A VIDEO GAME FOR LEARNING BRAIN EVOLUTION: A RESOURCE OR A STRATEGY?

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ABSTRACT

Learning resources are part of the educational process of students. However, how video games act as learning resources in a population that has not selected the virtual formation as their main methodology? The aim of this study was to identify the influence of a video game in the learning process of brain evolution. For this purpose, the opinions of the video game players were categorized into two groups (learning and entertainment) through a qualitative analysis in ATLAS.ti software. Then, the correlation between the grade obtained in the exam and the advance of the game was assessed using a Spearman correlation test in SPSS. Finally, an analysis of variance was performed taking into account the opinions categories (learning and entertainment), the advance in the game and the score of the exam. We found a low correlation ($\rho = 0.336$) between the advance in the video game and the score in the exam. Next, we found no effect on how the players perceive the entertainment and the learning during the game in how well they perform neither in the exam nor in the advance of the video game ($p>0,05$). Therefore, it is clear for this specific case the need for different instructional strategies and integration to complement the role of a video game when learning brain evolution.

KEYWORDS

Video game, learning, virtual learning object

1. INTRODUCTION

We are living in the digital age. In this age, rethinking the way of teaching and learning is essential. As part of this transformation, new tools have emerged. Del Moral et al, (2010) states that opportunities for design, development and innovation offered by Web 2.0, along with support structures and collaborative tools to accompany the process of teaching and learning in the network, allow a reformulation of approach to e-learning, leading to an opening and constant change in the shared construction of knowledge that can establish a set of digital resources for educational purposes, which can be used in learning environments supported by technology, commonly known as virtual learning objects (VLO).

According to the above and within the educational purpose set out in the portal *Colombia Aprende* (“Colombia learns”, 2016) a VLO must obey at least three components to ensure a structure of basic information: the definition of content to be treated, the structure of activities focused on learning and the contextualization of its elements. In addition, Cuervo (2011) noted that for a VLO to fulfill a significant educational structure and value it is necessary to accomplish the characteristics described in Figure 1.

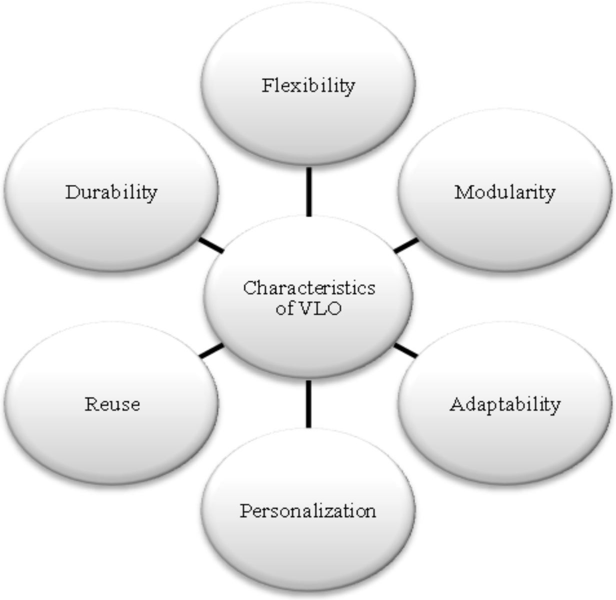

Figure 1. Characteristics of a good VLO as described by Cuervo (2011)

The features described in Figure 1 offer a structure that allows exploiting adequately the contents of a VLO (Del Blanco et al, 2011). This implies that as part of the modularity of a VLO, several tools can be used. For instance, video games or digital games. Video games appear in the school system as a way of including artifacts and own cultural symbols of this era. They are the icon of interactivity in virtual spaces, and offer the possibility of obtaining immediate response depending on the actions of users and the ability to handle large amounts of information along with their distant mass consumption. Because of this, video games are an alternative to the innovation and motivation characteristic of online educational environments.

Initial references of working with video games can be found by 1998, as described by Molinas (2005). In his work, part of the Grup F9 project developed in Spain, video games were used as a tool to achieve significant learning with students with learning difficulties. Nowadays, there are several cases of video games developed with specific curricular contents (Oblinger, 2006) that are used to teach. With them, it is proposed that students build knowledge and design strategies that involve higher order cognitive functions as attention, perception, memory, problem solving and understanding of some topics previously defined by the teaching and production teams.

Investigation related to video games in pedagogy focuses on primary and secondary education, as evidenced in numerous publications (Smith & Pellegrini, 2008). However, video game research focused on a college level is very poor. In general, there is a positive correlation between the "serious games" as mentioned by Rodriguez and Gomes (2013) and the impact of these on teaching and learning (Bai *et al.*, 2012; Ritterfeld *et al.*, 2009 and Kebritchi, *et al.*, 2010). These studies found an influence of video games on the results in mathematics, and highlight the multimodality and interactivity of the game. On the other hand, there are also research studies that found little influence of video games on education (Friedman & Saponara, 2008; Ketamo & Suominen, 2008; Anetta *et al.*, 2009). One of these investigations specifically assessed comprehension of biology concepts and failed to find improvement after using video games.

In this document we describe the research conducted by our group of teachers in the framework of processes of virtual training, to question the role that digital content – specifically video games-, play in the learning process of students enrolled in a virtual course as part of their minor. These virtual courses are mandatory for all students. Given that virtual contents occupy a central place in the VLO, it is essential for the techno-pedagogical design of virtual courses to investigate the relationship between video games and the learning they promote. When asked for the learning and the quality of these courses one finds a gap between objectives and achievements, which contributes to unveil the relevance that video games have in online education, a field still under construction.

This research evaluates the influence a video game has on learning brain evolution and therefore contributes to the understanding of virtual education processes at a college level that use video games as an innovative and alternative strategy of teaching specific content.

2. BODY OF PAPER

2.1 Population

In this research we assessed the learning process of 431 students (17 - 26 years old) from the Manuela Beltran University (Bogotá, Colombia). As part of their minor, every student in the university has to take the virtual course in basic neuroscience, the one under study, which means the students belong to various disciplines.

2.2 Methods

We designed a game called "The brain evolution game" in order to teach brain evolution. We asked the students to play the game, and noted how far they reached on it. According to how many levels they were able to complete, we assigned a grade from 0 (the student did not complete any level) to 5 (the student finished the game). Then, we designed an exam that questioned concepts related to brain evolution. After the students played the game, we asked them to take the exam. Again, according to how many questions they answered correctly, we assigned a grade ranging from 0 (the student did not get any correct answer) to 5 (the student answered correctly all the questions). Next, we correlated these two grades and performed a Spearman's rank correlation coefficient in SPSS Statistics (SPSS Inc, version 17.0, Chicago).

Furthermore, we asked the students to rate their experience with the video game, writing their opinions in a forum. Then, we categorized those opinions. To do that, we created two main clusters, named "Entertainment" and "Learning". For the qualitative analysis we used the Atlas Ti software (version 7, USA) and classified each participant's opinion into one of three categories inside each cluster: "high", "medium" or "low". This means, for example, that one participant that expressed about the game as "[it was] an excellent experience, I had so much fun playing it and learned a lot about brain evolution" was categorized as "high" inside both the entertainment ("he had much fun") and the learning ("he learned a lot") clusters. Next, we analyzed the relationship between the categorization in each cluster and the grades in the game and the exam. For this, we performed a Krukal-Wallis test using the software Statistix (version 8, USA). In total, we analyzed 153 participations related to "entertainment" and 285 related to "learning".

2.3 The Brain Evolution Game

Definitions related to digital games vary. However, digital games do have in common that they all provide visual information to one or more players, accept input from the player(s), and use a set of programmed rules. All this inside a sensory interface and a story that adds emotional appeal (Oblinger, 2006). The games that are designed to teach something are also part of the category called "edutainment", which comes from the words "education" and "entertainment". Here, we studied a digital game called "The brain evolution game" that falls into the classification of edutainments as it tries to use entertainment with the development of purely curricular contents. Moreover, this game is a role game, where the player assumes the role of a creature (Oblinger, 2006). To further describe the game, we used the criteria presented by Gross-Salvat (2000) and summarized it in Table 1.

Table 1. Description of the brain-evolution-game according to the criteria used by Gross-Salvat (2000)

Product description		
Name	The brain evolution game	
Game description	The game consists of an avatar that should be controlled by the player using the arrow keys. The avatar starts as a round structure, representing a single-celled organism. The objective is to make the avatar "evolve". To evolve, the avatar must eat "nutritious food", and avoid "toxic food". Also, at the beginning of each level there is a 3 to 6-minutes video that gives information about evolution. During each level, a set of pop-up windows appear giving the player more information of the evolution and the nervous system of a particular group of animals. Moreover, during each level the player must answer several questions related to the given information. If the player manages to feed the avatar and answer the questions correctly, they complete the level. As the player completes a level, the avatar "evolves": it changes from a single cell to a lobster-like representation, to a fish, to an amphibian-like body, to a monkey, and finally reaches a cavern-man-like shape. The game has twelve levels with increasing complexity.	
Type	Simulation	
Language	Spanish	
¿How important is language for the player?	Very important.	
Pedagogical criteria		
Main type of contents in the game	Concepts	
Related area of knowledge	Natural sciences	
Conceptual content of the game	Evolution of living organisms, and the characteristics of their nervous system.	
Procedures	Psychomotor skills.	○ Visual-motor coordination: High ○ Laterality: Low ○ Space organization: Medium
	Retention of information.	○ Attention: High ○ Memory: High
	Creative skills.	NO
	Analytical skills.	NO
	Metacognitive skills.	NO

The brain evolution game was designed for teaching nervous system evolution, as part of a virtual course given to every student in the university. So, it can be further classified as a "*serious game*", an application designed and built by a group of professionals who have an intention and a pedagogical approach (Rodriguez & Gomes, 2013).

2.4 Playing and Learning

To assess how the Brain evolution game rendered specific knowledge to its players, we evaluated the grades players got in the exam and correlated them with how much they advanced in the game. The results are shown in Figure 2. If the game is a real edutainment, then one would expect to see a positive correlation between these two variables. However, we found a weak correlation (ρ=0,336; n=431, Spearman's rank correlation coefficient, SPSS Statistics) between them. The results indicate that either the game is not achieving the learning process it intends, or it is not appropriate to assess learning measuring the grade in an exam. Both possibilities have been discussed in several studies (Buckingham, 2008).

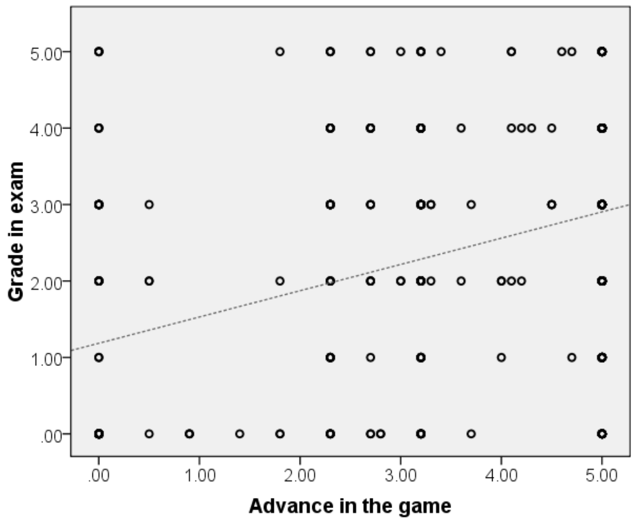

Figure 2. Relationship between the advance in the game the students had –measured as a grade according to how many levels they passed, and the grade they got in the exam. n=431

Several authors have shown that video games enhance the learning process of natural sciences. For instance, Kebritchi *et al.* (2010) showed an enhanced performance in tests that needed algebraic calculations in students that had previously played a video game. However, other authors (see Anetta *et al.*, 2009) have proven that when learning biology, the students that played a serious game did not show a better understanding of the concepts than a control group. Because we could not find a significant correlation between how far the students reached in the game and how well they performed in the exam, our results support the studies in the line of Anetta *et al.* (2009), in which the mere playing of a serious game does not improve the acquisition of concepts of the topic the video game is approaching.

One point that must be taken into consideration in the light of our results is game designing. Some studies that have found a positive correlation between video games and learning highlight as important characteristics the multimodality and the interactivity of the game. Although these two characteristics are also present in the brain evolution game, we did not find this correlation. Moreover, Kritzenberger (2010) discusses the characteristics that video games should have in order to improve the user experience. He concludes that one of the things that should be taken care of when designing serious games is that they should resemble as much as possible the commercial video games, given that serious games are often boring to users because they focus on the pedagogical dimension.

Next, we categorized the perception of the players in relation to the game, and assigned a level inside the clusters "entertainment" and "learning". We assessed the effect the categories had on how much the students advanced in the game and how well they performed in the exam. The results are represented in Figure 3 and Figure 4.

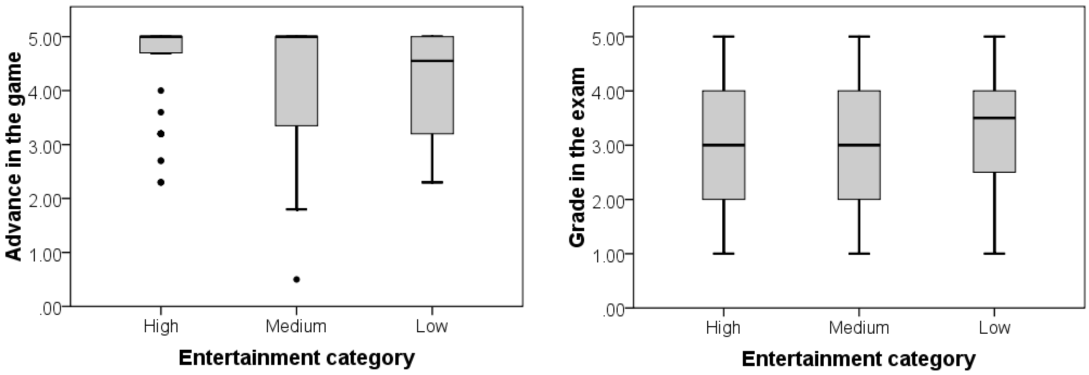

Figure 3. Advance in the game and grade in the exam according to the perception of entertainment players had during the game. n=153

One would expect to see a relationship between how entertaining a player finds a game and how far they reach on it. However, this was not the case for the Brain Evolution Game (see Figure 3) as no significant differences were found in the performance of the students that fell into three different entertainment levels (p=0,3078; n=153; Krukal-Wallis test; Statistix 8). Furthermore, the entertainment the player finds in the game does not affect how well they perform in the exam (p=0,4923; n=153; Krukal-Wallis test; Statistix 8).

It has been widely reported that motivation is one of the most important factors that drive learning. Some have said that "when motivation dies, learning dies and playing stops" (Gee, 2003). One of the definitions of motivation is the "learner's willingness to make an extended commitment to engage in a new area of learning (diSessa, 2000)". Good games should be highly motivated to many people. Although we found many students rating the game as "highly entertaining" this motivation they reported did not helped them improve neither in the advance on the game itself, nor in the exam.

This could be understood if one considers several possibilities. First, one of the most recurrent comments students made on the game was its slow response. Some authors propose that "entrainment, not to be confused with entertainment, which is the careful timing of moves, (…) the pace of the game, elicits a deep rooted connection with the character, which results in a sense of flow" (Squire, 2013). Without this sense of flow, the abilities are no longer matched with challenges. Therefore, a good video game must have these flow experiences; otherwise the user would likely experience some level of dissatisfaction with the game. In our case, we indeed found some dissatisfaction which could affect the engagement students had with the game and in that way with the contents on it. Secondly, game-based learning is not just creating games for students to play. It requires the design of learning activities that can incrementally introduce concepts, and guide users towards an end goal (Pho & Dinscore, 2015).

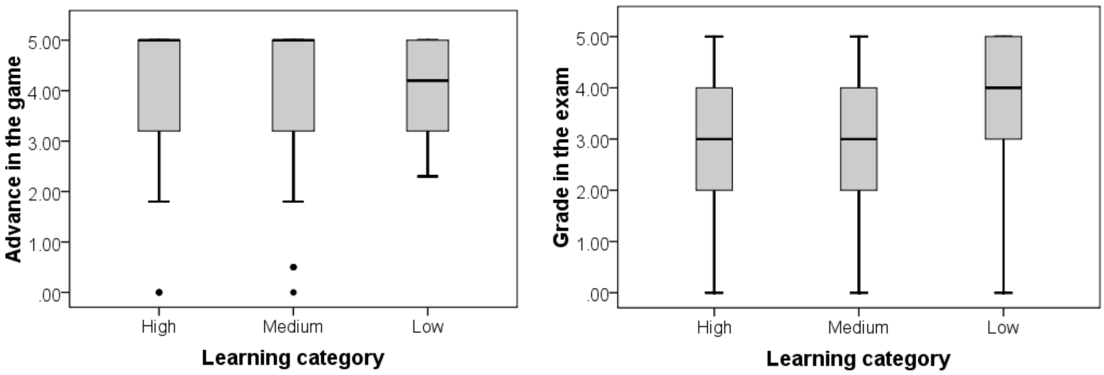

Figure 4. Advance in the game and grade in the exam according to the perception of learning players had during the game

In the Brain Evolution Game we did not find a relationship between the appreciation of learning a player had (i.e. how much they feel they learned) and the performance in the game (p=0,2316; Krukal-Wallis test; Statistix 8) or the exam (p=0,0709; Krukal-Wallis test; Statistix 8), as can be seen in Figure 4. If one considers that the behavior in an exam is a good measure of learning, then our results indicate that the game is not achieving the player's learning. At this point one must consider that the learning potential of games should be merged with how the game is used. As Van Eck (2006) describes: "simply using games may not be very effective; use is not synonymous with integration. What is more important is to consider how to add games to the educational tool set, blending them with other activities. Integration requires an understanding of the medium and its alignment with the subject, the instructional strategy, the student's learning style, and intended outcomes. Integration of games into curricula is much more likely to be successful than mere game use". Also, both meaning making and participation are key factors in the development and the application of a good video game. These genuine and deeply rooted learning opportunities can only be found in games that offer players the ability to construct goals, strategies, and theories about the game system (Squire, 2013).

One of the drawbacks to overcome in academic training processes including video games as the central element of learning is the difficulty of learning from games itself and the problem of establishing the relationships between video games and the curriculum content (Buckingham, 2008). With our study we find that, as Buckingham (2008) proposes, designing a video game should carefully think the way the curriculum contents are approached. We hypothesized that the Brain evolution game is not achieving the learning process it intends because it lacks an explicit relation between the learning objectives, the academic contents and the elements of the game.

The 2014 NMC Horizon Report lists games and gamification as a trend in higher education with an adoption timeframe of two to three years (Pho & Dinscore, 2015). We propose that, in this era of increasing gamification, where the idea is that video games can add an extra level of motivation and incentive to education activities, it is very important for teachers and game developers to consider the conditions that render actual game-based learning. Our results show that careful planning of games and related activities is crucial. Moreover, coming back to our initial question, we propose that video games can be a resource inside a learning strategy. As our results show, the mere act of playing a video game does not imply learning of specific curricular contents, so this resource should be used inside a planned learning strategy that goes beyond the act of playing.

3. CONCLUSION

In this study we did not find a positive influence of one video game in learning brain evolution. The correlations found are weak or non-existent between the advance in the game and the grade the students got in an exam designed to measure learning. Our results give information to take into account when designing VLOs and when intending to transform the relationships that take place in the virtual learning spaces: between the students and knowledge, content, learn and exams involved in the processes of massive formation in virtual education. Our results suggest that a video game is a learning resource that must be carefully planned inside a learning strategy in order to integrate the curricular content and in that way to successfully influence the learning process.

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