Exploring Application, Attitudes and Integration of Video Games: MinecraftEdu in Middle School

José-Manuel Sáez-López[1*], John Miller[2], Esteban Vázquez-Cano[1] and María-Concepción Domínguez-Garrido[1]

[1]Spanish National University of Distance Education (UNED), Spain // [2]Chalone Peaks Middle School, CA, USA // jmsaezlopez@edu.uned.es // jwmiller@kcusd.org // evazquez@edu.uned.es // cdominguez@edu.uned.es

[*]Corresponding author

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ABSTRACT

The aim of this study is to assess the use of MinecraftEdu in classroom practice analyzing the outcomes and attitudes of all members of the educational community through a quasi-experimental approach. The research presents three dimensions oriented to assessing the use of this application in a didactic unit "History and Architecture" compared through statistical inference (*t*-student) to a control group that develops the same unit with slides and traditional expositional methods. The second dimension values the attitudes of teachers, students and parents regarding the implementation of video games in formal education using descriptive analysis and nonparametric statistical inference through the Jonckheere-Terpstra test and the Kruskal-Wallis test, which allows each group ranks to be compared. The third dimension analyzes interactions in a virtual learning environment related to the implementation of MinecraftEdu. Although there are no significant improvements regarding academic outcomes and some parents hold negative attitudes, it is noteworthy that the majority of the sample considered that MinecraftEdu is fun, enhances creativity, develops discovery and is a good application for creating and exploring immersive historical environments.

Keywords

Computer-mediated communication, elementary education, game-based learning, improving classroom teaching, interactive learning environments, teaching/learning strategies

Introduction

Since the 80s, video game use has risen to the point where 60% of children between 8 and 18 years old now play them (Rideout, Foerh, & Roberts, 2010). Pew Internet and American Life Project showed that recreational use of video games is widespread, with 97% of young people and 53% of adults using them (Lenhart, Jones, & Macgill, 2008; Lenhart, Kahne, Middaugh, Macgill, Evans, & Vitak, 2008).

Video games are popular mainly because they are fun. Teenagers' intrinsic motivation towards games contrasts with their often noted lack of interest in curricular contents (Prensky, 2003). Motivation could be combined with contents in school (Eseryel, Law, Ifenthaler, Ge, & Miller, 2014); thereby, video games may also have advantages from a pedagogical perspective. Educational research provides findings that help to determine whether it is advisable to adopt goals and encourage learning activities that are meaningful and motivating for students.

Several theorists claim that there is insufficient scientific evidence regarding the relationship between gaming and learning. "There is not enough research to determine the relationship between video games and learning" (Blunt, 2007, p. 2). There is limited evidence regarding how educational games can be used to solve the problems inherent in the structure of traditional K–12 schooling and academia (Young, Slota, Cutter, Jalette, Mullin, Lai, Simeoni, Tran, & Yukhymenko, 2012).

Some authors ensure that there is no theoretical basis in this field. "I challenge anyone to show me a literature review of empirical studies about game-based learning. There are none. We are charging headlong into game-based learning without knowing if it works or not. We need studies" (Cannon-Bowers, 2006, p. 2).

Educational video games require a greater foundation in the evaluation processes. "Although a number of frameworks exist that are intended to guide and support the evaluation of educational software, few have been designed that consider explicitly the use of games or simulations in education" (de Freitas & Oliver, 2006, p. 262).

It is essential to "research educational video games already in use" (Young et al., 2012, p. 81). Some teachers utilize educational video games in their daily practice, therefore, analysing their current application would provide more valuable information regarding how video games influence student performance.

Taking the aforementioned research needs related to game-based learning into consideration, the motivation of the present research aims to provide information regarding the use of MinecraftEdu in educational settings, particularly in middle schools.

Several studies highlight the advantages of game-based learning as environments that promote student motivation and engagement (Blunt, 2007; Gee, 2007; Greenfield, 2010); therefore, it is important to confirm advantages related to this approach in educational settings though educational research. Some institutions, such as the Sweden educational system, are considering including Minecraft as an essential tool across the curriculum, even as a mandatory class (http://www.edudemic.com/this-swedish-school-now-has-a-mandatory-minecraft-class/). Thereby, administrators, policy makers, teachers, parents and students need to understand real possibilities related to game-based learning in general and with MinecraftEdu in particular.

Theoretical framework

Klopfer, Osterweil, and Salen (2009, p. 21) define digital-learning games as: "Those that target the acquisition of knowledge as its own end and foster habits of mind and understanding that are generally useful or useful within an academic context."

Serious games are defined as immersive virtual environments explicitly trying to educate (Shute, Ventura, Bauer, & Zapata-Rivera, 2009). The most important features of game-based learning are related to the fact that they are educational and they allow interaction in the virtual environment. In these environments, players are part of the learning environment, as decisions directly affect the course of the game (Prensky, 2001). The general trends in research indicate an increasing popularity among students using game-based learning that is integrated into the objectives of the curriculum (Aldrich, 2004; Blunt, 2007; Young et al., 2012), detailing statistically significant improvements. Games are able to promote higher-order thinking and social skills.

Much had been written about the educational potential of video games. Several studies present positive evidence regarding the use of game-based learning in educational contexts (Barab, Dodge, Ingram-Goble, Pettyjohn, Peppler, Volk & Solomou, 2010; Blunt, 2007; Chen, Shih, & Ma, 2014; Eseryel et al., 2014; Hickey, Ingram-Goble, & Jameson, 2009; Shaffer, 2007; Squire, 2006; Steinkuehler, 2006; Young et al., 2012), detailing statistically significant improvements. Games are able to promote higher-order thinking and social skills (Dondlinger, 2007; Steinkuehler & Duncan, 2008). In this context, positive evidence in several studies recommends designing games for educational purposes, reinforcing the concept of game-based learning.

From this evidence the questions are: Do teachers really apply game-based learning in education? What do students, teachers and parents think about this approach? In spite of the previously mentioned positive evidence, many educators are not open to the idea of using video games in their classrooms (Mayo, 2009). Another important question would be: "Do video games enhance academic achievement?" (Young et al., 2012, p. 84).

Prensky (2001) stresses that game-based learning provide feedback and enhance the development of activities related to real life and foster skills related to problem solving. With a proper design suitable for teaching, these resources can be applied to activities in which students solve problems and develop content. "Some educators see games as a useful and perhaps even necessary learning environment suitable for learners of all ages" (Blunt, 2007, p. 2).

Active approach of video games

Learning is more effective when it is active and problem-based and gives immediate feedback. In a context focused simply on acquiring information for later playback, responsibility and authority are external to the students, so this practice undermines the learning process (Gresalfi, Martin, Hand, & Greeno, 2009).

Educational video games foster the fact that students are actually part of the learning environment, rather than being a passive recipient listening to someone with more experience. "One of the most powerful opportunities offered by games is that players are not just observers but are often protagonists who make decisions that affect the game world" (Barab et al., 2010, p. 527).

Gee (2004) shows in his study that educational video games are a learning tool that allows students to be placed within the learning environment and contribute actively in the educational process. In the real world, constructivist learning experienced by players in an educational video game offers one of the few available truly three-dimensional learning experiences (DeKanter, 2005). Gee (2003) notes that players experience the game in a different way to reality, because in the real world they cannot test and test all around them.

More generally, game-based learning offer new technologies and methodologies for creating a deeply immersive and highly interactive curriculum. Studies detailing experiences with games include serious discussions that describe the approach related to educational benefits regarding gamification.

There are several video games that create a 3D immersive environment that recreates a period of history, so players experience interesting interactions with this kind of game. There are several games, such as "Civilization, Age of Empires and Rome Total War, that provide the opportunity to recreate historical events. Narratives embedded in historical content allow history games to offer unique affordances for reenacting, replaying, and gaining first person experiences within the realms of history and social studies" (Young et al., 2012, p. 78).

History-based video games, properly implemented from a pedagogical perspective, are motivating and engaging for students (Devlin-Scherer & Sardone, 2010; Lee & Probert, 2010; Watson, Mong, & Harris, 2011). However, we have to be careful regarding historical misconceptions and inaccuracies that may be fostered by video games (Charsky & Mims, 2008), and take into account that adding text or historical information to gaming is not enough to foster learning (Akkerman, Admiraal, & Huizenga, 2009; Moshirnia & Israel, 2010).

Method

Research design

There are models and methodological approaches in educational research, and the proposed research model applied is Design-Based Research (DRB) (Anderson & Shattuck, 2012), which is a strategy that allows a systematic and interactive process focused on learning and research as subjects to innovate in educational contexts. This naturalistic approach enables understanding of learning processes through informed exploration, enactment, evaluation within a local context, and the development of design principles (Anderson & Shattuck, 2012).

The DRB approach improves educational practice and research processes. "DBR offers a "best practice" stance that has proved useful in complex learning environments, where formative evaluation plays a significant role, and this methodology incorporates both evaluation and empirical analyses and provides multiple entry points for various scholarly endeavors" (Dede, Ketelhut, Whitehouse, Breit, & McCloskey, 2009, p. 6).

The main objective is to analyze the educational benefits of MinecraftEdu in middle school (6th to 8th grade). The specific objectives are:

- Check students' outcome improvement with MinecraftEdu.
- Assess students' outcomes with respect to learning, motivation, fun and engagement when they use video games in the history classroom.
- Analyze interactions regarding the use of games in virtual learning environments.
- Assess attitudes of the school community regarding the implementation of MinecraftEdu in history.

This research presents the following dimensions (Table 1):

Table 1. Dimensions, indicators and survey instruments (Sáez López, Leo, & Miyata, 2013, p. 6)

Dimensions	Indicators	Instruments
Dimension 1:Evidence of learning with MinecraftEdu	Student motivation Digital literacy Active approach Process evaluation Academic results	Test results academic unit (P1mp) *t*-student Control G and Exp G.
Dimension 2:Attitudes of parents, teachers and students regarding the use of MinecraftEdu	Educational effectiveness Content development Fun Creativity Discovery in the virtual world	Questionnaire education mixed (APMA)
Dimension 3:Analysis VLE interactions regarding use MinecraftEdu	Collaborative work Safe handling class group Student engagement Using resources and communities Interaction and communication	Message analysis – Edmodo VLE posts (HyperResearch)

Basic principles

Research intervention analyzes the pedagogical implementation of cross-curricular thematic approaches through interdisciplinary approaches. Principles of instruction (Gagne, Briggs, & Wager, 1992) are elemental in this process: gain the attention of the students, inform students of the objectives, stimulate recall of prior learning, present the content, provide learning guidance, elicit performance (practice), provide feedback, assess performance, enhance retention and transfer to the job.

Significant prior learning is important from the perspective of other classic authors being taken into account in this pedagogical design and collaborative learning through critical thinking, discovery learning (Ausubel, 1978; Bruner, 1966) and Project-Based Learning (Jonassen, 1977). Social interactions in learning environments are essential from the perspective of constructivism and sociocultural theory (Vygotsky, 1978). Interactions between the social and cultural context are important, developing educational activity and situated learning (Brown, Collins, & Duguid, 1989; Wenger & Snyder, 2000) and enabling active participation in learning communities with an intercultural component in this case.

Participants

In the first dimension, the research sample included students that are from 11 to 14 years old from several schools in the USA and Spain; they participated voluntarily. The experimental group included 131 students that worked with MinecraftEdu in classrooms, 41 students from a school in the province of Albacete (Spain) and 90 students from a high school in California, USA. Moreover, there were another 50 students (acting as a control group) from a school in the province of Cuenca (Spain). The experimental group was 61% of girls and 39% of students. Contingency analysis is not detailed because there are no significant differences regarding gender, country or school.

Dimension 2 analyses the attitudes of the school community across 205 participants (62.9% female and 37.1% male) who participated voluntarily. In this dimension, the sample consisted of 10.7% teachers, 25.4% parents and 63.9% students, who belong to the experimental group (Figure 1). Regarding countries, 50.7% of the sample was from Spain and 49.3% was from the USA. The experimental group of 131 students took part in the Edmodo platform, and interactions are analysed in Dimension 3 (Figures 7 and 8).

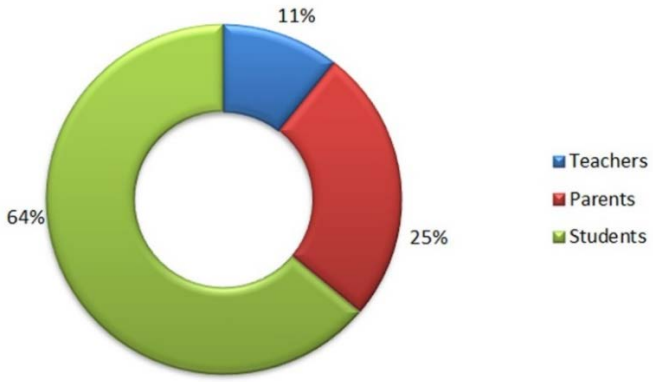

Figure 1. Dimension 2: School community sample

Procedure and intervention

This research analyses the pedagogical use of the application MinecraftEdu (http://minecraftedu.com/), which is the educational version of the popular Minecraft. Several teachers have designed and developed units and educational projects to work on in this program (http://minecraftedu.com/wiki/index.php?title=Main_Page).

MinecraftEdu is a collaborative effort of a team of educators and programmers in the United States and Finland in collaboration with Mojang AB in Sweden. It is intended that the application is affordable and accessible to schools worldwide.

Narrative video games in education can become active curricula that promote dynamic interaction between players and the storyline, between action and understanding (Barab et al., 2010). However, MinecraftEdu is an open virtual world in which there is not any plot or story; it leaves full freedom for exploring everything. You can explore, create, discover and experiment in this immersive environment in collaboration with classmates and tutored by the teacher, who also has an avatar in this world (Figure 2).

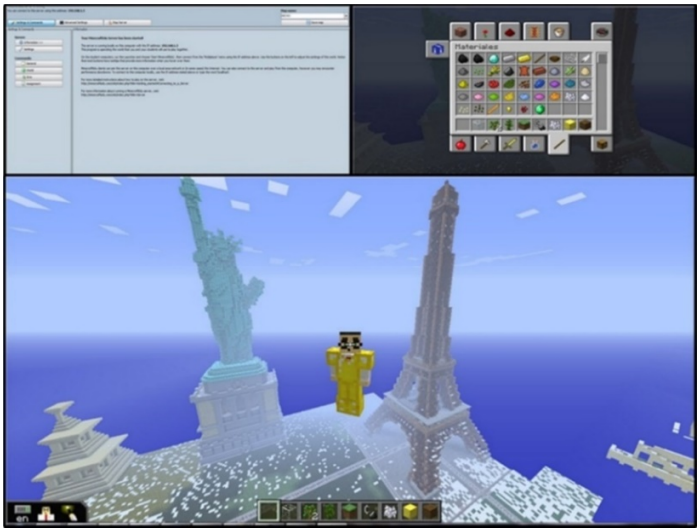

Figure 2. MinecraftEdu interface

Through Local Area Connection (LAN) teachers and students connect and enter this world in class. The teacher designs the unit and creates a map and may raise allocations that students should develop within this environment. The possibilities for interaction, exploration and discovery are numerous. This Mod is designed to give full control to the teacher in this virtual world.

One effective use of this application is to analyze the impact of educational contexts. It also discusses the attitudes of the school community to this approach.

It applies a unit entitled "History and Architecture," which contains learning about ancient civilizations and buildings in these periods, including the Chichen Itza Pyramid, the Roman Colosseum, the Pantheon in Rome (Figure 3) and medieval buildings (Figure 4).

Figure 3. MinecraftEdu History and Architecture unit (Sáez López, J. M, 2015b)

Through a quasi-experimental approach and data triangulation, the research presents three dimensions that seek to respond to the research objectives. In the first dimension, the mean of a control group and an experimental group is compared from results of a test after students worked on the mentioned unit (Test 1 MinecraftEdu Project, P1mp). In the second dimension, attitudes of the school community regarding game-based learning are measured. In the third dimension we analyze the interactions of students and teachers from Spain and the United States on the Edmodo platform.

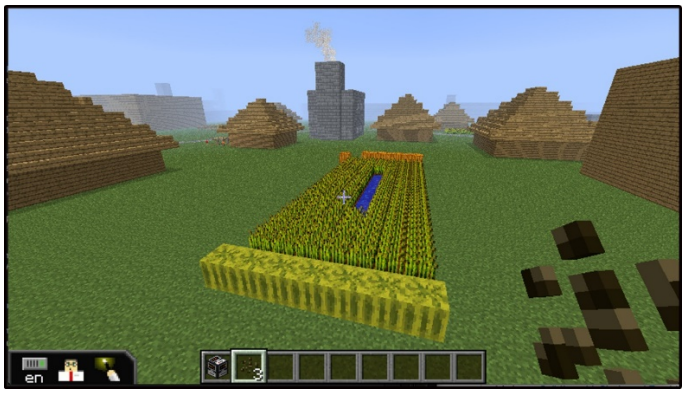

Figure 4. Medieval world based on a real English city (Sáez López, J. M, 2015a)

Instruments

Information is collected using a test (P1mp), a mixed questionnaire (APMA) and by analyzing messages on the Edmodo platform. These instruments present content validity through 14 judges in Spanish National University of Distance Education (UNED). Through data triangulation there is sufficient evidence to uphold the validity, which minimizes error variance (Goetz & LeCompte, 1988). Data triangulation (Cohen, Manion, & Morrison, 2000) was developed from quantitative test information (P1mp), the questionnaire, and the contributions in the analysis of the messages and open questions.

To assess the use of this application teachers developed a didactic unit "History and Architecture" in a control group with traditional expositional methods, using slides. Moreover, the experimental group learns all the content from this unit through the immersive environment created on MinecraftEdu. In order to assess the knowledge acquired by the

control group and the experimental group all students take a test (P1mp) after developing the "History and Architecture" unit.

The application of a student *t*-test enables analysis of the significant differences in academic performance. Test results (P1mp) are compared through statistical inference (*t*-student) comparing means from these independent groups.

Moreover, an AMPA mixed questionnaire also discusses the views and attitudes of the school community (parents, teachers and students) regarding pedagogical use of MinecraftEdu. These results derive from a descriptive analysis, with nonparametric statistical inference through the Kruskal-Wallis test and the Jonckheere-Terpstra test with a 0.01 level of significance (Table 4) analyzing the rankings obtained in these tests.

Applying data instruments provided with different approaches enables data triangulation, which reinforces the research validity (same result from different instruments and tests). The Cronbach's alpha reliability in the APMA questionnaire is 0.793.

Moreover, in dimension 3, the research shows an analysis and classification of messages on Edmodo using the *HyperResearch* application in order to appreciate students' interactions and discussions, from a creative perspective, of the use of MinecraftEdu in the mentioned didactic unit (Figures 7 and 8).

Design-Based Research (DRB) allows a systematic and interactive process focused on learning and research as subjects to innovate in educational contexts, understanding of learning processes. Data triangulation using different dimensions and instruments confirms and validate obtained results.

Results and discussion

Dimension 1: Evidence of learning with MinecraftEdu

The control group students work on the contents of the unit "History and Architecture" through an expositional approach with slide shows. The unit was developed by the experimental group using the MinecraftEdu application (http://ticjm.blogspot.com.es/2013/03/minecraft-edu-primary-school-project.html). Once both groups had finished their unit and taken the P1mp test, the results were as follows:

Table 2. Mean and standard deviation of experimental group and control group. Rating P1mp

	N	Median	*SD*	*SE*
Experimental Group	131	8.98	1.113	.097
Control Group	50	8.78	1.375	.194

Given the sample size and the Kolmogorov-Smirnov test, normality is assumed. There is also equality of variances due to the significant value of 0.07 in the Levene test. Therefore, the requirements for implementing the test are confirmed. The *t*-test gives a value of 0.996 (significance of 0.32), so the difference is not significant. Although the experimental group obtained a higher mean, there is no significant difference in scores between the control group and the experimental group.

*Table 3.*Result of the *t*-test for equality of means. P1m1 test

	Levene's test for equality of variances		*t*-test for equality of means		
	F	Sig. 0.01	*t*	Gl	Sig. (2-tailed)
Equal variances assumed	7.457	.007	.996	179	.320
Equal variances not assumed			.907	74.809	.367

Dimension 2: Attitudes of parents, teachers and students regarding the use of MinecraftEdu in education

Dimension 2 presents an analysis of attitudes of the school community regarding the use of MinecraftEdu in classrooms. Below are detailed descriptive data (Table 4 and Figure 5), Kruskal-Wallis test data and Jonckheere-Terpstra test data (Table 4 and Table 5), which are significant for items 1, 3, 4 and 7.

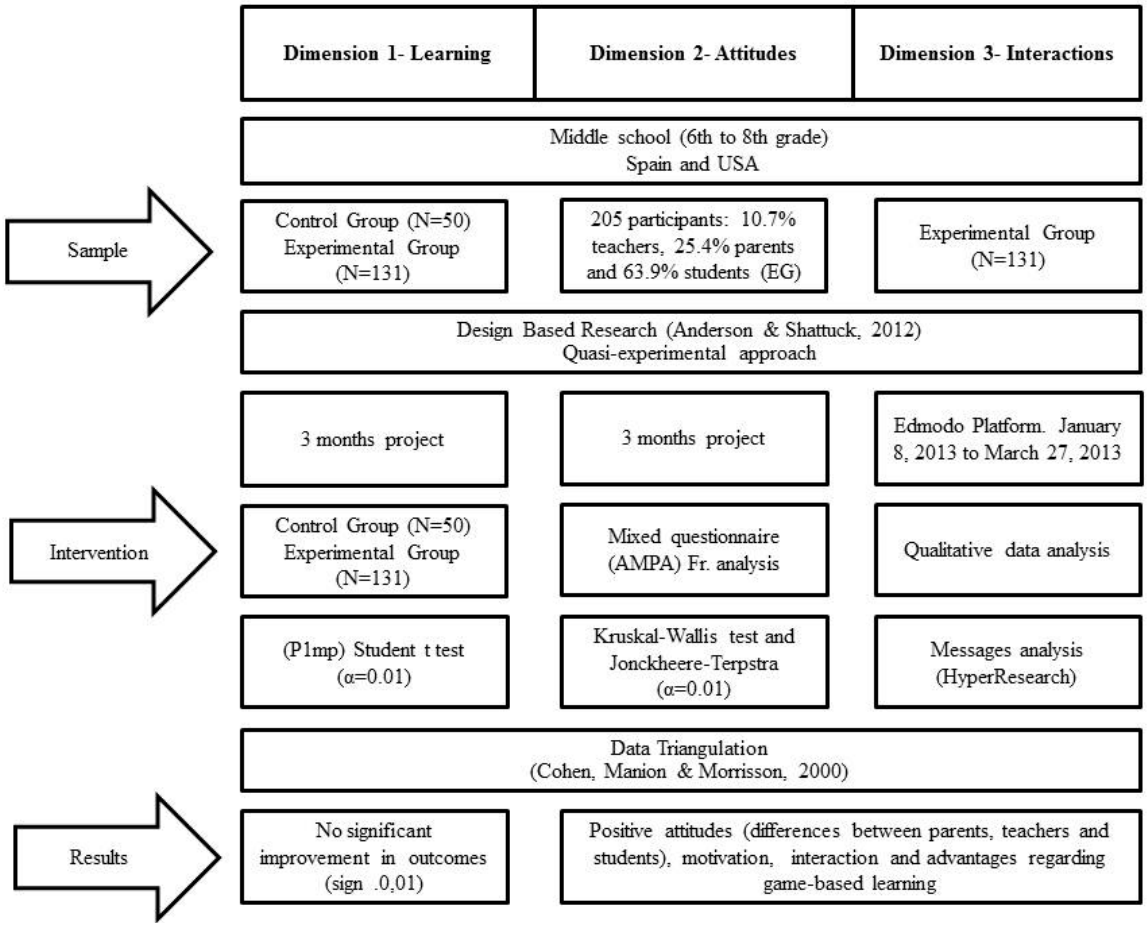

Figure 5. Flow Chart: Dimensions, instruments and design

The results of questionnaire 1 (APMA) indicate that most of the subjects in the sample thought that MinecraftEdu is fun (98.5 %): It enables discovery of new things (96.6%), it encourages learning about historical contents (97.1%), it enables rich interactions using virtual environments (96.6%), and it enhances creativity (96.1%) and learning (83.4%). Using game-based learning (71.7%) and exploiting the time in the classroom (63.9%) get lower results.

Attitudes of teachers, students and parents are very positive in general according to the results from the current descriptive analysis.

Table 4. Attitudes of parents, teachers and students toward working with the MinecraftEdu program (Descriptive analysis, Kruskal-Wallis and Jonckheere-Terpstra test)

Attitudes of parents, teachers and students with regard to the application of MincraftEdu (Item)	%				Kruskal-W. sign (0.01)	Jonckheere-T. sign (0.01)
	1	2	3	4		
1.When you work with MinecraftEdu you learn in	5.9	10.7	44.9	38.5	0.00*	0.00*
2.The historical contents of buildings with MinecraftEdu are suitable and interesting	1	2	28.3	68.8	0.28	0.15
3.Learning with this game is fun	0.5	1	22.4	76.1	0.00*	0.00*
4.Working with MinecraftEdu exploits the time in	10.2	25.9	27.8	36.1	0.00*	0.00*

5.Building in this environment develops creativity	0.5	3.4	35.6	60.5	0.31	0.40
6.In this virtual world we discover many new things	1	2.4	34.6	62	0.06	0.04
7.It is appropriate to use game-based learning in	9.3	19	23.9	47.8	0.00*	0.00*
8.Interacting with groups from other countries regarding creations in MinecraftEdu is positive	0.5	2.9	42	54.6	0.11	0.07

Note. 1 = Totally disagree; 2 = Disagree; 3 = Agree; 4 = Totally agree.

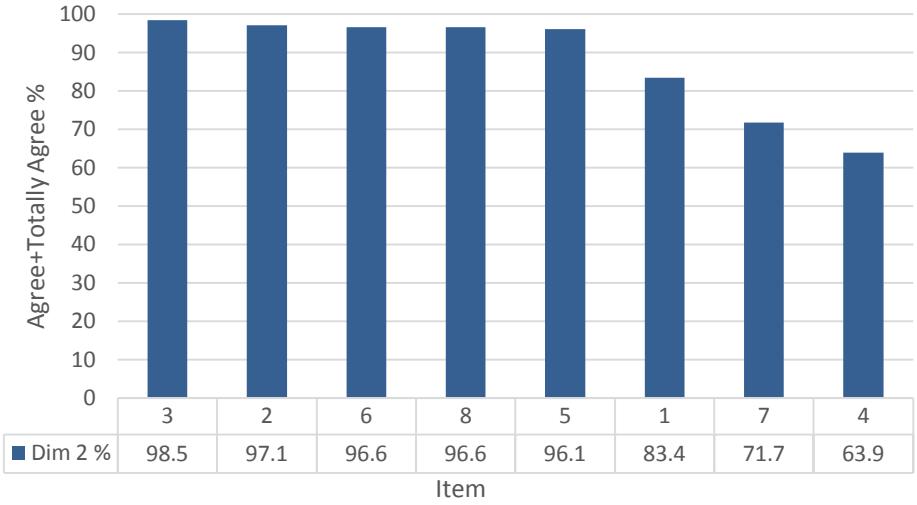

Figure 6. Dimension 2: Descriptive analysis of the attitudes of parents, teachers and students

When analyzing different groups, there are significant differences in some items between students and parents. The Kruskal-Wallis test and the Jonckheere-Terpstra test do not reflect significant differences in several items (Item 2, 5, 6 and 8), so parents, students and teachers have the same positive opinion on all these items.

Moreover, there are differences or discrepancies between these groups in items 1, 3, 4 and 7. When analyzing the means and Kruskal-Wallis rankings (Table 5), data show that students feel that MinecraftEdu is good for learning (Item 1), takes advantage of time in class (Item 4) and that it is appropriate to use game-based learning (Item 7), while teachers and especially parents show lower results in this regard due to low values in these groups. Although parents and teachers think that this application is fun (Item 3), students in the sample show significantly higher values in this regard.

Table 5. Kruskal-Wallis rankings

Item	Community	Rank promedio
1.When you work with MinecraftEdu you learn in class	Students	121.93
	Parents	58.37
	Teachers	95.80
2.The historical contents of buildings with MinecraftEdu are suitable and interesting	Students	99.85
	Parents	105.05
	Teachers	116.91
3.Learning with this game is fun	Students	115.37
	Parents	80.88
	Teachers	81.59
4.Working with MinecraftEdu exploits the time in class	Students	130.17
	Parents	46.50
	Teachers	74.77
5.Building in this environment develops creativity	Students	105.85
	Parents	93.84
	Teachers	107.68
6.In this virtual world we discover many new things	Students	108.76

	Parents	89.87
	Teachers	99.77
7.It is appropriate to use game-based learning in school	Students	129.92
	Parents	35.42
	Teachers	102.43
8.Interacting with groups from other countries regarding creations in MinecraftEdu is positive	Students	108.37
	Parents	90.75
	Teachers	100.00

Mixed open-question questionnaire

When asked *9.-AB., Do you think MinecraftEdu should be used in school?*, this gives a number of responses of interest analyzed by the program HyperResearch V 1.25. Participants responded by providing diverse opinions openly because the instructions in this open question invite to reasoned answers (Figure 7).

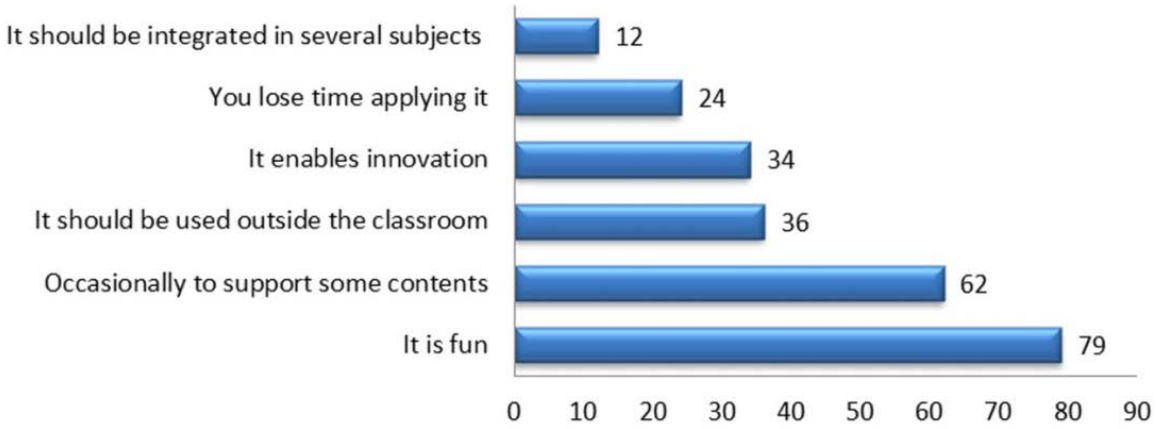

Figure 7. Open question 9AB. frequencies

The main frequencies obtained in this section highlight the fact that the MinecraftEdu app is fun and can be used as a support tool in the classroom (79). Some individuals believe that it should be fully integrated (12) and that it is innovative (34). On the other hand, there are participants who believe that you lose time in the classroom applying it (24) and it should be applied outside the classroom (36). The most negative responses to this application are given by parents, with 79.1% of the frequencies relating to waste of time and 75% of the frequencies stating that MinecraftEdu should be applied outside the classroom.

Dimension 3: Analysis of VLE interactions regarding use of MinecraftEdu

In this dimension interactions are detailed in a group in the Edmodo platform (http://www.edmodo.com/?language=es) called *Minecraft create and discover* (Figures 7 and 8). There are students and teachers from Spain and the USA in the group, interacting with messages in English. These interactions have several advantages and benefits in the learning process (Sáez López, Leo, & Miyata, 2013).

The procedure used in this dimension is to analyze interactions in the Edmodo group called *Minecraft create and discover* from January 8, 2013 to March 27, 2013. We distinguish and classify the interactions of groups according to their purpose, quantifying and classifying messages using the application HyperResearch V 1.25. In Table 6 the messages are classified and quantified according to their purpose.

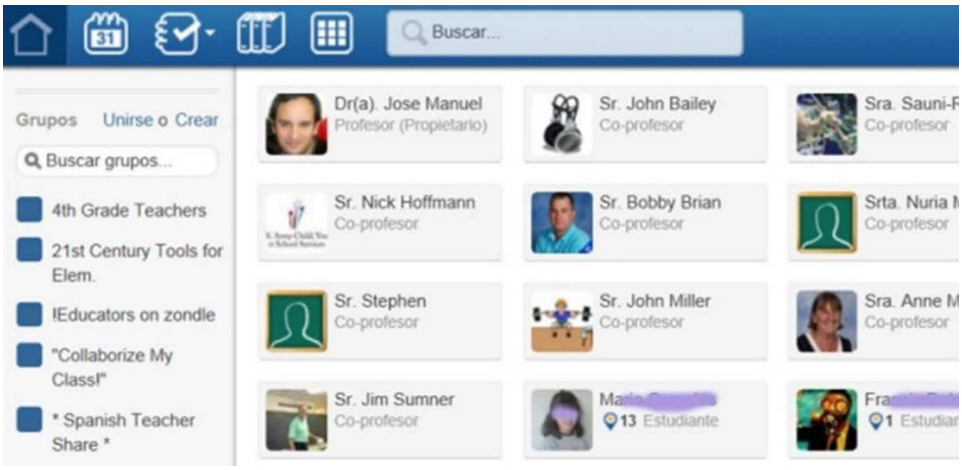

Figure 8. Teachers, parents and students in Edmodo group: *Minecraft create and discover*

Table 6. Interactions on Edmodo (Minecraft create and discover group)

No. of words	Unit contents	Buildings comments	Discovery	Social purposes
Teachers	212	40	29	452
Students	338	166	73	445
Total	550	206	102	897

There is a very enriching interaction between students and teachers addressing topics of interest in the unit with the opportunity to discover and display creations (Figure 9):

Teacher (19/03/2013): *Hello, this is the Pantheon. We learned about this today.*

Student 1 (20/03/2013): *The Pantheon is very old. The Romans built it and it is like a dome that is thicker...*

Student 2 (20/03/2013): *The Pantheon of Minecraft is very cool because it was built by the Romans...*

Student 3 (20/03/2013): *The Pantheon is one of the first domes ever built...*

Student 4: (22/03/2013): *This monument is very nice. I love it. The roof is made of a stone called pumice stone, it is volcanic...*

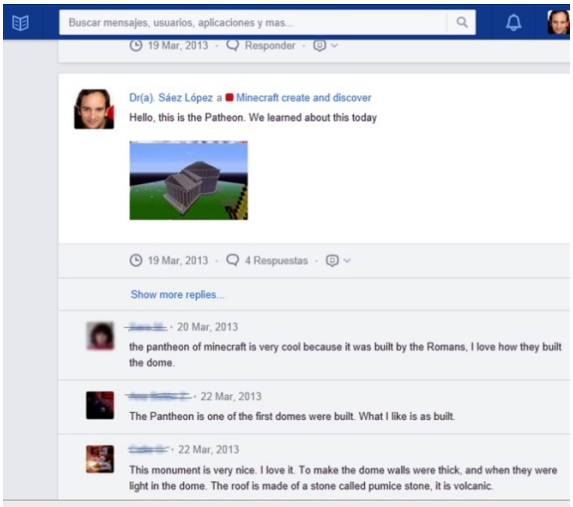

Figure 9. Minecraft create and discover group interactions

Once presented analyzed results, it is possible to discuss and compare several outcomes by other authors related to impact of game-based learning approach in educational settings, and how games for learning can engage players and support learning and skills.

Regarding academic results, some studies assure that game-based learning improves significantly students' outcomes (Cameron and Dwyer, 2005; Davidovitch, Parush and Shtub, 2008; Miller and Hegelheimer, 2006; Orvis, Horn, and Belanich, 2008; Yaman, Nerdel & Bayrhuber, 2008). Nevertheless, the present study describes in dimension 1 that there are not significant improvements in academic results after using MinecraftEdu. In this sense, the present research agree to Kirriemuir and McFarlane (2004) findings, which highlight that there are few examples of entertainment games being explicitly used in the classroom, due to difficulties in matching the entertainment to curricular outcomes.

Moreover, some researches note positive attitudes and advantages related to motivation and interaction when applying game-based learning in educational contexts (Barab, Dodge, Ingram-Goble, Pettyjohn, Peppler, Volk & Solomou, 2010; Blunt, 2007; Chen, Shih, & Ma, 2014; Eseryel et al., 2014; Hickey, Ingram-Goble, & Jameson, 2009; Russell, & Newton, 2008; Shaffer, 2007; Squire, 2006; Steinkuehler, 2006; Young et al., 2012). In the present study we agree that these authors given the information collected in dimension 2 and dimension 3.

Conclusions

The aim of this study is to analyze the pedagogical benefit of using the MinecraftEdu application in an educational context. We estimated the results obtained in relation to the evidence of learning, as well as interactions and attitudes of the school community to the pedagogical integration of this application.
From data triangulation the conclusions are as follows:

- We did not notice significant improvements in academic results after using MinecraftEdu from the tests applied and the resulting value of the Student *t*-test (Under the section Dimension 1: Evidence of learning with MinecraftEdu, Table 2 and 3)

- Most of the participants thought that MinecraftEdu enhances creativity (96.1%), improves learning (83.4%), is fun (98.5 %), enables discovery (96.6%) and facilitates learning of historical content (97.1%) (Items 1, 2, 3, 5 and 6; under the section Dimension 2: Attitudes of parents, teachers and students regarding the use of MinecraftEdu in education, Figure 5).

- Interactions on Edmodo are very rich (96.6%) (Item 8, under section Dimension 3: Analysis of VLE interactions regarding use of MinecraftEdu, Table 6). In this context, students and teachers interact about topics of interest in the unit with the opportunity to comment on activities and display creations (Figures 7 and 8).

- 71.7% of the participants thought that applying game-based learning in class is appropriate for the learning process. There are discrepancies between students and parents in items 4 and 7. When checking means and Kruskal-Wallis rankings, it is noteworthy that students feel that MinecraftEdu takes advantage of time in class (Item 4) and that it is appropriate to apply game-based learning in education (Item 7), while teachers and especially parents show significantly lower results in these items (Kruskal-Wallis and Jonckheere-Terpstra test). These significant values highlighted clear differences of opinion between parents, who believe that this approach will waste time in the classroom, and students, who find it appropriate (Under the section Dimension 2: Attitudes of parents, teachers and students regarding the use of MinecraftEdu in education, Tables 4 and 5).

- There are also differences of opinion among students and parents about the possibilities of MinecraftEdu for learning in class (Items 1 & 3, Figure 3).

There were some important questions mentioned in the theoretical framework: What do students, teachers and parents think about this approach? Do video games enhance academic achievement? The present research gives some particular answers based on the intervention and collected data.

From the theoretical foundation it is shown that there are numerous serious and important studies that are widely considered to be very beneficial to the use of game-based learning (Barab et al., 2010; Blunt, 2007; Hickey, Ingram-Goble, & Jameson, 2009; Shaffer, 2007; Squire, 2006; Steinkuehler, 2006 ; Shute et al., 2009; Young et al., 2012).

When applying the unit "History and Architecture" there are no significant improvements regarding the academic results when applying MinecraftEdu in the classroom in this study (Under the section Dimension 1: Evidence of

learning with MinecraftEdu, Table 3). Moshirnia and Israel (2010) found similar results: no significant difference between the knowledge gained in the traditional expositional classroom using PowerPoint and the application of the unit with video games.

Some parents retain clearly negative attitudes and opinions towards the use of game-based learning in general and the use of MinecraftEdu in particular. Some of them also highlight that it is a waste of time in the classroom. They express (Figure 6) that it could be a good tool outside the classroom or occasionally in some subjects.

Nevertheless, there is a consensus and a majority agreement by the entire school community that recognizes the pedagogical benefits of MinecraftEdu (Table 4, Figure 5) due to several advantages that practically all participants highlighted: MinecraftEdu is an appropriate application for creating immersive activities with historical buildings and content; this approach enhances creativity, facilitates learning through discovery, is fun and provides interactive advantages using virtual learning environments.

Teachers' attitudes are positive although moderate (Table 6). Students are in full agreement with this approach, mainly because of the fun and dynamic classes that allow them to be active protagonists who discover and develop contents and creativity in an immersive world.

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