Alien Health: Promoting nutrition with video games in support of a science education curriculum in Chile

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***Abstract*—In order to be successful on a complex, computer-based and knowledge-driven society, both students and teachers must include Information and Communication Technologies (ICT) efficiently in learning and instruction. The visual nature of some technologies, particularly animations, simulations and mobile imagery, engages more students and reinforces the understanding of content. Video games offer the possibility to understand complex real-world ideas in an interactive manner both within the classroom as well as outside of it. An educational intervention was carried out through the collaboration between Chile, United States and Spain, focusing on the use of an interactive videogame to strengthen healthy nutrition habits with 45 primary education students in Chile. All students participated in a regular natural sciences unit during three weeks. Afterwards, the 3th graders were randomly assigned to either the ''Alien Health'' videogame or a treated control condition. A pre and post-intervention food habits test measured the acquisition of the knowledge content. Statistical analysis showed that the experimental group obtained significant learning gains on both the immediate nutrition knowledge and in the follow up test, compared to the control group. There were no gender differences. We can conclude a positive effect in knowledge retention, which suggests that the game and its narrative may have instructed in and helped to consolidate content memory.**

Keywords— videogames; serious games; nutrition habits; science education; knowledge retention.

I. INTRODUCTION

There is a new digital profile that describes today's students. According to different authors, students can be named as the Net Generation [1], Digital Natives [2], Solutionaries [3] or the Global Empowered Kids [4]. Today's youth systematically use digital technologies and these uses are emeshing them into a globalized society [5, 6]. Between teachers and students there can exist a cognitive and generational difference, as today's children are individuals who multitask during many waking hours and handle digital devices with an innate appropriation. In addition, they interact within hypertextual environments and on-line learning communities with confidence. In order to be successful in a complex, computer-based and knowledge society, both students and teachers must include Information and Communication Technologies (ICT) efficiently, so as to "help students to acquire the basic competencies needed to be proficient" [7, p. 2].

To keep up with ICT demands, educational institutions are investing in equipment and connectivity and are developing platforms to manage information systems and virtual learning environments. UNESCO [8] emphasizes the growing importance of these technologies and stresses that the incorporation process they have had in the Latin American and Caribbean educational system has failed to provide a substantial effect on the quality of education. One explanation for this is related to the lack of an educational purpose or objective for the use of these technologies and the strategies to

reach these goals. The first generation of computerized educational content was not strong [9]. There is still a dearth of high quality educational videogame and Virtual Reality content (Johnson-Glenberg in press). The educational integration of technologies, strong content, and policies related to their use in educational and national settings are relevant elements of the new educational environment on the search for quality in education.

As pointed out by Claro, Espejo, Jara & Trucco [10] technological devices can potentially create or increase the existing gap in education and society, in terms of access or their educational use. It is evident that one of the main uses of technologies is aimed to improve or facilitate a learning process. Accordingly, one of the major difficulties for researchers is the lack of a stated relation between the type of impact and/or effect that ICT can have on learning. There is a clear contrast between the prevalence of findings focused on constructs like motivation and attention [11, 12 and 13], and the scarce positive results on students' academic achievement [14, 15, 16 and 17].

Passey, Rogers, Machell, & McHugh [18] and Condie and Munro [19] have shown that the visual nature of some technologies, particularly animations, simulations and mobile imagery, is highly engaging for students and can serve to reinforce the understanding of concepts. Video games offer the possibility to learn and understand complex real-world concepts in an interactive way without losing the connection between abstract ideas and real-world problems in which they can be used to solve problems by organizing meaningful learning experiences both within the classroom, as well as outside of it.

We believe that STEM (Science, Technology, Engineering and Mathematics) especially lends itself to learning via simulations (see for example www.PHET.org) and games. In this context, there are interesting video games focuses on STEM education. One of them was created by students of the University of Caucain Colombia, called *Nutri-Galaxy* [20]. It is aimed to teach the nutrition function to children in 6th grade of primary school. The other one was designed by Parra-Navarro, Paez, Pirez and Marques [21] called *Space Adventures*, a serious game for childhood obesity prevention in Brazil. It promote healthy feeding through the consumption of healthy food by children in the three main mails (breakfast, lunch and dinner) and drinks.

In the same field, the Embodied Games Lab in Arizona (https://www.embodied-games.com/) creates educational video games to empower learners to comprehend 4th to 16th-grade content using gesture-based methods and motion capture. Examples of some of the content are: Mitey Fields and Electric Fields in which a simulation of the electric field are explored and players interact with the formula for Coulombs' law. The science of nutrition is of interest to this team and so we chose to focus on one of the lab's games called Alien Health which instructs students about nutrition and healthier food habits.

II. ALIEN HEALTH VIDEO GAME

An experiment was performed that focused on the use of interactive video games to strengthen healthy nutrition habits of several primary education students in Chile through the use of Alien Health. This Video game was chosen because it has been tested previously with excellent results [22, 23] and it has a Spanish version.

This game was designed using the embodied cognition theory, which is based on the hypothesis that cognition is tightly linked to the body and its physical affordances [24].

As Johnson-Glenberg, Savio-Ramos and Henry describe [22] this video game was developed to teach about five nutrients: protein, carbs, fiber, vitamins/minerals and fat, taking in account policies promoted by the Dietary Guidelines - Center for Nutrition Policy and Promotion - USDA [25]. In this context the three levels of the the video game focuses on the food quality over caloric quantity, and encourage students to develop the ability to think about what food could satiate more and is nutritive to the body (see figure 1).

Fig. 1 Alien Health's screenshot

The research questions of this paper are:

1) Will primary school Chilean children learn more nutrition content when the learning is accompanied with an interactive embodied activity and an engaging game narrative?

2) Will the learning gains be maintained after 3 months?

In this context our prediction as a main research hypothesis is:

Hi: The experimental "Alien Health" game group will show greater learning gains on the post-test and in the follow up test compared to the control group.

III. METHOD

A. The research approach

This research was carried out through an intervention during the second semester of 2016, at the end of the academic year, in a semi-public school in Chile thanks to the collaboration between three institutions: Universidad Católica de la Santísima Concepción (Chile), Arizona State University (United States of America) and Universidad de Extremadura

(Spain). The method used was quantitative with a type of research transactional involving forty-five 3rd graders divided into two groups. This children had between 7 and 8 years old. The control group (Cont) was formed by 25 students while the experimental group (EG) was constituted by 20 students (Boys=56%; Girls = 44%).

Students were randomly assigned to either the use of the "Alien Health" video game methodology or the traditional method without the use of technologies in the classroom.

In the first phase, all students participated in a regular class covering the contents of the first unit from the natural sciences' subject. During three weeks students needed to achieve the following learning objective: to classify food, distinguishing its effects on health, and propose healthy eating habits [26]. In Accordance to the program studies, they have to identify healthy foods that contribute to the body's nutrition, to recognize hygiene habits for food handling and to apply knowledge of the food pyramid, its food groups, and contributions. In addition, this research seeks to help strengthen specific skills in the use of ICT mentioned in the curriculum of this educational level, which seeks specifically to integrate technologies in the development of projects and activities at all stages where the scientific learning occurs at school [27].

In the second phase, one month later, the experimental group interacted with the video game and experienced the full game narrative of feeding the Alien certain foods and then receiving immediate automated feedback on the quality of performed exercises. The 3rd-grade students played and interacted with the Alien Health game in the computer lab equipped with 20 computers and Internet connection, where the video game was installed in its Spanish version (can be accessed here https://www.embodied-games.com).

The data collection instrument was used to test food habits, this was applied as a pre-test and post-test to measure the acquisition of the contents studied. Before the test application, it was validated by three science teachers, in order to ensure that the questions were in agreement with the contents suggested by the national curriculum. The test included a mixture of 46 forced-choice and open-ended items.

The data collected was statistically analyzed in a descriptive and inferential manner using the SPSS program in its 20.0 version.

IV. Results

The comparison analysis through the t-test for independent groups shows that there were no significant differences in the knowledge test scores of healthy habits between Cont and EG before the intervention. In order to respond the research questions a comparative analysis was made. Descriptive statistical analysis through the Mean (M) and Standar desviation (SD) showed that the EG obtained significant learning gains (Pre-test M=20.85; SD=6.95; Post-test M= 43.20; SD= 7.804;) on the immediate nutrition knowledge than the Cont (Pre-test M=20.60; SD= 8.56; Post-test M= 31.48; SD= 8.74).

After the use of the "Alien Health", the analyzes showed significant differences in the test scores for healthy eating habits ($t(43)=4.68$, p <.0001). This difference was also evidenced when the follow-up test was performed three months later, in which the EG results were significantly higher than those of the Cont compared to the initial test ($t(43) = 6.01$, p <.0001).

Within group, both groups made significant gains in learning by post-test (EG paired $t(19) = 9.94$, p<.0001; Cont paired $t(24) = 5.88$, p<.0001) and follow up test (EG paired $t(19)=10.86$; p<.0001; Cont paired $t(24)= 2,99$, p<.006).

Analysis according to gender also revealed that girls demonstrated higher scores than boys in healthy habit tests. In sum ,girls obtained 2.86 points more than boys on the pre-test, and 4.00 points more in post-test. Despite this, those differences are not significant before or after the intervention using the game Alien Health. In the follow up test, boys (M= 31.10, SD 6.06) did somewhat better than girls (M= 28.76, SD 6.76) obtaining 2.34 more points.

V. Discussion

Our findings are similar to others like those published by Johnson-Glenberg and Hekler [22], and specifically the results agree with those reported by Nicolas and Badilla [28] where the experimental group obtained higher scores showing significant differences than the control group using the Word-E video game in secondary education to learn English as a second language.

The findings agree with Kebritchi, Hirumi and Bai [29] who investigated the effects of the use of mathematics games (Dimension U) on high school students. Although it could not be compared to the control group due to the lack of development of similar activities without video games, the results indicate that the treatment group increases their scores in a performance test in standardized mathematics.

Results obtained strongly suggests that the video game activity and the compelling game narrative may have helped to consolidate content memory. These findings are in the same line that those mentioned by Johnson-Glenberg, Savio-Ramos and Henry [23] who used the Alien Health video game with the Microsoft *Kinect* sensor while engaging in short cardiovascular exercises.

VI. Conclusions

Here we address the two main research questions. The first one related to the pedagogical content: Will primary school Chilean children learn more nutrition content when learning is accompanied with ICT that includes an embodied activity and an engaging game narrative? Results suggest that the use of the Alien Health educational video game, in addition to the regular classroom activities, enhanced learning about nutrition content in children who participated in the intervention. Although both groups had better scores in the post-test, the

difference was significantly higher in children who played the video game.

There was also a positive effect of video game use on knowledge retention, which is related to the second research question. Results in the follow-up test were expected, since the experimental group obtained significantly better scores than those of the control group compared to the initial test. Although the results in both groups decreased compared to those in the post-test, they remained statistically significantly higher than those obtained at the beginning of the experiment. Finally, and in accordance with the results obtained, one can accept the research hypothesis that the experimental "Alien Health" game group showed greater learning gains on the post-test and follow up compared to the control group.

This study also suggests the importance of an adequate evaluation of the National Curriculum before the intervention regarding integrating this kind of technology to achieve learning goals. It is not only necessary to integrate curricularly ICT and to evaluate its impact, but also to train teachers how to use the new technologies and disseminate innovative pedagogical practices using ICT [30]. Our study also revealed the relevance of collaborative work in schools. In our case, this required a fluid conversation between teachers in traditional classrooms and teachers in charge of computer labs to the intervention success. To assure learning goals acquisition, both teachers needed to contextualize the use of the video game and to establish an adequate learning context within the use of this kind of technologies.

ACKNOWLEDGMENT

Thanks to the support of the National Commission for Scientific and Technological Research, CONICYT, Ministry of Education, Chile, through the Becas de Postdoctorado en el Extranjero Becas Chile granted to Dr. María Graciela Badilla Quintana.

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