

REVIEW ARTICLE

Use of video games in elementary school: A systematic review

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ABSTRACT

It shows the results of a research developed at the University of La Sabana, with the aim of identifying the uses that have been given to video games in primary education in the world. A systematic review of literature published in scientific journals between 2000 and 2019 was carried out. The results show that the area of greatest use of video games is natural sciences, and that their use favors interaction and innovation in educational practices.

Keywords: video games; serious games; basic elementary; information and communication technologies

1. Introduction

In recent years, technological advances have increased exponentially, allowing people to have access to a variety of digital tools and resources that facilitate the generation of communicative, social and cultural links^[1]. Modifying the way we communicate, relate, learn and interact^[2,3]. The above, has generated in education a marked difference between the conceptions that students and their teachers have about how Information and Communication Technologies (ICT) should be integrated in the classroom^[1]. Differences that hinder student learning, as they generate frictions within the process^[4]. In the same sense, experts agree that the traditional training process based on the knowledge transfer model has fallen short of the current needs of society^[1]. Moreover, all these factors demand changes in “the contents that are taught, the learning activities, the evaluation and the ways of communicating with the students”^[5].

All of the above, has generated in teachers the

need to transform their pedagogical practices, increasingly involving a diversity of technological resources^[1], ranging from Web 2.0 tools to Metaverse environments and video games. However, many of these processes are done in response to trends in technology integration issues found in social networks and specialized sites or through successful experiences reported by other teachers in blogs.

Although this process is not bad and contributes to transform practices, some of these initiatives do not come to fruition because there are many doubts among teachers about the different factors that must be considered when integrating them. Even more so, when it comes to integrating video games, because, although it is one of the emerging trends in the context of Technology Supported Learning (TSL) thanks to its audiovisual appeal, its challenging and motivating character^[6], there are still many questions that teachers have around when and how to integrate them. This is since commercial video games are designed for entertainment and not to support

ARTICLE INFO

Received: October 25, 2022 | Accepted: November 18, 2022 | Available online: December 2, 2022

CITATION

Mendez M, Boude O. Use of video games in elementary school: A systematic review. *Metaverse* 2022; 3(2): 11 pages.

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training processes, which generates certain difficulties for teachers when integrating them into the requirements established in the course syllabus.

In response to the above, Serious Games have emerged, which are video games aimed at building knowledge and skills from the contents of school, work and health. Their design and production are not limited only to entertain but to promote learning intentionally^[7]. However, many of them have failed to promote learning over entertainment. The fact is that the design of serious games is a complex process that requires teachers to step out of their comfort zone and think about the different elements that their students would expect to find in the game, the mechanics that attract them and the dynamics that need to be promoted in order to foster the competencies and skills that are formulated in the curriculum^[8].

So much so, that nowadays, the development of video games for educational purposes has led to research aimed at finding different ways and strategies of use to support educational processes. Currently there are numerous video games designed for learning, which are implemented in classrooms and other teaching spaces, this accelerated development has generated interest in various fields of knowledge, to study their relevance and effects on the learning of various skills^[9].

For all of the above reasons, the purpose of this research was to identify: the uses that are being made of video games in elementary education, the characteristics of those that are successful, the relationship between the subject area and the type of video game that is most appropriate for each of them, the skills and competencies that are usually developed and the technologies used in these games. In order to provide the academic community with answers from the systematic review of the research that has been reported since 2000, the year in which the number of publications in Scopus on the use of video games in education began to grow.

This exercise made it possible to recognize that, about the areas of application. There is a significant

percentage oriented to the natural sciences, social sciences and mathematics. It is also important to mention that, during the review, other areas of use and texts referring to other technologies combined with video games were found, which were characterized within the same categories of analysis and their coincidences are described in this report.

2. Methodology

An integrative review method was used for this review^[10], a method whose purpose is to obtain new conclusions based on the results of other research already carried out. Particularly for the literature review process, the method of Conn and collaborators^[11] was followed. This indicates that the following stages should be followed: delimitation of the objective; definition of the inclusion criteria; search of the texts in the databases; analysis of the summaries; selection of the texts according to the inclusion criteria; critical evaluation of the texts and analysis of the data collected.

For this case, the primary purpose of the study was to identify the uses given to video games in teaching at the elementary education level, as well as the skills and competencies they develop, the characteristics, elements and technologies used in them, based on the research that has been reported on this subject. However, in order to limit the review to the stated objectives and thus adequately include or exclude texts during the process, the following inclusion criteria were defined:

- Articles published in scientific journals indexed in the main databases.
- Studies carried out in elementary education that integrate video games.
- Studies available in Spanish, English and Portuguese.
- Studies published between 2019 and 2000.

With these criteria, a documentary corpus was defined that included articles published in journals indexed in the following databases: ISI, Scopus,

ProQuest, EBSCOhost, and ScienceDirect, as well as master's and doctoral theses obtained with Google Scholar and university repositories. The search descriptors used were: "video games + primary education", "serious games + primary-elementary", "video games + elementary education", "video games + primary education", "serious games + primary-elementary".

This approach produced a corpus of 160 initial documents after reviewing the titles of the texts obtained with the keywords used in the different databases. This corpus was reduced to 92 texts after comparing and unifying the results obtained in the different databases. Finally, the abstracts of the abovementioned texts were analyzed and the inclusion criteria were applied, which limited the corpus to the final 80 texts included in the review.

For the data analysis process, the thematic analysis method indicated by Braun and Clarke^[12] was followed, which consists of the following

processes: data familiarization, initial coding, pattern search, pattern review, pattern definition, and writing and production of the final report.

3. Results

The data found were analyzed and categorized according to the intentions of the review, and for this reason the results are shown below in light of the intentions indicated above.

3.1. Uses given to video games in elementary school

The results obtained show a wide variety of areas in which video games are used in elementary school education processes. These range from the support of areas such as Natural Sciences, Mathematics and Social Sciences, to their use in educational inclusion strategies and therapeutic use by students, as shown below (**Figure 1**).

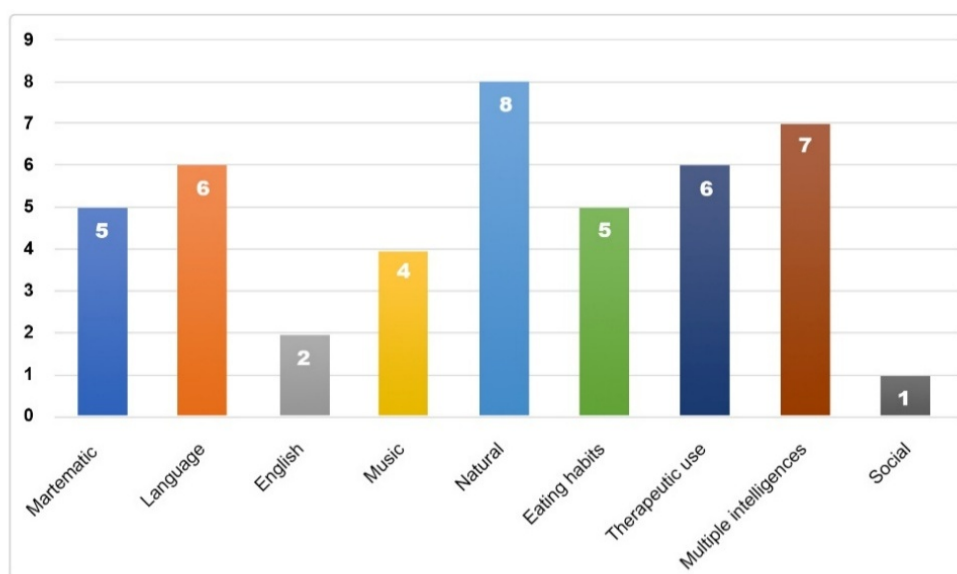


Figure 1. Distribution of research by area of implementation.

However, grouping the results shows that 46% of the studies were carried out in the areas of Natural Sciences, Social Sciences and Mathematics. Of these, 42% in mathematics teaching, 24% in Social Sciences and the remaining 24% in Natural Sciences. Now, at the level of mathematics, researchers report that video games help the development of mental

calculation, problem solving, spatial logic, location and identification of geometric figures and practical exercises with fractions^[13-18]. In addition, it incentivizes attention levels thanks to the excitement generated by its use^[19,20]. Likewise, students are more motivated and less afraid of making mistakes, because they can repeat the activity or look for new

strategies to develop it^[21].

At the level of social sciences, studies indicate that video games are innovative and to the extent that they are adapted to primary school curricula, they improve the levels of knowledge and attitudes of students towards learning. They also serve as a complement for history classes, spatial orientation, recognition and location of the territory among others^[16,22–26].

In Natural Sciences, researchers agree that interest, motivation^[27] and conceptual appropriation of science topics have increased^[28–30], as well as the correlations made by students in real environments^[31,32]. Likewise, it is important to highlight that the topics most addressed are awareness of the care of fauna, recycling processes, awareness and care of the environment, levels of organization of living beings and their recognition in the natural world.

At the level of other areas, they contribute to the development of skills for the knowledge society, critical thinking, digital literacy and new forms of participation^[33–35]. As well as, the development of digital competencies, encouraging critical inquiry of the information found on the web and its relevance^[26,36–39]. The management of new technologies for learning opens windows of opportunity to make new readings from the audiovisual, iconic and graphic, which is far from traditional teaching and allows the student to have flexibility in the face of changes, favoring innovation and creativity strategies to develop in society^[30,40,41]. Video games can be considered as an effective form of digital literacy because they have become a way to communicate, express themselves and exchange knowledge^[42] in addition to generating digital skills in students and favoring the acquisition of concepts^[30,39,43–45].

Finally, the literature shows video games designed for learning music, handling staves, knowledge of musical instruments and territorial folklore, noting motivational and significant effects in the area^[46–49].

3.2. Uses of video games in areas outside the curriculum

Likewise, video games have been used as a therapeutic alternative to improve: psychomotor development in children with cerebral palsy, finding positive effects in terms of postural control and balance^[50], motor coordination and planning in cases of dyspraxia and disposition before therapy sessions^[51], attention and treatment to improve laterality difficulties^[52], pedagogical intervention in the treatment of dyslexia and phonological awareness^[53–55] and empathy, school conflict, and emotion management^[56,57]. As well as, for the adoption of healthy behaviors such as hand washing^[58] and getting boys with autism to take a shower independently^[59].

The creation and use of video games to promote eating habits as treatment and prevention of childhood obesity, whose research agrees that their use encouraged the adoption of healthy eating behaviors, providing motivation and entertainment by experiencing and assessing different game situations when making the right decisions regarding food to improve health^[60–62]. Others found in video games an excuse to develop awareness of child famine, creating strategies to bring humanitarian aid to other territories^[63].

3.3. Skills and competencies developed with the use of video games in the research

Because video games give the player a bias-free environment^[14], in which he can experiment and solve a set of problems with creativity and motivation^[35,64] through, reflective processes. The player manages to develop skills that allow him/her to organize information to solve problems, improve planning by developing mental calculations, manage resources and make decisions^[14,15,65].

Studies highlight that the use of video games increases creativity and promotes the development of creative teaching practices^[66]. Thanks to the fact that they allow teachers to transform their teaching practices^[67], design different strategies for use in and

out of class^[68,69] and improve students' ability to apply knowledge to real life^[43].

Now, the reading of the iconic and graphic languages within the video game implies the understanding of linguistic codes that lead to the comprehension of different topics. Several researches addressed the development of communicative skills in which the objective was to accompany the reading and writing processes, expand vocabulary or learn another language^[70-74].

3.4. Characteristics of video games used for education

Successful video games in education usually include elements of sensory stimulation such as movements and sounds assembled in the graphic content, character interaction to achieve the overcoming of challenges and third-person design to appreciate the actions of the characters in each scenario, providing fun and entertainment to students^[27,42,49,75,76]. And it is the latter, which leads students to interact with technology and achieve greater interest in their learning^[54,77]. Moreover, Marín^[44] indicates that integrating cultural and social themes in the video game interface allows: bringing students closer to knowledge in an attractive and interactive way, recognizing situations of their context, enabling active and experiential learning, as well as associating and correlating learning and as has happened in industrial and military fields^[6].

Now, the interaction manages to emotionally

involve the player, since it allows him/her to become the protagonist of the story he/she is building^[45,78]. To such an extent, that when the student manages to get hooked to the virtual world, the video game becomes a solution center for real situations or environments where the student demonstrates his knowledge^[20,71,79,80].

However, it is essential to articulate the integration of video games to the curricular contents of the course, and for this the most common strategies are usually to use them as a complement to teaching practice, support for textbook content and as didactic tools to integrate cross-cutting themes^[30,74,81]. In addition, Sanchez et al.^[82] confirm that, if video games are well adapted to the curriculum, they have a positive impact on student learning, in contrast to those who receive traditional classes.

Finally, multiplayer video games tend to increase interaction, encourage participation and motivation because players can explore worlds alternately with other players, which makes for greater and better immersion^[14,20]. The above, propitiates collaborative spaces in which players exchange information to achieve the goals of the game and therefore goals in learning^[81]. Likewise, Yagüe et al.^[50] postulate that this type of games allow social integration favoring the exchange of knowledge. The different characteristics identified are shown below (**Table 1**).

Table 1. Characteristics of video games used in primary school

No.	Most relevant characteristics of video games	References
1	Interaction of video game elements as a motivational factor for learning	[27], [42], [45], [49], [54], [77], [78]
2	Immersive components and their effect on learning	[20], [35], [71], [80], [83]
3	Elements of emotional gratification	[42]
4	Adaptation of curricular themes	[30], [39], [67], [74],[81], [84], [49]
5	Video game design related to real environments	[44], [60], [74], [81]
6	Present simulators	[6], [9], [35], [85]
7	Present multiplayer gameplay possibilities	[14], [20], [81], [84]
8	Easy navigation	[29]
9	Obtain feedback and scores	[29], [39], [65], [73], [77]

3.5. Types of video games used

Although not all research indicates the type of video game used, it was possible to determine that most studies used adventure games, since they invite the player to interact with the scenario and characters, as well as to socialize with other players to understand the ways in which the game goals can be overcome^[78]. Secondly, there are arcade games that, due to their intuitive handling, favor motor development, directionality and space management, as well as knowledge of rules and stereotypes^[44]. In third place are simulation games, which provide experiences from real environments and situations recreated in the virtual world. To a lesser extent are role-playing games, in which the player identifies with a character within the game, assuming attitudes, values, practices and skills that are projected in real contexts.

3.6. Other technologies integrated with videogames to support the learning process

The review allowed detecting that along with video games, researchers have used other technologies such as Augmented Reality (AR). Since, its use allows improving the ability to perform game tasks, enhance visuospatial memory, detect and prevent future learning problems and mainly increase motivation, being in front of a different learning environment^[29,86].

In subjects related to mathematics and science, learning geometry, classification of elements, use of the tangram, classification of living beings, zoo design and wildlife, are the ones that stand out most so far^[29,86,87], while Virtual Reality (VR), in addition to generating total immersion for the player, helps to overcome laterality difficulties and strengthen spatial thinking by modeling geometric elements, respectively^[76,78]. 3D modeling printing is also often used for the appropriation of geometric concepts and to contrast the digital dimensions of objects against the physical ones^[21].

In the same sense, the Kinect is a device that

uses motion monitors in a camera following the movements of the entire body^[51]. It has been an accessory used in research as a complement to physical therapy for children with dyspraxia, the use of Kinect favors the planning and organization of movements, which improve psychomotor processes in players. Similarly, it has been used to promote good eating habits and combat childhood obesity, the use of the Kinect motivates players to perform movements while advancing through the levels of the video game^[61].

Similarly, educational robotics is articulated to the use of video games. In their research, Diaz and collaborators^[80], emphasize the learning of programming through a video game, in which children must get the robot to make movements. This exercise involves coordination, cooperation and creativity, for which the researchers conclude that these practices can reduce the existing digital divide, providing new and better environments close to the students in the educational dynamics, which motivate and achieve significant learning that leads to the development of critical thinking and problem solving in today's society.

4. Conclusions

One of the first aspects that caught my attention during the review analysis process is that the use of video games in elementary school is not limited to the development of competencies in areas such as mathematics and science. On the contrary, they are being used in almost all areas of the curriculum, which implies a change of position on video games by institutions and teachers, who no longer see them as a distracting agent in the learning process^[8].

In the same sense, it is important to highlight that in addition to strengthening the training process. Video games are being used to strengthen children in aspects related to learning difficulties, special educational needs and behavior modification^[55], which have a direct impact on the motivation, disposition and academic performance of children during their school process.

However, research oriented to the mathematical area reports that video games develop analytical skills, enhancing the processes of logic and problem-solving training. On the other hand, research oriented to the social sciences facilitates learning history, spatial orientation and cooperative social processes due to the motivation it generates, and at the natural sciences level, research indicates that they facilitate awareness of environmental care and recognition of living beings.

But, regardless of the area or use given to video games, all studies agree on the importance of the level of interactivity of the video game in order to establish participatory dynamics.

On the other hand, topics such as communication skills, reading and writing processes, language learning and music, form another group of texts that highlight the possibilities offered by video games to transform the teaching practices of teachers, offering them a variety of mechanics and dynamics that make the training process more fun and attractive for students.

However, it is important to mention that like any other technology, the prolonged use of it will cause the loss of the novelty effect and decrease motivation, turning this process into a daily activity of which the students get tired.

Likewise, it is important to mention that, when thinking about the integration of video games into educational curricula and teaching practices, teachers have a fundamental role in terms of the objectives and pedagogical intention of the use of video games in the classroom or outside the classroom. In order to have a real effect on teaching and learning, it is necessary to promote the use of the tool as a practical strategy for the application of knowledge.

Finally, although the review shows a change in the perception of the use of video games in education, there are still very few studies reported on the subject and many questions remain about the advantages and disadvantages of incorporating this type of

technology in the educational process, as well as the development of longitudinal studies on the risks and benefits of its use in the long term.

Conflict of interest

The authors declare no conflict of interest.

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