

Review of game-based learning in secondary education: Considering the types of video games

MARTA MARTÍN DEL POZO, VERÓNICA BASILOTTA GÓMEZ-PABLOS, JOSÉ CARLOS
SÁNCHEZ-PRIETO AND ANA GARCÍA-VALCÁRCEL MUÑOZ-REPISO

ABSTRACT: Video games are increasingly used as educational resources in today's classrooms. In that sense, this paper shows a systematic review of game-based learning in Secondary Education to know the results of its implementation in this educational level. In total, 951 articles were found in repositories and 23 papers were included applying the inclusion and exclusion criteria. From a pedagogical point of view, most video games used in the studies are designed for learning, not for entertainment. The most used and most effective type of games are 'animated tutorial', 'simulation', 'puzzle', 'role-playing' and 'strategy'.

KEYWORDS: Databases; Search Terms; Serious Games, 12-16-Year-Old Students.

ARTICLE HISTORY: Received: 12-january-2019 | Accepted: 14-january-2019.

THEORETICAL FRAMEWORK

Video games are digital leisure resources commonly used by young people and are one of the most popular forms of entertainment today. Furthermore, video games are increasingly used as educational resources in today's classrooms (Martín, Basilotta and García-Valcárcel 2017). Video games can be a powerful educational tool, in particular, for secondary education, but we need to know the real results of the implementation of video games in this stage to disseminate this practice to all the schools

In this paper, it is proposed to carry out a systematic review of the literature that enables to know the objective results of the application of video games in secondary education (based on research results), considering the age range from 12 to 16 years.

METHODS

In this study, we applied a systematic literature review method to locate, critically evaluate, and synthesize studies about effects of video games focused on their impact on learning outcomes in 12-16-year-old students. Petticrew and Roberts (2008) defined a systematic literature review as an interpretation of a selection of documents on a specific topic that involves summarization, analysis, evaluation, and synthesis of the documents.

Marta Martín del Pozo (✉)
Universidad de Salamanca, España
mmdp@usal.es



OBJECTIVES

Taking into account that this paper is part of a broader systematic literature review, the general aim of the systematic literature review is to look for evidence about the effects of video games related to their impact on learning outcomes in 12–16–year–old students. Considering that, in this paper we focus on three research question of the systematic review:

- What are the main objectives of the video games used in the studies (taking into account Games for learning–Serious Games or Entertainment Games–Commercial Off–The–Shelf Games)?
- What genre of video games has been used more often in schools (Action, Adventure, Animated tutorial, Puzzle, Role–playing, Simulation, Sports, Strategy, Platform, Virtual reality, Virtual Word, Augmented Reality, Other Types, Not specified)? To establish the classification of genres we adapted the proposal used by Hainey et al. (2016) in their systematic literature review.
- What kind of video game is more effective from a pedagogical point of view?

DATA SOURCES

To carry out the systematic review we used the following databases: Science Direct and Scopus. Also, the search terms employed were: games AND “secondary education” AND learning. Furthermore, a series of inclusion and exclusion criteria were applied to select the appropriate studies to include in the review (as can be seen in Appendix 1).

RESULTS

As results, 951 articles were found in repositories and 23 papers were included applying the inclusion and exclusion criteria (see Appendix 2).

In terms of the specific questions, the results of the 3 research questions are shown in the following sections.

Research question 1: What are the main objectives of the video games used in the studies? The video games used in the analysed studies were mostly video games originally designed for learning purposes (which could be included within the label Serious Games), namely, 19 studies. Only 4 studies presented the use of entertainment video games (COTS or Commercial Off–The–Shelf Games) (see Appendix 3).

Research question 2: What genre of video games has been used more often in schools? Firstly, it should be noted that, in this case, the studies analysed can be categorized in different genres of video games since they can refer to several video games or because the same video game can present characteristics or belong to several genres of video games. That said, the genres or types of video games mostly used in the selected studies were ‘Animated tutorial’ and ‘Simulation’ accounting for eight studies that incorporate these types of video games, followed by ‘Puzzle’ with seven studies, and ‘Role–Playing’ and ‘Strategy’ with six (see Appendix 4)

Research question 3: What kind of video game is more effective from a pedagogical point of view? Given the use of different types in the studies included in this systematic review, we can consider that the genres of video games that are most effective from a pedagogical point of view are the Animated tutorial (used in 8 studies), Simulation (used in 8 studies), Puzzle (used in 7 studies), Strategy (used in 6 studies) and Role–Playing (used in 6 studies). We can consider that the animated tutorials present situations in which different issues are taught as a tutorial with animations of the characters or situations. On the other hand, simulation allows us to create and

generate situations in virtual worlds that simulate reality allowing us to experiment and test without suffering damage in a safe environment. Puzzle and strategy can favour reasoning, the search for strategies and plans to solve the problems that arise. Finally, Role-Playing games allow the students to assume the role of a character and to experience different identities as well as the consequences of actions in a virtual world.

CONCLUSIONES AND SCIENTIFIC OF THE STUDY

The results of the present study, which is part of a broader systematic review of the literature on the educational effects of video games in secondary education, help to highlight the educational potential of video games.

From a pedagogical point of view, most video games used in the studies are designed for learning, not for entertainment. The most used and most effective type of games are ‘animated tutorial’, ‘simulation’, ‘puzzle’, ‘role-playing’ and ‘strategy’.

We are aware that our research may have three limitations. The first is the number of databases used. We only used Science Direct and Scopus because we could access to the articles from those databases thanks to our University. The second is the number of research terms. We only used games AND “secondary education” AND learning. The third limitation can be the classification of video games by genre. There are different classifications of video games in terms of genre and, also, a video game can be categorized in different genres by different authors due to their characteristics.

Despite these limitations, we believe our work could be the basis for a more detailed and deeper systematic review on the educational use and the educational effects of video games in 12–16-year-old students, taking into account that this paper was focused solely on the main objectives of the video games used, the genre of video games and the kind of video games that is more effective from a pedagogical point of view. Further work needs to be done in other databases and with more detailed research terms. Also, our future work will concentrate on the effectiveness of different video game genres in learning in other stages (e.g. Primary Education, Higher Education, and Vocational Training).

ACKNOWLEDGEMENTS

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No732420.

This publication reflects only the author's view. It does not represent the view of the European Commission and the European Commission is not responsible for any use that may be made of the information it contains.

REFERENCES

- Hainey, Thomas; Connolly, Thomas M.; Boyle, Elizabeth A; Wilson, Amanda & Razak, Aisya (2016). «A systematic literature review of games-based learning empirical evidence in primary education». *Computers & Education* 102: pp. 202–223. Doi: 10.1016/j.compedu.2016.09.001
- Martín, Marta; Basilotta, Verónica & García-Valcárcel, Ana (2017). «A quantitative approach to pre-service primary school teachers’ attitudes towards collaborative learning with video games: previous experience with video games can make the difference». *International Journal of Educational Technology in Higher Education* 14, no. 11: pp. 1–18. doi:10.1186/s41239-017-0050-5

Petticrew, Mark & Roberts, Helen (2008). *Systematic reviews in the social sciences: A practical guide*. Malden, MA: Wiley.



MARTA MARTÍN DEL POZO
Universidad de Salamanca, España
(✉) mmdp@usal.es
iD <https://orcid.org/0000-0002-1971-7904>

JOSÉ CARLOS SÁNCHEZ-PRIETO
Universidad de Salamanca, España
(✉) josecarlos.sp@usal.es
iD <https://orcid.org/0000-0002-8917-9814>

VERÓNICA BASILOTTA GÓMEZ-PABLOS
Universidad a Distancia de Madrid, España
(✉) veronicamagdalena.basilotta@udima.es
iD <https://orcid.org/0000-0003-1976-4548>

ANA GARCÍA-VALCÁRCEL MUÑOZ-REPISO
Universidad de Salamanca, España
(✉) anagv@usal.es
iD <https://orcid.org/0000-0003-0463-0192>

APPENDIX 1

Inclusion and exclusion criteria for the systematic literature review

Inclusion/exclusion	Criteria
Inclusion criteria	<ol style="list-style-type: none"> 1. Scientific journal articles 2. Data from 2006 to 2016 3. Articles must include empirical evidence relating to the impacts and outcomes of digital games 4. Reference to all type of video games and digital games (serious games, computer games, video games, simulation games, game-based learning...) 5. Include participants in Secondary Education (12–16 years)
Exclusion criteria	<ol style="list-style-type: none"> 1. Lax articles (no define research questions, no define search process, no define data extracted process) 2. Articles which refer to non–digital games (chess, board games...) 3. Duplicate reports of the same study (when several reports of a study exist in different journals the most complete version will include and the others will exclude). 4. Articles which use sample with other ages or from other educational level 5. Articles which study other topics that are not digital games or non–digital games. 6. Articles that not show or have empirical direct evidence of using video games in an educational context (e.g. systematic reviews).

APPENDIX 2

Papers included in the systematic literature review applying the inclusion and exclusion criteria:

- Admiraal, Wilfried; Huizenga, Jantina; Akkerman, Sanne & Ten Dam, Geert. (2011). «The concept of flow in collaborative game-based learning». *Computers in Human Behavior* 27(3), pp. 1185–1194. Doi: 10.1016/j.chb.2010.12.013
- Annetta, Leonard A.; Minogue, James; Holmes, Shawn Y. & Cheng, Meng-Tzu (2009) «Investigating the impact of video games on high school students' engagement and learning about genetics». *Computers & Education* 53(1), pp. 74–85. Doi: 10.1016/j.compedu.2008.12.020
- Appel, Markus (2012). «Are heavy users of computer games and social media more computer literate? » *Computers & Education* 59(4), pp. 1339–1349. Doi: 10.1016/j.compedu.2012.06.004.
- Arnab, Sylvester; Brown, Katherine; Clarke, Samantha; Dunwell, Ian; Lim, Theodore; Suttie, Neil; Louchart, Sandy; Hendrix, Maurice & De Freitas, Sara (2013). «The development approach of a pedagogically-driven serious game to support Relationship and Sex Education (RSE) within a classroom setting». *Computers & Education* 69, pp. 15–30. Doi: 10.1016/j.compedu.2013.06.013
- Bowen, Erica; Walker, Kate; Mawer, Matthew; Holdsworth, Emma; Sorbring, Emma; Helsing, Bo; Bolin, Annette; Leen, Eline; Held, Paul; Awouters, Valère & Jans, Sebastiaan (2014). «It's like you're actually playing as yourself': Development and preliminary evaluation of 'Green Acres High', a serious game-based primary intervention to combat adolescent dating violence». *Psychosocial Intervention* 23(1), pp. 43–55. Doi: 10.5093/in2014a5
- Brom, Cyril Levcík, David; Buchtová, Michaela & Klement, Daniel (2015). «Playing educational micro-games at high schools: Individually or collectively?» *Computers in Human Behavior* 48, pp. 682–694. Doi: 10.1016/j.chb.2015.02.025
- Brom, Cyril; Preuss, Michal & Klement, Daniel (2011). «Are educational computer micro-games engaging and effective for knowledge acquisition at high-schools? A quasi-experimental study». *Computers & Education* 57(3), pp. 1971–1988. Doi: 10.1016/j.compedu.2011.04.007
- Charsky, Dennis. & Ressler, William (2011). «Games are made for fun: Lessons on the effects of concept maps in the classroom use of computer games». *Computers & Education* 56(3), pp. 604–615. Doi: 10.1016/j.compedu.2010.10.001.
- Cheng, Meng-Tzu; Lin, Yu-Wen & She, Hsiao-Ching (2015). «Learning through playing Virtual Age: Exploring the interactions among student concept learning, gaming performance, in-game behaviors, and the use of in-game characters». *Computers & Education* 86, pp. 18–29. Doi: 10.1016/j.compedu.2015.03.007.
- Clark, Douglas B.; Nelson, Brian C.; Chang, Hsin-Yi; Martinez-Garza, Mario; Slack, Kent & D'Angelo, Cynthia M. (2011) «Exploring Newtonian mechanics in a conceptually-integrated digital game: Comparison of learning and affective outcomes for students in Taiwan and the United States». *Computers & Education* 57(3), pp. 2178–2195. Doi: 10.1016/j.compedu.2011.05.007

- Favier, Tim T. & Van der Schee, Joop A. (2014). «The effects of geography lessons with geospatial technologies on the development of high school students' relational thinking». *Computers & Education* 76, pp. 225–236. Doi: 10.1016/j.compedu.2014.04.004
- Giannakos, Michail. N. (2013). «Enjoy and learn with educational games: Examining factors affecting learning performance». *Computers & Education* 68, pp. 429–439. 10.1016/j.compedu.2013.06.005.
- González–González, C. & Blanco–Izquierdo, F. (2012). «Designing social videogames for educational uses». *Computers & Education* 58(1), pp. 250–262. Doi: 10.1016/j.compedu.2011.08.014
- Huizenga, Jantina; Admiraal, Wilfried; Akkerman, Sanne & Ten Dam, Geert (2009). «Mobile game–based learning in secondary education: engagement, motivation and learning in a mobile city game». *Journal of Computer Assisted Learning* 25(4), pp. 332–344. Doi: 10.1111/j.1365-2729.2009.00316.x
- Jong, Morris S. Y. (2015). «Does online game–based learning work in formal education at school? A case study of VISOLE». *The Curriculum Journal* 26(2), pp. 249–267. Doi: 10.1080/09585176.2015.1018915.
- Lee, Chun–Yi & Chen, Ming–Puu (2009). «A computer game as a context for non–routine mathematical problem solving: The effects of type of question prompt and level of prior knowledge». *Computers & Education* 52(3), pp. 530–542. Doi: 10.1016/j.compedu.2008.10.008
- Papastergiou, Marina (2009). «Digital Game–Based Learning in high school Computer Science education: Impact on educational effectiveness and student motivation». *Computers & Education* 52(1), pp. 1–12. Doi: 10.1016/j.compedu.2008.06.004
- Sampayo–Vargas, Sandra; Cope, Chris J.; He, Zhen & Byrne, Graeme J. (2013). «The effectiveness of adaptive difficulty adjustments on students' motivation and learning in an educational computer game». *Computers & Education* 69, pp. 452–462. Doi: 10.1016/j.compedu.2013.07.004
- Sun, Chuen–Tsai; Wang, Dai–Yi & Chan, Hui–Ling (2011). «How digital scaffolds in games direct problem–solving behaviors». *Computers & Education* 57(3), pp. 2118–2125. Doi: 10.1016/j.compedu.2011.05.022.
- Theodoropoulos, Anastasios; Antoniou, Angeliki & Lepouras, George (2017). «How do different cognitive styles affect learning programming? Insights from a game–based approach in Greek schools». *ACM Transactions on Computing Education* 17(1). Doi: 10.1145/2940330
- Vrugte, Judith ter; Jong, Ton de; Vandercruysse, Sylke; Wouters, Pieter; Oostendorp, Herre van & Elen, Jan (2015). «How competition and heterogeneous collaboration interact in prevocational game–based mathematics education». *Computers & Education* 89, pp. 42–52. Doi: 10.1016/j.compedu.2015.08.010.
- Watson, William R.; Mong, Christopher J. & Harris, Constance A. (2011). «A case study of the in–class use of a video game for teaching high school history». *Computers & Education* 56(2), pp. 466–474. Doi: 10.1016/j.compedu.2010.09.007.
- Yang, Ya–Ting Carolyn (2015). «Virtual CEOs: A blended approach to digital gaming for enhancing higher order thinking and academic achievement among vocational high school students». *Computers & Education* 81, pp. 281–295. Doi: 10.1016/j.compedu.2014.10.004.

Type of video game by its objective in its original design used in included studies.

Video game type	Number of studies	Research studies
Video Game for Learning	19	Admiraal, Huizenga, Akkerman and Ten Dam (2011); Annetta, Minogue, Holmes and Cheng (2009); Arnab et al (2013); Bowen et al. (2014); Brom, Levcík, Buchtová and Klement (2015); Brom, Preuss and Klement (2011); Cheng, Lin and She (2015); Clark et al (2011); Favier and Van Der Schee (2014); Giannakos (2013); Huizenga, Admiraal, Akkerman and Ten Dam (2009); Jong (2015); Lee and Chen (2009); Papastergiou (2009); Sampayo-Vargas, Cope, He and Byrne (2013); Theodoropoulos, Antoniou and Lepouras (2017); Vrugte et al. (2015), Watson, Mong and Harris (2011), Yang (2015).
Game For Entertainment	4	Appel (2012); Charsky and Ressler (2011); González-González and Blanco-Izquierdo (2012); Sun, Wang and Chan (2011).

APPENDIX 4

Genres of video games used in included studies.

Video game genre	Number of studies	Research studies
Action	1	Appel (2012).
Adventure	1	Appel (2012).
Animated Tutorial	8	Bowen et al (2014); Brom, Levčík, Buchtová and Klement (2015); Brom, Preuss and Klement (2011); Cheng, Lin and She (2015); Clark et al (2011); Giannakos (2013); Huizenga, Admiraal, Akkerman and Ten Dam (2009); Vrugte et al (2015).
Puzzle	7	Brom, Levčík, Buchtová and Klement (2015), Clark et al (2011); Giannakos (2013); Lee and Chen (2009); Sampayo-Vargas, Cope, He and Byrne (2013); Sun, Wang and Chan (2011); Theodoropoulos, Antoniou and Lepouras (2017).
Role/Playing (RPG)	6	Admiraal, Huizenga, Akkerman and Ten Dam (2011); Appel (2012); Arnab et al. (2013); Bowen et al. (2014); González-González and Blanco-Izquierdo (2012); Jong (2015).
Simulation	8	Appel (2012); Bowen et al. (2014); Brom, Preuss and Klement (2011); Charsky and Ressler (2011); Favier and Van Der Schee (2014); Jong (2015); Vrugte et al. (2015); Yang (2015).
Sports	1	Appel (2012).
Strategy	6	Appel (2012); Charsky and Ressler (2011); Huizenga, Admiraal, Akkerman and Ten Dam (2009); Jong (2015); Watson, Mong and Harris (2011); Yang (2015).
Platform	2	Annetta, Minogue, Holmes and Cheng (2009); Papastergiou (2009).
Virtual Reality	1	Annetta, Minogue, Holmes and Cheng (2009).
Virtual World	1	González-González and Blanco-Izquierdo (2012).
Augmented Reality	0	

Other Types	1	Arnab et al. (2013).
Not Specified	4	Anneta, Minogue, Holmes and Cheng (2009); Giannakos (2013); Papastergiou (2009); Yang (2015).
