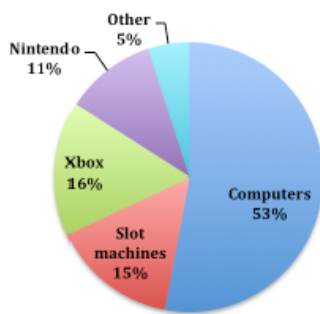


Figure 3. in what platform did children play games the most?

D. Interview

We found that the strategy genre was difficult for children, and although "Learn to Play" was the first part to play, the use of both mouse buttons and the keyboard to navigate in the game was complicated, accounting for 10 out of 12 children. Only 2 of them (a girl and a boy), completed the tasks in a short time and accurate; the boy said to have experience with this type of video game.

Another comment of some children was that is not funny to send their "heroes" to battle against the bad guys, and do not have total control of them, because they cannot manipulate their player as they want. The icons and options of the game were misunderstood. For example, we asked to all the children to exit the game and no one could do it, because they were looking for a button with an "X" on it. On the other hand, they

enjoyed the introduction of the video game and the "voice of the game" that was helping them with clues.

The second video game was an action/adventure 3D game. The first problem we found with this video game it was the movement of the main character, because when children were trying to steer it over the room rom the game, they crashed against the wall in the game, and they got stuck there for seven minutes. Thus, there was no easy control of the avatar. There was an alarm to warn about the "life" of the avatar, which had for and against comments; some children found it very annoying and even frustrating, while others found that it was a warn for puting more effort into the game. Another problem was the use of some combination keys in order to jump or do special moves. Only one boy found how to do it. Only 3 children were not lost in the map. The rest of them were constantly passing the same halls or rooms in the game. Something they liked the most was to change the name of the main character by the children's names.

Regarding the third video game used in our study, most of the children already had experience in this type of game. They commented that it was not difficult, but they lost faster in this game than in the others. Also, we noted that those children did not care about losing in the game. They were excited trying to get fast to the next level. They had no problems with the steering of the avatar. One of the features they liked best was to choose among different characters, being a male or female avatar.

Finally, the children interacted with a role-playing game, which was chosen by 10 children as their favorite. They mentioned that one of the features that they really enjoyed from that game was that the movement of the character was really simple; they also mentioned that the map not only showed where they were, but also where they had to go. As in the second game, they could also enter the character name, so some of them were very happy when their name appears in the story. They liked having hidden passageways and the idea of the story, to be the one that help vulnerable people. The only problem that we noticed was when they were trying to enter their name, they had to use arrow keys as a Cartesian map in order to find the letters. They even mentioned that it would be easier if they just enter their names using the keyboard.

IV. INSIGHTS AND FINDINGS

As [14] pointed out, a contextual study will always be useful and important for the development of user-centered projects. The power to give voice to the needs of communities that are vulnerable or, at times, that are not always taken into account in a particular way, leads to great rewards that are not measured only with numerical indicators. When it have a correct approach, users respond with gratitude and they share details of their daily life, which is why it have to operate ethically and respond with a solution to their needs.

This step was very important for our research because we found many interesting issues that we will use for designing our future prototypes. For example, children from the study preferred a simple way to move with only a few keys; graphics are not the most important, but the simplicity of the gameplay.

The story of the game was also very important, because, as they mentioned, they enjoyed being the good ones to help others.

Now we can say that, even when children have reading and writing issues, they enjoyed playing video games without worrying if they had to read, listen or write in the game, and that is a good signal.



Figure 4. A child playing a game during the interview.

V. FUTURE WORK

Now with these highlights that we have collected, the next step will be to design a prototype on a serious game for improving reading comprehension in third graders. In addition to national diagnostics and results of the deficiencies on the reading skills, we are going to apply some tests to fully identify which skills need more attention, so we can also start to work the instructional design.

ACKNOWLEDGMENT

We want to thank to the Secretariat of Public Education in the state of Colima, especially the Educational Services Unit of Armería, Mexico for allowing us to work and offer their support. We also thank to the National Council of Science and Technology (CONACYT) for its financial support.

REFERENCES

[1] Education, Audiovisual and Culture Executive Agency. 2011. *Teaching reading in Europe: Context, Policies and Practices*. Technical Report. European Commission.

[2] K. Nation, J. Cocksey, J. S. H. Taylor, and D. V. M. Bishop, "A longitudinal investigation of early reading and language skills in children with poor reading comprehension.," *J. Child Psychol. Psychiatry.*, vol. 51, no. 9, pp. 1031–9, Sep. 2010.

[3] F. Gómez-Velázquez, A. González-Garrido, D. Zarabozo, and M. Amano, "La velocidad de denominación de letras," *Rev. Mex. Investig. Educ.*, vol. 15, pp. 823–847, 2010.

[4] OECD. PISA 2012 Result in focus. What 15 years old know and what they can do with what they know. Technical report. 2013.

[5] T. Marsh, "Serious games continuum: Between games for purpose and experiential environments for purpose," *Entertain. Comput.*, vol. 2, no. 2, pp. 61–68, Jan. 2011.

[6] Papert, S. 1998. Does Easy Do It? Children, Games, and Learning. *Game Developer Magazine*. 5, 6 (Jun. 1998).

[7] M. Zyda, "From visual simulation to virtual reality to games," *Computer (Long. Beach. Calif.)*, vol. 38, no. 9, pp. 25–32, Sep. 2005.

[8] V. Vangnes, N. T. Gram Økland, and R. Krumsvik, "Computer games in pre-school settings: Didactical challenges when commercial educational computer games are implemented in kindergartens," *Comput. Educ.*, vol. 58, no. 4, pp. 1138–1148, May 2012.

[9] L. Armería-Zavala, S. Hernández, and M. A. García-ruiz, "Designing Interactive Activities within Scratch 2.0 for Improving Abilities to Identify Numerical Sequences," in *Interaction Design Children*, 2013, vol. 2012, pp. 423–426.

[10] C. García-García, J. L. Fernández-Robles, V. Larios-Rosillo, and H. Luga, "ALFIL," *Int. J. Game-Based Learn.*, vol. 2, no. 3, pp. 71–86, Jan. 2012.

[11] L. Gaytán-Lugo and S. C. Hernandez-Gallardo, "Towards Improving Reading Comprehension Skills in Third Graders with a Serious Game," in *20 International Conferences of Computers in Education*, 2012, pp. 1–4.

[12] P. C. Santana, "Arquitectura para Interacción Multimodal en los Juegos por Computadora," pp. 114–117, 2011.

[13] PROMEXICO. ¿Por qué México? Por su amplia red de tratados y acuerdos comerciales. (2012, October 20). Available <http://mim.promexico.gob.mx/>

[14] M. A. Moreno Rocha and C. A. Martínez Sandoval, "Desarrollo del Proyecto de Red Contextual: Estudio Contextual y Pruebas de Usabilidad en la Comunidad de," in *Congreso Internacional de Tecnologías de la Información*, 2012.

[15] J. L. Tan, D. H.-L. Goh, R. P. Ang, and V. S. Huan, "Child-centered interaction in the design of a game for social skills intervention," *Comput. Entertain.*, vol. 9, no. 1, pp. 1–17, Apr. 2011.

[16] Education, Audiovisual and Culture Executive Agency. 2011. *Teaching reading in Europe: Context, Policies and Practices*. Technical Report. European Commission.

[17] R. Puentedura. (2012, November 15). Game and learning: an introduction to educational gaming. Available: <http://www.hippasus.com>