

A NEUROCOGNITIVE VIDEO GAME INTERVENTION EFFECTS ON THE READING SKILLS AND COGNITIVE ABILITIES OF ENGLISH LANGUAGE LEARNERS: PILOT STUDY

MODIFICACIÓN DE LAS DESTREZAS DE LECTURA Y
LOS PROCESOS COGNITIVOS MEDIANTE EL USO DE UN VIDEO JUEGO
EN LÍNEA BASADO EN LA TEORÍA DEL PASS: ESTUDIO PILOTO

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ABSTRACT

The present study evaluated the effectiveness of a video game intervention, based on the PASS neurocognitive theory, on the reading skills and cognitive abilities of ELLs. A two-group experimental design was employed. Participants in the experimental group were subjected to a video game intervention for a period of 20 weeks, while the control group did not receive any intervention. Despite recruiting 52 students to participate, most did not spend enough time playing the game for it to be successful. In addition, the devastation caused by hurricane María forced researchers to discontinue the intervention, which led to losing great part of the experimental sample. The analysis is focused on how to better integrate the intervention so that students can take advantage of a video game intervention based on PASS theory. The discussion addresses how PASS interventions are better suited for dealing with reading problems among ELLs and how video games can prove to be a useful technology for psychologists and educators.

KEYWORDS: PASS, Reading, Video Games.

RESUMEN

Este estudio pretende evaluar la eficacia de un video juego, basada en la teoría neurocognitiva PASS, para mejorar las habilidades de lectura y cognitivas de estudiantes con dificultades de lectura en inglés. Este estudio utilizó un diseño experimental de dos grupos. El grupo experimental fue sometido a una intervención de videojuego por un período de 20 semanas, mientras que el control no participó en ninguna intervención. A pesar de haber reclutado 52 estudiantes, la mayoría no participó en la intervención el tiempo suficiente para que esta tuviera éxito. Además, la devastación causada por el huracán María obligó a los investigadores a descontinuar el estudio lo cual llevó a la pérdida de gran parte de la muestra del grupo experimental. En este escrito examinamos cómo integrar más efectivamente la intervención para que los estudiantes puedan aprovecharla. Además, se discute cómo las intervenciones PASS pueden ser más efectivas para tratar los problemas de lectura entre los aprendices del idioma inglés y cómo los videojuegos pueden ser una tecnología útil para psicólogos y educadores.

PALABRAS CLAVE: Lectura, PASS, Video juegos.

INTRODUCTION

The present study presents the results of a pilot study that aimed to modify the reading skills and cognitive abilities of Puerto Rican students, using an online video game intervention called Skate Kids Online (SKO). The intervention was based on the PASS neurocognitive model of intelligence, which targets reading problems by modifying the cognitive skills that enable reading. Interventions such as SKO can provide fun engaging alternatives to traditional reading interventions. It is important to mention that difficulties brought by the passing of hurricane María, complications during recruitment, and lack of adherence to the intervention made it difficult to complete original objectives. Instead, our discussion will focus on how to correct the shortcomings of our original design presenting alternative ways to address them.

One of the main challenges that Latinx students confront in the United States is learning a new language. Hispanics represent the majority of English Language Learners (ELLs) in the United States. According to the federal government's public law (No child Left Behind (NCLB) act of 2001) an ELL is a person who is 3 to 21 years of age, that is enrolled in an elementary or secondary school and whose difficulty in speaking reading, writing or understanding the English language may be sufficient to deny the individual the ability to meet the state's proficiency level of achievement on state assessments. The National Center for Education Statistics (NCES, 2014), reported that 4.6 million students participated in English language programs in the United States. Spanish Speaking ELLs represent 77.1 percent of all ELL students and 7.6 percent of all public K-12 students. A study by the NCES revealed that in 2011, the achievement gap between non-ELL and ELL students was 36 points at the 4th-grade level and 44 points at the 8th-grade level. Reading is an important skill for academic success. The inability to acquire or develop reading skills might affect ELLs capacity for learning which in turn will have an impact on the socioeconomic development of

the population. Among Hispanic subgroups, Puerto Ricans are the second largest, representing 9.3% of the total Hispanic population. The percentage is expected to increase due to the poor socioeconomic situation on the islands. According to Cohn, Patten and Lopez (2014), the U.S. Census Bureau determined that between the years 2010 and 2013, 48,000 people left the islands for the mainland and for the first time since 2006 the population of Puerto Ricans in the mainland (4.6 million) is larger than that of the islands (3.5 million). Puerto Ricans migrate with their families often with school age children that later join the mainland's educational system with unique challenges. This migration is also expected to increase due to many factors. Among them are the islands poor economic situation, high crime rate, high taxations (11.5%), and high unemployment rate 11.5% compared to U.S. average 5.5% (Schoen, 2015). In addition, the passing of hurricane María and the devastation brought by it has propelled the migration thousands of Puerto Ricans looking for better living conditions. Many Puerto Ricans will continue to migrate even without complete mastery of the language hoping to find better opportunities that help them develop economic independence (Criollo, 2018).

Puerto Rican students receive English instruction since primary grades; despite this, the majority of children fail to meet state proficiency standards. According to the most recent data from the Puerto Rican Department of Education, in the 2017-2018 school year, only 42.31% of students were proficient in English in grades 3 thru 8. In the eleventh-grade, the percentage of students that achieve proficiency in English is even lower at 41.52%. This evidences that traditional instruction does not seem to be an effective method for teaching Puerto Rican students English; therefore, there is a need for alternative methods. This calls for innovative and evidence-based interventions that help develop the English proficiency of the students in Puerto Rico.

PASS Theory

The theoretical framework for this study is the Planning, Attention, Simultaneous, and Successive Processing Neurocognitive Theory of Intelligence (PASS Theory), developed in 1994 by Jagannath Prasad Das, Jack Naglieri, and John Kirby. According to Medina (2007), this theory is the result of a combination of research done by Luria on the brain's functional units, information processing models, and cognitive psychology (Das, Kirby, & Jarman, 1979). The PASS theory is primarily an operationalization of Luria's conceptualization of the brain's three functional units that provide four basic psychological processes. The P in PASS stands for planning; this process allows for the completion of goals through the development of strategies (Naglieri and Otero, 2011). The concept of planning is associated with Luria's third brain functional unit located in the frontal lobe (Luria, 1974). A mental process enables students the ability to select strategies and make decisions to solve problems. Planning also includes auto regulation, impulse control, development and implementation of a plan (Naglieri & Otero, 2011; Otero, Gonzales, & Naglieri, 2013). The A in PASS stands for attention and refers to Luria's first unit. In the brain, this structure is located in the reticular activating system (RAS). This structure has a dual relationship with the cortex because it influences both the tone of the cortex, and its regulation (Luria, 1974). PASS theory authors defined Attention as a cognitive process associated with the ability to concentrate on a specific stimulus, whilst other possibly distracting stimuli are in resting states (Otero, Gonzales, & Naglieri, 2013). The first S in PASS is for successive processing; this process is in the posterior region of the neo cortex, including the occipital, temporal, and parietal lobes (Luria, 1974). This cognitive ability is associated with the organization of stimuli in sequential order. The last S in PASS is for Simultaneous Processing; this process allows for the grouping of information that has interrelated elements in common (Otero, Gonzalez & Naglieri 2013). Simultaneous

processing also corresponds to Luria's second functional unit located in the occipital, temporal and parietal lobes. The authors of the PASS Theory share Luria's vision of the brain and conceptualize cognitive processing as a complex activity that takes place with the combination of all four cognitive processes. While all four processes are involved in most human activity, it is possible that in some tasks there are some that are more central than others. In this manner, it is possible to devise ways to measure and design interventions directed to modify specific processes.

There is substantial evidence regarding the effectiveness of cognitive modifications on students' reading development (Baker, 2002; Harvey, 2000; Janzen, 2000; Forget, 2002; Hayward, Das, & Janzen, 2007; Papadopoulos, Charalambous, Kanari, & Loizou, 2004). Initial studies on cognitive remediation focused on the successive and simultaneous processing (Janzen, 2000). Individual problems with word reading were often associated with poor performances in successive processing especially in early grades (Das, Mishra, & Kirby, 1994; Das & Siu, 1989; Janzen, 2000; Kirby, Booth, & Das, 1996; Kirby & Robinson, 1987; Snart, Das & Mensink, 1988). Also, research shows differences in the successive processing of the reading disabled groups and non-reading disabled groups (Das, Mishra, & Kirby, 1994). As noted earlier simultaneous processing is also important for reading. Reading comprehension tends to be significantly related to simultaneous tasks after grade three or four (Mahapatra, 1990). Planning is also considered a significant process that underlies student-reading achievement in general (Haddad et al., 2003). This evidence shows how different processes work together to enable reading. The reader uses attention to focus on the page while resisting possibly distracting stimuli, processes the information serially and integrates it to generate ideas and reactions about what is being read. Despite some processes being more involved than others, all are important because of their interdependence. Therefore, a deficit or

problem in one of the processes can affect reading.

PASS theory-based reading interventions have been found to be effective in helping children develop reading skills without relying on traditional instructional strategies (Baker, 2002; Harvey, 2000; Janzen, 2000; Forget, 2002; Hayward, Das, & Janzen, 2007; Papadopoulos, Charalambous, Kanari, & Loizou, 2004). These interventions often target cognitive processes to help develop reading skills, such as the PASS Reading Enhancement Program and the Cognitive Stimulation Program for Child Education. The PASS Reading Enhancement Program (PREP) and the Cognitive Stimulation Program for Child Education (CONGENT) were developed to help children with reading and writing difficulties by using diverse strategies designed to modify cognitive processes without direct instruction (Das, Naglieri, & Kirby, 1994). The PREP has been used in research in many countries due to its neurocognitive approach that broadens its usefulness in different settings. There is abundance evidence regarding the PREP and CONGENT model's effectiveness in helping children develop reading skills (Churches, 1999; Chiyoko, 2000; Baker, 2002; Forget, 2002; Papadopoulos et al., 2004; Baez, 2005; Hayward, Das & Janzen, 2007; Medina, 2007; Mahapatra, et al., 2010). These interventions are particularly effective for diverse populations because cognitive processes can often be modified without little mastery of the language component. Interventions based on this model will be especially effective for ELLs because it exposes students to the English language while at the same time helping to strengthen their cognitive processes. Moreover, video game interventions could provide a more appealing and accessible intervention than traditional approaches.

Video Games

The Entertainment Software Association estimates that 59% of Americans from all ages play video games (Greitemeyer et al., 2011).

The average video game playing time per week in recent years was estimated at 13 hours, almost three times more than that of the 1980's, which was about four hours (Mathiak, Klasen, Weber, Ackermann & Shergill, 2011). Video games have become a part of everyday activities and every year more and more people are immersed in these technologies. Taking advantage of these technologies, SKO provides entertainment in the form of cognitive modification task that help children develop reading skills. The available evidence supports the use of educational video games and how these help develop reading skills (Din & Calao, 2001; Young et al., 2012). An example of this is the Din and Calao (2001) study, in which researchers found that the educational video game were more effective than traditional instruction in developing kindergarteners reading skills (Young et al., 2012). Warren, Dondlinger, and Barab (2008), as cited by Young and colleagues (2012), reported that the use of educational video games showed statistically significant increases in motivation and language-arts-based standardized test achievement, whereas their teachers reported statistically significant decreases in time spent explaining and re-explaining directions to their fourth-grade students.

According to Annetta (2008), in 2003 there was a movement called Serious Games that promoted the use of video games in teaching and training. According to Girard and colleagues (2013), Serious Games combine gaming, learning, and represent a new area of interest in the educational field. Serious Games are video games that are created for the purpose of knowledge acquisition, skills development, and cognitive modification. Bhuiyan & Mahmud (2015) analyzed the impact of digital games on education. The authors analyzed 37 studies that explored the impact of video games on knowledge and skills. The meta-analysis of the effect of video games on knowledge included 16 studies and estimated an effect size of .59. Indeed, researchers have demonstrated strong positive results supporting the notion of that

video games can improve knowledge. The meta-analysis on the effect of video games on skills revealed similar findings. The authors found 21 studies and estimated an effect size of .52 for video games improving skills. The conclusion is that digital game based education seems to have a potential to increase students' knowledge and skills. A more recent meta-analysis by Clark et al. (2016) reviewed research on digital games and learning for K–16 students. The authors compared game vs nongame conditions and augmented games vs standard game designs. The results for the media comparison meta-analysis revealed that digital games significantly enhance student learning ($g = 0.33$, 95% confidence interval [0.19, 0.48], $k = 57$, $n = 209$). These results add to the evidence that video games have a positive effect on students learning and development. Novak and colleagues (2019) studied the effects of learning video games on mathematics achievement of Pre K-12 grade students compared with traditional classroom instruction models. The authors used 24 meta-analyses. The results revealed a small significant effect ($d = .13$, $p = .02$). The findings suggest that video game intervention are slightly more effective at improving student's mathematical achievement than traditional teaching instruction.

Video games also have the potential to help develop cognitive processing. The available research demonstrates the positive effects of video games on different cognitive processes (Adams, 2013; Boot et al., 2013; Bozoki et al., 2013; Colzato, Van den Wildenberg, Zmigrod, & Hommel, 2013; De Giglio et al., 2015; Adams, Mayer & Pilegard, 2016). The interaction between the gamer and interface promotes adaptations and modification that help the player succeed in the game. Stanmore et al., (2017) measured the effects of physically active video games (exergames) on a broad range of cognitive processes. Based on their meta-analysis of 17 studies, Stanmore and colleagues reported an effect size of $g = 0.436$ suggesting that videogames have a moderate positive effect

on cognitive processes. Bediou and colleagues (2017) found that action games have a moderate effect on cognition ($g = 0.55$). They also analyzed the effect of action games in long-term studies and found a small effect ($g = 0.34$). A third meta-analysis (Powers, et al., 2013) estimated the effect of video games on information processing skills. These authors considered whether the studies used an experimental or quasiexperimental design. Similar to the previous two studies, Powers and colleagues reported positive effect of video game playing on processing speed. The analysis by design yielded interesting results, with the quasi-experimental studies providing a higher effect size ($d = 0.61$).

Skate Kids Online. SKO is an evidence-based video game intervention rooted in the PASS Theory of Intelligence discussed earlier. According to the SKO teacher's handbook, the video games helps students develop a true mastery of skills that can be applied and transferred to academic areas. The various mini games are inspired by traditional market video game design, attempting to harness the engaging capabilities that commercial games offer. SKO teaches children to reflect on their behavior, provides immediate feedback on their performance and prompts them to consider alternative strategies. There is evidence in literature of SKO helping children better their reading scores (Naglieri, 2009; Naglieri, Conway & Rowe, 20009; Rowe, Naglieri & Conway, 2009). A study by Naglieri, Conway & Rowe (2009) examined the effect of SKO on 66 third grade Title I students' reading skills. This study divided their results into two groups: a high playing group that played for an average of 16.8 hours and a low playing group that played an average of 5.7 hours. The effect sizes for the high paying group was 1.16 and .57 for the low playing group. The results of this study suggest that SKO is effective in helping children develop better reading skills. In addition, these findings suggest that the more students play the intervention the more they can benefit from it.

In a second study, Jack Naglieri and Cara Conway (2009) used the intervention on group of 36 second grade (Naglieri, 2009). The findings showed a strong relationship between the pre-post differences and amount of SKO usage, suggesting that the online program is an effective method for improving reading test scores for students in Title I settings. In a third study by Rowe, Naglieri and Conway (2009) the intervention was tested with 50 second grade students that had access to SKO in a regular classroom setting. This study had three group, each with significantly different playing times. The results of revealed that the group that played the game most had the better posttest scores regarding their reading skills. These findings suggest that students need an adequate degree of exposure with the intervention so that results can be significant. The results of these studies continue to be consistent, suggesting again that SKO is an effective method for improving reading scores for students with reading difficulties. Despite excellent results with SKO, there are no studies that on how SKO can help the reading skills of ELLs. Also, there is no evidence of how it affects basic cognitive processing scores. This study intended to explore whether SKO is effective in improving the reading skills and cognitive abilities scores of Puerto Rican ELL's.

METHOD

The original purpose of this study was to assess the effects of a video game intervention on the reading and cognitive skills of Puerto Rican ELLs. This study was approved in 2016 by the Institutional Committee for the Protection of Human Participants in Research (CIPSHI, for its acronym in Spanish) and assigned the protocol number 1415-268. This quantitative study had a two-group pre-post experimental design.

Sample

Difficulties during the data collection process and lack of participant engagement in the

intervention hindered the completion of this study's original objectives. In addition, the woes brought by the passing of hurricane María forced researchers to discontinue the study, which led to losing great part of the experimental group sample. The original sample for this study consisted of 52 students. However, the final sample was retrieved from the 32 students that were evaluated before the passing of the atmospheric event. The experimental group consisted of the students that played the game for more than 30 minutes, totaling eight students. After this, eight students were randomly selected from the non-playing group to serve as control. The sample for this analysis was 16 private school students from fourth to sixth grade. The private schools that participated in the study were selected by availability. The mean age of the participants was 9 years old. Gender was equally divided among groups (8 females and 8 males). Participants for this study were selected according to the following criteria: (1) student in the fourth, fifth or sixth grade of the selected private schools, (2) students that obtained below average score in one or more of the Woodcock Johnson III reading subtests, (3) students that had access to a computer with unlimited internet connection at home and (4) students that had characteristics suitable for completing the testing process and intervention, for example not being afflicted by any of the following conditions: blindness, deafness, epilepsy, severe autism or brain damage. After completing the English reading test, they were randomly assigned to either the control or experimental conditions. Students in the experimental condition were given access to SKO and were instructed to play at least one hour a week for 20 weeks. Students in the control condition had no intervention. After the 20 week period the students cognitive processes and reading skills were assessed again.

Instruments

SKO consists of twelve different games individually designed to help develop reading skills and cognitive abilities. Each game targets different cognitive and reading skills

with the purpose of developing them progressively through continuous play. Besides the intervention with SKO, the instruments used in this study were a sociodemographic questionnaire, the Woodcock Johnson III, and the Brief Version of the Cognitive Assessment System 2 (CAS2 Brief). The sociodemographic questionnaire was used to determine the student's eligibility to participate in the project. This document included the student's date of birth, gender, grade, whether they present any diagnosis, information of previous evaluations, accessibility to the internet, whether their internet connection is limited or unlimited, treatment information and extracurricular activities. The Cognitive Assessment System 2 was designed to measure the four basic cognitive processes included in the PASS theory (Naglieri, Das & Goldstein, 2014). Researchers used the CAS 2 Brief to measure the difference in cognitive processing before and after the intervention. The CAS 2 Brief subtests are Planned codes, Expressive, Nonverbal Matrix and Digits. The Woodcock Johnson III Reading Battery (WJ III) is an individually administered diagnostic test that assesses reading achievement and important related reading abilities. The study used the Broad Reading compound that includes word letter identification, reading fluency and passage comprehension subtests.

Procedure

More than 50 private schools were contacted by phone or email to participate in the study. A total of seven private educational institutions participated in the study. All students from the 4th, 5th and 6th grades were invited to participate in the study through an envelope that contained the informed consent and the sociodemographic questionnaire. After selecting the eligible students, they were administered the Woodcock Johnson III. If the score was below average in at least one of the subtests administered, the participant was then eligible to participate in the study. Subsequently, the participant was evaluated with the CAS 2 Brief and assigned randomly to the control or experimental group. The

experimental group was instructed to play the online game for a minimum of 1 hour a week, however, they were not required to do so. Researchers contacted students bi weekly with emails, texts and calls to encourage students to participate in the intervention. After the 20-week period, student's reading skills and basic cognitive processes were assessed for both the control and experimental groups.

RESULTS

The original purpose of this study was to assess the effect of SKO on the reading skills and cognitive abilities of Puerto Rican ELLs. However, we note that it was due to difficulties during the data collection process and participants' lack of adherence to the intervention we were unable reach the original objectives. Despite continuous encouragement through phone calls, text messaging and emails, most students in the experimental group did not participate enough time in the intervention for it to be successful. In addition, some participants could not finish the intervention due to power outages and/or internet connectivity problems due to the prolonged devastating effect of Hurricane María on Puerto Rico during the last months of 2017. Eight participants used the online intervention for at least 30 minutes during the 20-week period, while the other eight did not engage in any activity. The average playing time for the experimental group was 202.5 minutes. The usual recommendation by the game developers is 300 minutes of playtime. Thus, our sample participants were well below the minimum cutoff. The following are descriptive statistics for both the experimental and control group. The differences between both posttests was measured using a Welch's t test and the effect was estimated using Cohen's D. This study explored if the time played, albeit small, enabled changes to the students reading skills or cognitive processes. In addition, the results include the pre and posttest of the two case studies that showed the highest playing time and their differences before and after the intervention.

TABLE 1.
Mean Comparison of Reading Tests Experimental and Control.

Group	Test	Pretest Mean	SD	CI 95%	Posttest Mean	SD	CI 95%
				Lower			Lower
Control	Letter Word Identification	90.03	8.31	83.08-96.98	93.88	11.61	84.17-103.59
	Reading Fluency	76.88	12.77	66.20-87.56	70.38	16.14	56.88- 83.87
	Reading Comprehension	64.13	12.41	53.76-74.51	62.50	13.67	51.07-73.93
	Reading Compound	76.00	10.16	67.51-84.49	76.50	13.53	65.19-85.81
				Upper			Upper
Experimental	Letter Word Identification	88.63	5.34	84.17-93.09	95.25	10.54	86.44-104.06
	Reading Fluency	78.50	5.24	74.12-82.88	79.00	9.43	71.12-86.88
	Reading Comprehension	63.88	5.64	59.17-68.60	63.38	6.95	57.59-69.19
	Reading Compound	75.00	4.17	71.51-78.49	79.95	7.85	73.38-86.51

Table 1 shows descriptive statistics for reading and cognition for both the experimental and control group. A Welch's t-test was performed to explore differences between the mean reading scores of the experimental and control group. The results of this test revealed that there were no significant differences between the control and

experimental group reading skills after the intervention. This is further evidenced by the overlap in the confidence intervals. The effect size was also calculated to see whether there would be any effect related to the intervention. Cohen's D was used to calculate the effect size. The effect sizes are presented in Table 2 along with Welch's significance test.

TABLE 2.
Significance and Effect Size Estimates for Reading Skills.

Reading Test	t	Df1	Df2	Sig.	Cohen's d
Letter Word Identification	.062	1	13.872	.808	0.123558
Reading Fluency	1.703	1	11.277	.218	0.652147
Reading Comprehension	.026	1	10.390	.875	0.081153
Reading Compound	.247	1	11.233	.629	0.311912

The results of the significance test revealed a small effect size for letter word identification ($d=0.12$), and moderate effect size for reading fluency ($d=0.65$). However, care should be taken in the interpretation of these results because of the low playing times. These effect

sizes might be related to a placebo effect, testing or sampling error. The impact of the intervention on cognitive processes was also analyzed. Table 3 shows descriptive statistics for the control and experimental group regarding cognitive processes.

TABLE 3.
Mean Comparison of PASS Experimental and Control Group.

Group	Test	Pretest Mean	SD	CI 95%	Posttest Mean	SD	CI 95%
				Lower			Lower
Control	Planning	98.13	11.94	88.15-108.11	104.12	11.26	94.71-113.53
	Attention	91.00	10.39	79.87-106.89	87.13	13.35	75.97-98.29
	Simultaneous	99.75	17.56	85.07-114.43	92.25	10.86	83.17-101.33
	Successive	89.50	7.86	82.93-96.07	93.75	7.15	83.68-102.82
				Upper			Upper
Experimental	Planning	102.63	12.00	92.60-112.66	103.12	7.49	96.86-109.38
	Attention	93.38	16.16	82.31-99.69	90.88	16.64	76.97-104.79
	Simultaneous	98.25	14.66	85.99-110.51	98.75	10.69	89.81-107.69
	Successive	92.75	6.65	87.19-98.31	93.25	11.45	87.77-99.73

Analyses were conducted to test for differences in the pretest of both groups. The results revealed no significant differences between the control and experimental group regarding their cognitive processes. The

results are presented in Table 4. The overlap in confidence intervals also shows that there were no differences between the control and experimental group.

TABLE 4.
Significance and Effect Estimates for Cognitive Processes.

Reading Test	t	Df1	Df2	Sig.	Cohen's d
Planning	.044	1	12.184	.838	0.104574
Attention	1.456	1	13.996	.248	0.248592
Simultaneous	.247	1	13.373	.627	0.603229
Successive	.011	1	11.736	.918	0.052382

Intervention effects on cognitive processes were also analyzed. The analysis revealed a small effect size of the intervention for planning (d= 0.10) and attention (d= 0.24). Additionally, a medium effect size for simultaneous processing (d= 0.60) was observed. The results discussed previously suggest that the time the students play was not nearly enough to elicit cognitive or reading modifications. The effect size found are more likely to be related to error. However, there were two cases where students were close or surpassed the desired playing time. Therefore, these cases were selected for analysis to see if the intervention had any effect on these students' reading skills and cognitive abilities.

Case #1

The first case is a nine-year-old boy whose native language is Spanish. He obtained a low score in comprehension, making him eligible for the study. The student participated in the 20-week intervention and played a total of 3 hours and 36 minutes and completed 83 game activities. The games he favored were Kayak Attack where he completed 23 activities and Kickflip Fury where he completed 22 activities. These games help boost successive processing that in turn provides benefits to phonetic awareness and word decoding. Table 5 shows the pre and posttest scores for the reading skills and cognitive processes for case 1.

TABLE 5.
Pre and Post test Scores for Reading Skills and Cognitive Processing for Case #1.

Test	Pretest Case #1	Posttest Case #1	Difference Case #1	Pretest Case #2	Posttest Case #2	Difference Case #2
Letter Word Identification	91	107	+16	82	88	+6
Fluidity	84	77	-7	86	84	-2
Comprehension	64	61	-3	59	62	+3
Reading Compound	77	84	+7	70	76	+6
Planning	108	103	-5	113	112	-1
Attention	83	94	+11	118		N/A
Simultaneous	128	124	-4	100	94	-6
Successive	95	98	+3	94	96	+2

The results from Case #1 revealed that after participating in the game, the student had an increase in Letter Word Identification; this is noteworthy because the game that the student played most are related with phonemic

awareness a skill related to letter word identification. Despite this increase, the student performed slightly worse in the fluidity and comprehension test. The effects of the game on the student's cognitive processes

was also assessed. Case #1 experimented an increase in attention and successive. The increase in successive is rather small and it's within the statistical error for this test. The advance thinking skills and strategies promoted by the games might help explain the increase in attention. The SKO skills chart says that Kayak Attack might help promote visual scanning. Therefore, by playing this game the student might have developed better visual scanning skills that in turn helped him do better in the attention test.

Case #2

The second case study was a nine-year-old girl attending the fourth grade whose first language was Spanish. The student was eligible for the study because of her low score on the comprehension test. Case #2 played for a total of 15 hours and 15 minutes in which time she completed 189 activities. This participant played the game the most out of all students. Among the game she favored are Beach Builder (38 activities completed), Gallop Park (26 activities completed) and Snow Board Blast (24 activities completed). These games were expected to help develop reading fluency and comprehension, among other skills. Table 5 shows the pre-posttest scores for reading skills of the second case study.

Table 5 shows the increases in letter word identification and comprehension. Beach builder, the game most played by the participant, is expected to help in word decoding, perhaps explaining the better score in letter word identification. Gallop Park helps develop the student's comprehension, which might explains her gains in this area. The cognitive processes of the second participant were also assessed to explore if there were differences before and after the intervention. Table 5 shows the results of the analysis. There appears to be no difference in cognitive process before and after the training for case # 2. As noted earlier, the brief version of the CAS 2 was used to access cognitive processes. The CAS brief might be less

susceptible to detect cognitive changes related to the intervention. The brief version of the CAS was used due to the size of the original sample.

DISCUSSION

Reaching the original objectives of our study was difficult. Challenges during the recruitment process and participants engagement with the intervention presented serious challenges to achieve proper playing times for the experimental group. In addition, the impact of hurricane María forced researchers to discontinue the intervention, which led to losing part of the sample. As mentioned earlier, dozens of schools were contacted to participate in the study, but only eight decided to participate. Recruitment was challenging, especially when participants were informed that the intervention was an online video game. School principals often questioned whether the game had violent content and were skeptical about how video games could modify reading and cognitive processes. There seemed to be a general negative attitude of video games that may explain why principals seemed reluctant to allow such intervention in their schools. Such negative attitudes have been documented by other investigators that used video game interventions (Egenfeldt-Nielsen 2006; Ferdig 2007). Other studies have encountered similar challenges in the engagement of participants with the intervention, as well as getting schools to participate. Researchers point out that the resistance may be related to the negative stigma following video games (Egenfeldt-Nielsen 2006; Ferdig 2007). While it is understandable that schools are wary of video games, completely disregarding the use of these technologies for educational purposes is not necessarily the best course of action. Video games have been shown to promote positive changes in both behavior and cognitive process (Anderson & Bushman, 2001; Bavelier et al., 2011). Eliminating access to these technologies may deprive children of the different benefits new technologies can provide. Future studies

should consider reframing the language of the intervention and/or using recruiting strategies that selectively target school personnel, principal, parents, and students taking into consideration that new technologies can be intimidating to different groups. Also, educating people on the possible benefits these technologies might bring to education may help recruitment. For example, a presentation to school principals about the benefits of video games may help school personnel consider video games as complementary tools for traditional education.

A similar scenario took place during the participants recruitment. In this phase, students were given an envelope to compile their information and determine their eligibility. Around 240 students were given these documents to participate in the study, but only 130 students returned it. There were cases in which parents did not allow their children to participate in the study solely because it was a video game intervention. Parents commented on how they restrict access to video game and computers to their children. Despite stressing, that the game was educational, parents were still reluctant to allow participation due to preconceptions regarding these technologies, a clear sign of the negative view that video games have. Future studies should consider educating parents of the benefits of playing video games. In brief, the fact that the intervention was a video game hindered the recruitment process, derived mainly from the negative assumptions that often come from the use of video games.

A second, and most deleterious difficulty faced was related to the participants' engagement with the video game. Video games are often lauded as highly engaging experiences; however, this was not the case for SKO. The playing times for the game during the 20-week period were extremely low. The original experimental group before Hurricane María consisted of 16 students. Out of these, only eight played the game more than 30 minutes during the 20-week period

and participated in the posttest. The approach to encouraging gameplay included bi-weekly phone calls, texts, and emails. However, the strategy was not successful as students were sometimes not completely truthful about their use of the video game. Discrepancies were found between participants' self-report playing time and the electronic log of playing time recorded online. The reasons given for not playing the game included the heavy academic work load, extracurricular activities, parents limiting their playing times and problems accessing a computer. To address these issues, I recommend integrating the video game intervention to traditional instruction. In this study, the game was an alternate activity, but by integrating the game to English instruction it can encourage students to play the game as part of the course. In addition, teachers could assign playing time as homework or give extra credit to urge students to engage with the game more often. Teachers could also reward students based on their playing times and their performance in the game. A more structured exposure to these technologies might help students participate in it more often.

Another difficulty encountered regarding playing time was the use of their personal computers. I often found that students' computers were malfunctioning, or they could not engage in the intervention because there was only one computer for the whole family. Also, parents were reluctant to allow children to use the computer without supervision. Such concerns can be corrected by allowing students to use the computers in school. While such a change can impact the way the intervention is experienced, it can help to control playing times and student supervision can be done directly encouraging play. In this study, participants were free to play whichever game they liked, while not necessarily picking the ones that may improve their areas of cognitive or reading weaknesses. By integrating the video game with traditional instruction and using the school computers, the teacher or facilitator of the intervention can

make sure that the students dedicate enough time to games that are related to their reading and cognitive weaknesses. This can help see the real effect of the game and give the intervention a targeted approach.

While we fell short of documenting specific findings regarding the capability of the game for cognitive or reading skills modification, our pilot study provided helpful information to better understand how to integrate video game online intervention to help ELLs. The results of the case studies seem promising and further studies are needed to help assess the effectiveness of this intervention in ELLs. The use of these interventions by psychologists can encourage educators to use them in their practice, helping change the narrative of video games from only negative technologies to positive resources.

Compliance with Ethical Standards

Funding: This study did not receive funding from any organization.

Conflict of interest: The author declares that he has no conflict of interest.

Institutional Review Board Approval: This study was approved in 2016 by the Institutional Committee for the Protection of Human Participants in Research (CIPSHI, for its acronym in Spanish) and assigned the protocol number 1415-268.

Informed Consent or Ascent: Informed consent and ascent was obtained from all individual participants included in the study.

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