The Effect of Stimulating Children's Brains Using Digital Games on Their Information Retention

Ahmad Hammoud, Global University, Lebanon
Ahmad Shatila, Global University, Lebanon
Nisrine Adada, Global University, Lebanon

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Abstract

Children of the "Digital Age" are very attached to smart devices. It is not easy for parents and educators to resist this "smart" wave; therefore, the challenge is to make use of it. The researchers believe that the children are in their optimum time of mental activity when they play games. While playing, they race, jump, and make many critical decisions; their minds become stimulated and ready to receive knowledge. At this optimum time, if they study or review their school lessons, they will show improved information retention because they reviewed their lessons when they were in their optimized and receptive mental condition. In this study, the researchers investigated the effect of digital games on student information retention. The research question was: Would stimulating children's brains using digital games enhance their information retention?

An experimental design was used. Ninety five children ages 7 to 14 were divided into six groups. All groups went through three scenarios where they were asked to memorize information. In the first scenario, children were stimulated using digital games while they were not in the other two scenarios. After each scenario, the children sat for a 5-minute test composed of 10 questions. At the end, scores of the three scenarios were compared. Results of the scenario that incorporated playing digital game were the highest among the three different scenarios. This was the only scenario where children played digital games. This showed that children's attention, working memory, and information retention improved while they were playing digital games.

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1. Introduction

Today, we are living in a rapidly changing world of technology. It is claimed that our children are defined by the technology devices they use. They are the Z generation; technology is their native tongue. They are not only highly dependent on technology, but also are compelled to stay connected (Turner, 2015). Their digital devices, especially their smart phones, have become extensions of their bodies and portals to their entire world. They take them to their classes, to their beds, and even to bathrooms!

Rideout, Foehr, and Roberts (2010) reported that the American child played, on average, at least one hour of digital games on his/her game console (such as, Nintendo Wii, Sony PlayStation, or Microsoft Xbox), or handheld device (such as, Nintendo DS, smart phones, or tablets). That was seven years ago! Nowadays, our children's world is highly saturated with technology; "they think and process information fundamentally and differently than their predecessors" (Prensky, 2001, p. 1)

2. Effect of Digital Games on Cognition

When it comes to digital materials, research has taken various directions: how children process these materials; what cognitive skills they affect; how they aide the formation of mental models; and how cognitive skills can be improved in relation to academic learning (Pedró, 2008). He also added that digital media use - whether in formal or informal settings - can potentially enhance various cognitive skills including: memory, attention, thinking, and executive functions, such as strategy use and planning. Moreover, Bejjanki et al. (2014) stated that playing digital games improves children's attention, perception, and cognition in a substantive manner.

Researchers have been studying how different digital materials (including digital games) affect children's cognitive abilities and how these abilities could be better trained in the context of academic learning (Pedró, 2008). Bavelier, Green, Han, Renshaw, Merzenich, and Gentile (2011) reported that their participants' cognitive functions significantly improved when they played digital games. The acknowledged gains were in mental processing speed, memory retention, attention, and cognitive control. They also stated that behavioral changes were directly affected by brain changes which meant performance improvement was highly expected from these children. Digital games not only influence children's cognition positively, but they also cause "corrective" neurological changes in their brains. They added that their use could result in generalized benefits one of which was academic success (Bavelier, et al., 2011). However, at the same time, they reported that children's playing digital games on a daily basis was inversely associated with their academic achievement; the time they spent on digital games was extracted from their homework time thereby diminishing performance (Bavelier, et al., 2011).

3. The Research Experiment

In 2014, the researchers began working on an app that can be used to make students study in a new innovative way (Hammoud, Shatila, & Adada, 2014). This app allows the child to keep playing for a few minutes. Then, all other apps are paused and a popup screen presents an academic question to be answered by the child. S/he is not able to close the popup screen before getting the right answer. Just then, the app closes allowing the student to go back to his/her game. Having had good results, the researchers decided to further investigate the effect of creating an intervention in children's game play.

In this study, the researchers are investigating the effect of digital games on student information retention. The research question was:

Would stimulating children's brains using digital games enhance their information retention? The researchers believed that when children's brains are stimulated through playing digital or video games they would be more prepared to process information than when their brains are not stimulated by video or digital games.

3.1 Methodology

3.1.1 Research Design

For this research, an experimental design was used. Six groups of children of various ages went through three scenarios. In the first scenario, children were stimulated using digital games while they were not in the other two scenarios. After each scenario, the children sat for a 5-minute test composed of 10 questions. At the end, scores of the three scenarios were compared.

3.1.2 Sample

The sample for this research was composed of 95 children ages 7 to 14. Seventy males and twenty five females participated in this study. Children were chosen from a local scout colony that hosts children from various areas, ages, and socioeconomic status. The participants were divided into two categories according to age. The first category had 47 children of ages 7 to 10 while the second category had 48 children ages 11 to 14. The 47 children of the first category were divided into three groups with 16 children in the first two groups (Group 1 & Group 2) and 15 children in the last group (Group 3). The 48 children of the second category were divided into three groups of 16.

Inclusion Criteria

Children who participated in the study know how to play games on mobile phones and are aged between 6 and 15 years inclusive.

Exclusion Criteria

Children who do not know how to play games / use mobile phones and those who are aged below 6 or above 15 were excluded.

3.1.3 Instruments

For the experiment, there were two categories of tests. The first category was prepared for children ages 7 to 10 and the other was prepared for children ages 11 to 14. Each category had three different tests of equal difficulty and each test included 10 multiple-choice questions. The tests were numbered from 1 to 6. Tests 1, 2, and 3 were in the first category while tests 4, 5, and 6 were in the second category. To ensure validity of the results, the researchers distributed the test versions over the scenarios. Each scenario had a different test version for the different groups. This way, all three tests of each category were solved in each scenario (but each test for a different group). For example, Test 1 was solved by Group 1 in Scenario A, by Group 2 in Scenario B, and Group 3 in Scenario C and so on. Table 1 summarizes the distribution of the various test on the different groups according to scenarios

Table 1. Test Distribution

	Scenario A	**Scenario B**	**Scenario C**
Group 1	Test 1	Test 3	Test 2
Group 2	Test 2	Test 1	Test 3
Group 3	Test 3	Test 2	Test 1
Group 4	Test 4	Test 6	Test 5
Group 5	Test 5	Test 4	Test 6
Group 6	Test 6	Test 5	Test 4

The tests were distributed to children as hard copies and children had to circle the right answer. The maximum grade a child could get on each test was 10 and all questions had an equal weight of 1/10. All questions were general questions about different animals and children had to solve the questions after studying the information in one of the three different scenarios.

3.2 Procedures

3.2.1 Implementation

The experiment was conducted on Tuesday 22nd of November 2017, a holiday in Lebanon, at 1 P.M. Children arrived at the experiment site and were directly sorted according to age into the six groups mentioned earlier. Each group of children was accompanied by two supervisors. Each group went through three different scenarios. After each scenario, children sat for one of the 10-question tests. Tests were then scored on a scale of 0 to 10 and tabulated on an excel sheet. Grades related to the different scenario were then compared.

3.2.2 Scenarios

The researchers believe that when children are playing, their brains would be stimulated to a high extent. Thus, they would process information faster and more efficiently. This in turn would improve information retention. In order to do so, three scenarios were used to check the effect of digital games on student retention.

In the first scenario (Scenario A), children were given smart phones to play and a set of papers containing 10 pieces of general information on animals. The children were allowed to play for 3 minutes then they were stopped in order to study the first piece of information in the sheet. This process continued until they finished all the sheet. Following the playing and studying process, the children sat for a 5-minute test to check their retention of the information they had studied whilst playing. The children played for 30 minutes, but they were stopped every 3 minutes for 1 minute to study. The overall time for this scenario was 45 minutes (30 minutes of play, 10 minutes of study, and 5 minutes for assessment). This scenario was designed to measure retention when children study after stimulating their brains with digital games.

In the second scenario (Scenario B), children replicated what they did in the first scenario but playing with smart phones was replaced with resting and chatting. Children rested and chatted for 3 minutes and then spent 1 minute studying. They did this for 10 pieces of information. Then, they sat for a 5-minute test to check their retention of the information they studied. The researchers wanted to check if taking breaks between study periods had the same effect as stimulating children' brains with digital games.

The third scenario (Scenario C) was different. Children were given 10 minutes to continuously study 10 pieces of information. Immediately after that, they sat for a 5-minute test to check their retention of the information they studied. This scenario symbolized the normal way students study. It was designed to measure student retention through "traditional studying".

The order of scenarios differed for each group. Groups 1 and 4 went through Scenario A then Scenario B then Scenario C. Groups 2 and 5 went through Scenario B then Scenario C then Scenario A. Finally, Groups 3 and 6 went through Scenario C then Scenario A then Scenario B.

Fig.1 shows the flow of events in Scenario A.

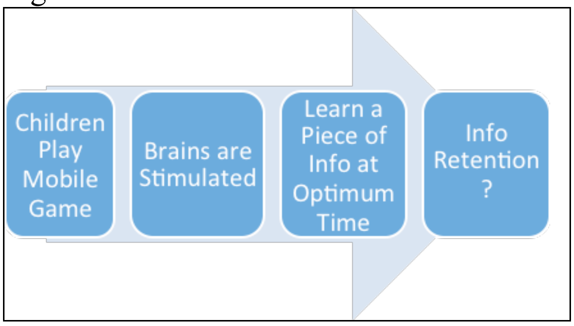

Fig.1 – Proposed Innovative Way

As illustrated in Fig.1, the children used smart phones to play a game. After 3 minutes of playing, every child was requested to read a piece of information. Once done reading, the child resumed playing. Every 3 minutes, the child read a new piece of information.

Fig.2 depicts Scenario B that included giving the children a break after each piece of information.

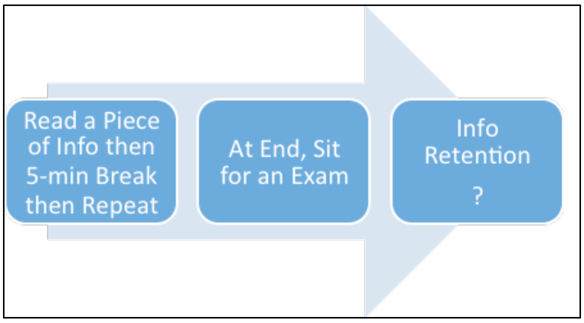

Fig.2 – Break after Reading a Piece of Info

Fig.3 represents Scenario C (traditional method). The children read one piece of information after the other without taking breaks. At the end, they sat for an exam to check how much they learned.

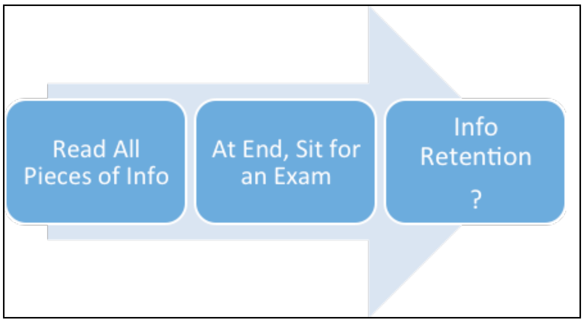

Fig.3 – Traditional Way

3.2.3 Statistical Tests

The researchers used SPSS to analyze the data they got from the experiments. Grades were tabulated and then labeled according to scenarios. Grades for Scenario A were labeled as 1, grades for Scenario B were labeled as 2, and grades for Scenario C were labeled as 3. Then, the researchers used an ANOVA to compare the grades children got on each scenario. The ANOVA showed that a difference existed between the grades on each scenario so it was followed by a post hoc test.

3.3 Results

The ANOVA showed that there was a significant difference between two of the three scenarios. The ANOVA was followed by a post hoc test to check which scenarios were statistically different. The tests showed that Scenario A had the best grades followed by Scenario B and then Scenario C. Table 2 shows the detailed statistics.

Table 2. Descriptives

Points over 10

Scenario	N	Mean	Std. Dev.	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
A	93	6.10	2.313	.240	5.62	6.57	1	10
B	93	5.47	2.362	.245	4.99	5.96	1	10
C	93	5.18	2.413	.250	4.69	5.68	0	10
Total	**279**	**5.58**	**2.385**	**.143**	**5.30**	**5.87**	**0**	**10**

As shown in Tables 3 and 4, children of Scenario A had an average of 6.10, children of Scenario B had an average of 5.47 and children of Scenario C had an average of 5.18. There was a statistically significant difference between grades of Scenario A and grades of Scenario C with p=0.09. Grades of Scenario A and grades of Scenario B were very close to being statistically different with p=0.073. Grades of Scenario B and C were not statistically different.

Table 3. ANOVA

Points over 10

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	40.566	2	20.283	3.632	.028
Within Groups	1541.204	276	5.584		
Total	**1581.771**	**278**			

As per the Post Hoc Test, it is revealed in Table 4, where the first two columns represent the scenarios. As shown in the two shaded cells, the mean difference is significant at the 0.05 level.

Table 4. Multiple Comparisons

Dependent Variable: Points over 10 LSD

(I) Num Type	(J) Num Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
A	B	.624	.347	.073	-.06	1.31
	C	.914	.347	.009	.23	1.60
B	A	-.624	.347	.073	-1.31	.06
	C	.290	.347	.403	-.39	.97
C	A	-.914	.347	.009	-1.60	-.23
	B	-.290	.347	.403	-.97	.39

Fig.4 shows the Means of the children's grades in the three scenarios.

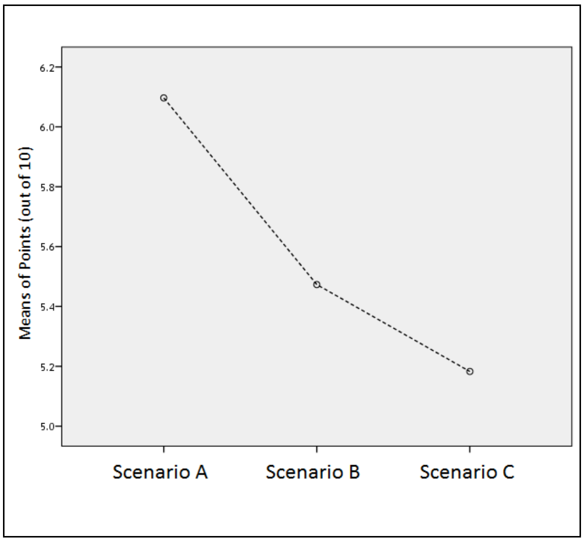

Fig.4 – Means of Children's Points

4. Discussion

When children play digital games, it is hypothesized that a variety of their cognitive skills are improved in ways that can help them benefit academically and in different fields (Greenfield, 2009; Newcombe, 2010; & Papastergiou, 2009). Bavelier, Green, Pouget, and Schrater (2012) stated, "What video games teach is the capacity to quickly learn to perform new tasks – a capability that has been dubbed 'learning to learn' " (p. 392). Moreover, according to Green and Bavelier (2012), playing digital games has an effect on children's behavior as well as their metacognitive skills; a child with improved attentional abilities "will learn to perform new tasks at a faster rate than an individual without such capabilities — in other words, they will have 'learned to learn'." (Green & Bavelier, 2012, p.R204). Moreover, Bavelier, Green, Pouget, and Schrater (2012) studied how digital games affected brain plasticity and learning; they found out that the participants' metacognitive capacities improved when they played digital games - their learning to learn bettered. Other researchers argued, however, that although repeated exposure to such digital tasks might improve children information processing as it relates to games, it is not evident that such improvements will transfer to other nongaming contexts, such as education (Owen et al., 2010; Shipstead, Redick, & Engle, 2012).

In this research, the researchers were studying the effect of digital games on children's information retention. They wanted to see if children's brains function differently after being stimulated through the use of digital games. Results of Scenario A were the highest among the three different scenarios. This was the only scenario where children played digital games. This showed that children's attention, working memory, and information retention improved while they were playing digital games. This is supported by several studies. When Clark, Tanner-Smith, and Killingsworth, (2016) compared children's use of digital games to other instruction conditions without the use of digital games, they found a moderate to strong positive effect on children's cognitive competencies when they played digital games. Furthermore, when Green and Bavelier (2012) studied the role of participants' improved attentional control to explain the observed differences found in their behavior when they played digital games, they affirmed, "While some viewpoints may assume that enhanced attention is the proximal 'cause' of the superior performance — in other words, an end in and of itself — we have recently considered the possibility that enhanced attention is instead a means to an end, with that end being better probabilistic inference." (Green & Bavelier, 2012, p.R204). Abbott (2013) also claimed that when participants played digital games, some of their cognitive skills- such as attention and working memory- that were not directly targeted by the game itself enhanced. Moreover, according to Green and Bavelier (2012), digital games could potentially improve children's memory, speed up processing, enhance executive functions, and boost fluid intelligence. Furthermore, Campbell-Dollaghan (2015) also reported that digital gamers' frontal cortexes and hippo campuses, which are associated with memory formation and learning, were more active than those of non-gamers, and their posterior cingulate cortexes, which are associated with episodic memory and spatial learning, exhibited more activity. In addition, Powers, Brooks, Aldrich, Palladino, and Alfieri (2013) stated that in quasi-experimental studies as well as in true experiments, the use of digital games had a positive effect on participants' information processing. Other research showed that digital game play improved children's ability to choose appropriate information over time (Green & Bavelier, 2012).

5. Future Work

The researchers believe that this is only a small perceptible part of a much larger research work. Teaching children with stimulated minds should not only result in better information, but also in better analysis, comprehension, and overall mental conditions. Future research work should focus on how good stimulated children can be in terms of analysis, information processing, problem solving, and mathematical logic.

6. Acknowledgements

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