Revista Colombiana de Educación
ISSN: 0120-3916
ISSN: 2323-0134
Universidad Pedagógica Nacional de Colombia

Marín-Suelves, Diana; Esnaola-Horacek, Graciela; Donato, Donatella
Videogames and Education: Analysing of Research Trends
Revista Colombiana de Educación, no. 84, e209, 2022, January-April
Universidad Pedagógica Nacional de Colombia

DOI: https://doi.org/10.17227/rce.num84-12125

Available in: https://www.redalyc.org/articulo.oa?id=413674311011

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# Videogames and Education: Analysing of Research Trends

## Videojuegos y educación: análisis de tendencias en investigación
## Videogames e educação: análise das tendências de pesquisa

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**Para citar este artículo**
Marín-Suelves, D., Esnaola-Horacek, G. y Donato, D. Videojuegos y educación: análisis de tendencias en investigación. *Revista Colombiana de Educación*, *1*(84), 1-17. https://doi.org/10.17227/rce.num84-12125

Fecha de recepción: 24/07/2020
Fecha de recepción: 27/12/2020

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## Abstract

Much has been recently written about the possibilities and controversies of using video games in education. In order to know the research trends, through productivity, impact, collaboration and dissemination, a bibliometric analysis was performed on 226 documents available in the Scopus database. This was supplemented with a content analysis of 62 open-access articles. The results show the interest of studying this question and the boom of the past decade, the weight of countries like Spain, and the strong impact of almost half the articles. The expectations set by Lotka's and Bradford's laws were confirmed. Research confirms that video games have positive effects on learning, motivation and class dynamics, without forgetting the fundamental role of teachers, and the design and purpose of games. Finally, future research lines related to necessary teacher training or the evaluation of video games from a pedagogical perspective are indicated.

**Keywords:** educational game; research; teaching; technology; educational development

## Resumen

Mucho se ha escrito en los últimos tiempos acerca de las posibilidades y controversias del uso de los videojuegos en educación. Para conocer las tendencias en investigación, a través de la productividad, impacto, colaboración y difusión, se realizó un análisis bibliométrico sobre 226 documentos disponibles en la base de datos Scopus. Además, se complementó con un análisis de contenido de los 62 artículos disponibles en acceso abierto. Los resultados muestran el interés por el estudio de esta cuestión y el auge en la última década, el peso de países como España, y el elevado impacto de casi la mitad de los artículos. Además, se confirma lo esperado según la Ley de Lotka y Bradford. Las investigaciones confirman que los videojuegos tienen efectos positivos en el aprendizaje, la motivación y la dinámica de la clase, sin olvidar el papel fundamental del profesorado, el diseño y la finalidad del propio juego. Por último, se señalan futuras líneas de investigación vinculadas a la necesaria formación del profesorado o la evaluación de los videojuegos desde una vertiente pedagógica.

**Palabras clave:** juego educativo; investigación; enseñanza; tecnología; desarrollo de la educación

## Resumo

Muito tem sido escrito nos últimos tempos sobre as possibilidades e controvérsias do uso de videogames na educação. Para conhecer as tendências da pesquisa, por meio da produtividade, impacto, colaboração e disseminação, foi realizada uma análise bibliométrica em 226 documentos disponíveis no banco de dados Scopus. Além disso, foi complementada por uma análise de conteúdo dos 62 artigos disponíveis em acesso aberto. Os resultados mostram o interesse no estudo dessa questão e o boom da última década, o peso de países como a Espanha e o alto impacto de quase metade dos artigos. Além disso, o que é esperado é confirmado de acordo com a Lei de Lotka e Bradford. Pesquisas confirmam que os videogames têm efeitos positivos na dinâmica de aprendizado, motivação e classe, sem esquecer o papel fundamental dos professores, o design e o objetivo do jogo. Por fim, são apontadas futuras linhas de pesquisa relacionadas à necessária formação de professores ou à avaliação de videogames sob uma perspectiva pedagógica.

**Palavras chave:** jogo educacional; pesquisa; ensino; tecnología; desenvolvimento educacional

# Introduction

Today we can confirm that video games constitute an expression of interactive digital culture. As we move into the second decade of the 21st century, we can define gaming culture as part of many people's routines and activities. However, how can we define the changes of this era known as "gaming culture"? Clearly, we are moving from a Gutenberg culture, which generalised writing, to a gaming-digital culture.

We stand by the following observation: uses and practices leave psychosocial marks on our actions. Widespread use has shaped practices in the modern world. Just as orality had to be ordered and time and space coordinates had to be established to make writing possible, paper-based practices also left an imiprint on our social organisation: a hierarchical and ordered society to accompany these marks. This structural concept produces a very interesting cognitive residue (San Martín, 1995, p. 158): a mind in dialogue with culture. In the modern age we aimed at a hierarchical, ordered, and segmented society. Writing underwent the same cultural transition, from orality to writing. When the world of rumour was ordered and a direction was set, even the value of writing became hierarchical. Following this thinking, in the middle of the first decade of the 21st century, we witnessed a true "change of an era", rather than an era of changes. The new cultural paradigm was labelled *digimodernism* (Kirby, 2009). It involved different media and new ideas about the creation of texts and how they work and produced distinctive ways of categorising and explaining the new digital world and our place in it. This is where we inscribe gaming culture: everyday practices marked by the expansion of video games that can be played in short and flexible times in casual, mobile environments. The school institution also participates in this culture by rejecting submissive and memory-based practices, typical of previous educational times. Students demand teaching materials that are more than just a physical support for content. They need to be agile and fun. A new niche has opened up for the development of video games, which can easily support the most challenging curricular subjects.

The process of digitisation produces a change in two fundamental components of social identity: space and time. Writing demands a static space of exhibition, serenity, and contemplation of the object, that is, the word, the knowledge, the book. Contemplation is often the teacher's demand, silence. This is an obstacle to the inclusion of video games in the classroom and the teacher must overcome it by evaluating the benefits of playing, laughing, and becoming immersed in a narrative that facilitates problem solving processes. Teachers who include video games in the classroom appreciate how they help in the development of competences and skills in gaming teams who have fun while they learn. Games also bring joy into the classroom. In postmodern times, linear narratives and sequential orders are in crisis because these new texts demand interactivity (or are constructed based on it). If a text is not interactive, it is not dynamic, and if it does not allow for alternative routes, it becomes tiring, exhausting, and users lose interest. Users are "prosumers", they want to intervene: this is *cultural interactivity*. Nowadays, spaces must be immersive, and this has affected reading and the construction of meaning. It is a participatory space, with multiple windows. Neurosciences have found a new object of study in education: our hitherto sequential neurons now have

multiple connection pathways and different types of connections are appearing. Society worked in linear time, with routines that structured our lives and different times for intimacy, for work, and for resolving everyday issues. Separate times linked to everyday spheres. Today's temporal remodeling has blended work time with everyday time. Since it became possible to be synchronously connected, times and spaces have become intertwined; we can communicate with people who live in distant places and yet we do not know our neighbours. The population structure has become, as Castells rightly stated, "a series of individual shacks" (1997, p. 374). A new category of subject appears, linked to these new cultural practices.

When we understand school subjects as individuals immersed in culture and not as isolated biological entities, we will be able to reinvent didactics for these students who question the teaching system because it still fails to take into account the characteristics of gaming culture, which does capture the students' attention. Twenty-first century subjects are no longer tied to a specific time and space. They are on the move, they are once again nomadic, they carry their office in their mobile phones and work or study remotely from home. Cobo & Moravec (2011) define them as *knowmads* (a portmanteau of *knowledge* and *nomadic*). This metaphor describes a shift from situated knowledge (the school, the library, the university, the textbook) towards a nomadic subject-object that is constantly under construction and reconstruction. In "Aprendizaje invisible", Moravec and Romaní Cristóbal Cobo define subjects as nomadic and talk about "knowmad society", a nomadic society where borders become increasingly undefined. Bauman's (2003) description of liquid modernity allows us to define the school institution as solid in our liquid modernity. Living with this level of uncertainty is difficult, especially in education, since our task is constantly in perspective. These concepts are very interesting to understand the changes required in the new teaching paradigm, because they connect good practices and cultural categories.

These socio-cultural conceptualisations provide the basis to define what we mean by *educational video game*. We define an educational video game as a Digital Didactic Material (DDM) because they are explicitly designed to reinforce teaching contents. In traditional didactics, the teacher would first present and explain the curricular contents, sequenced according to the syllabus. Once the content has been explained, an activity or game is played to reinforce it. The concept of educational video game is here linked to school content. DDMs fulfil a motivational or behaviour reinforcement function, a pedagogical vision developed in the last century with varying degrees of success. But the socio-cultural context was different. Today, the learning paradigm has changed. There is no need for explicit work, one learns by doing, at every opportunity. This is where we can define DDMs (and video games in particular) as didactic tools that facilitate learning. Different aspects of video game development provide multiple learning possibilities beyond curricular contents. They go further and can contribute in different ways: a narrative as a symbolic framework, play mechanics and aesthetics that invite self-learning, and the development of strategic problem-solving, for example.

Our definition of educational video game refers to an interactive digital tool that seeks to develop cognitive and psychosocial competences, essentially framed within a recreational digital environment. By definition, educational game developers must create video games that teach competences but are still games, i.e., they must retain the advantages of "game-based learning". In the content of the papers evaluated, we observe how video games are designed, how they are developed, how new users learn to play, how all parts involved (*consumers* or *gamers*, but also *game design*) change to understand this new mind, this new possibility.

Some aspects of the cultural industry of video game development are not well known in the educational world. Students spend long hours playing video games and the gaming culture is expanding into transmedia narratives. However, some studies remind us that excessive play time is a necessary aspect of video game addiction (albeit not a defining one), which involves a variety of external and internal reward mechanisms that lead to playing for inordinate amounts of time (Chamarro, Oberst, Cladellas, & Fuster, 2020).

Nevertheless, following the latest trends in the scientific papers evaluated, we considering a type of transmedia pedagogy that can establish a dialogue between these two worlds. The new educational paradigm proposes a dialogue with this image-filled world that can then be transferred to experience and transformed into knowledge. We should move from a pedagogy of enunciation to a *pedagogy of experimentation*, of participation, of looking for the possibilities that the media provide to understand our students' reality. We have explained the theoretical bases to understand why it is necessary to incorporate video games into teaching practices; they fit the students' usual learning process and their recreational strategy encourages pupils to search for information and solve practical problems. Following coinciding content analyses, the challenge for teachers is to evaluate different possibilities for video games to accompany learning based on digital spaces and good teaching practices.

This paper aims to survey academic precedents and check the different strategies from which they have approached the inclusion of video games in the classroom. The objective of this study was to learn more about the current research trends on video games in education, from a scientometric and content analysis perspective. The specific objectives were to determine the production, collaboration, scattering, and impact of this field and the main characteristics of previous studies. We hope they can contribute programme designs or educational applications which, based on scientific evidence, can provide some guarantee of success.

# Methodology

This work includes a descriptive and retrospective bibliometric study. It uses the traditional methodology of this type of study (Moreno, 2019) to provide an overview of the state of the art. The objective was to quantify the main characteristics of the scientific literature on a specific area (Tomás-Górriz & Tomás-Casterá, 2018), namely the use of video games in education, and to analyse the trends in research, as indicated by Zulueta & Bordons (1999).

The Scopus database was chosen for its recognised prestige, extensive historical coverage, and number of publications, as stated by García, Gallardo-López, and López-Noguero (2020), or Martínez-Heredia and Moreno (2020). The search and analysis was carried out during the month of May 2020, to determine the trend at this point in time, using data from the first four months. A mesoanalysis was proposed to increase reliability and specificity, limiting the results to scientific production in the area of Social Sciences (King, 1987), since the aim of the study was to analyse the consequences or implications of the use of video games in education. The bibliometric indicators proposed by Aleixandre (2010) were used to analyse the data, based on structural variables such as scientific productivity, collaboration, scattering, and impact. The documents selected for the bibliometric analysis were those obtained after searching for the terms *videogame OR serious game AND education* in the title, keywords, and abstract, since the introduction of terms such as *play game* or *school* did not increase the number of

results. Inclusion and exclusion criteria included a publication date filter (papers were limited to the last decade) and a document type filter (scientific papers). Figure 1 shows the process for the selection of the documents. Three phases can be distinguished: the identification of texts susceptible to analysis; the screening process, which eliminated documents that were not relevant to the objectives of this work; and finally, the inclusion of documents for the bibliometric analysis. Based on the analysis of the documents by two researchers, 226 articles were selected, with high intercoder reliability and a high level of agreement (Altman, 1991), with a Cohen's kappa test result of 0.697.

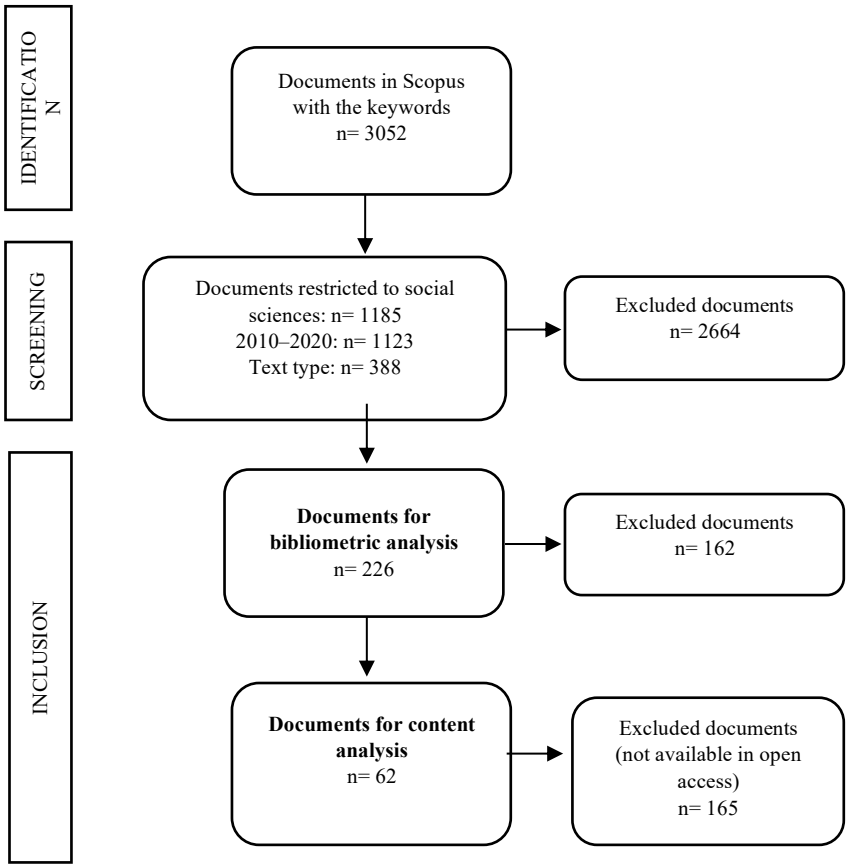


**Figure 1.** Flowchart

**Source:** Adapted from the PRISMA framework.

In addition, this study was complemented by a content analysis of the papers that were available in open access, which amounted to 62 items in total. A record sheet was used for the content analysis, covering the sample, educational stages, areas and results of each study. Lastly, the graphic representation of the results was created using VOSviewer (Van Eck & Waltman, 2011).

# Results

This section shows the findings of the bibliometric study and the content analysis. Regarding the bibliometric study, various indicators were taken into consideration to analyse production, collaboration, scattering, and impact.

First of all, in terms of scientific productivity, the number of documents published in the area of Social Sciences was taken into consideration. After identifying the items in the Scopus database and screening the sample by applying the previously mentioned inclusion and exclusion criteria, a total of 226 articles were selected. The diachronic production, represented in Figure 2, suggests that the number of publications has been increasing over the years, reaching a peak in 2019, with a total of 42 articles.

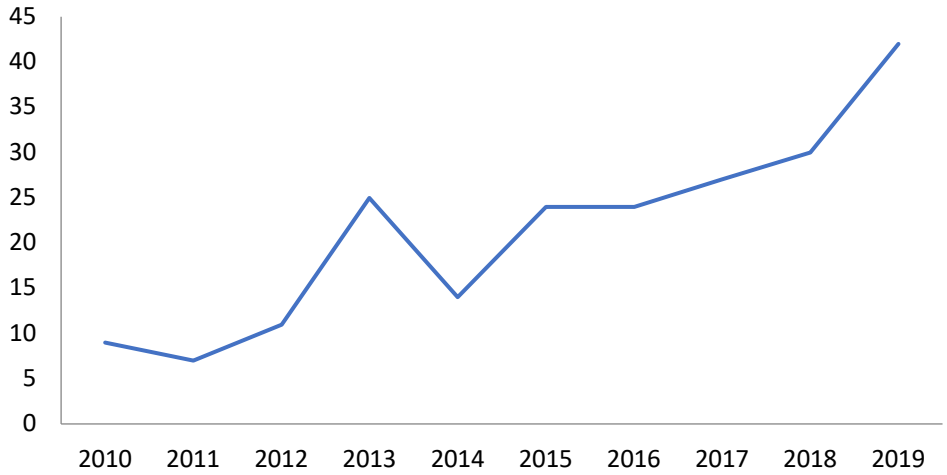


**Figure 2.** Publications by year

**Source:** Created by the authors from Scopus data.

In terms of personal productivity, a total of 160 authors signed the 226 papers. This information is analysed based on Lotka's law of scientific productivity, which establishes that only a small number of authors publish a significant number of texts on the same subject. As can be seen in Table 1, in this case, occasional producers predominate. A total of 117 authors (73%) have only published one article and 37 authors (23%) have written two articles. The rest (4%) can be considered medium-sized producers, and no major producer was found.

**Table 1**

Number of documents per author

| Number of documents | Number of authors |
|---|---|
| 1 | 117 |
| 2 | 37 |
| 3 | 0 |
| 4 | 5 |
| 5 | 1 |
| Total | 160 |

Medium-sized producers include Fernando Luís Almeida (Universidade do Porto), Sylvester Arnab (Coventry University), Francesco Bellotti (Università degli Studi di Genova), Sara Isabella de Freitas (Murdoch University), and Alessandro de Gloria (Università degli Studi di Genova), with 4 papers each, y Riccardo Berta (Università degli Studi di Genova), with 5 papers. From a gender perspective, it is necessary to highlight the low representation of women in this field of study.

Additionally, the languages of the scientific papers analysed were considered (Figure 3). Most of them (85%) are written in English, and 12% in Spanish. There are also papers published in four other languages: Portuguese (Esqueda & Fernandes, 2019; Finco & Fraga, 2012; Finco, Reategui, & Zaro, 2015; Saldanha, Pinto, & Ferreira, 2018), German (De Moll, 2019), French (Ferreira, 2014), and Dutch (Smallenbroek, de Vries, & Lindhout, 2015), which evidences the existing interest in disseminating knowledge on this topic.

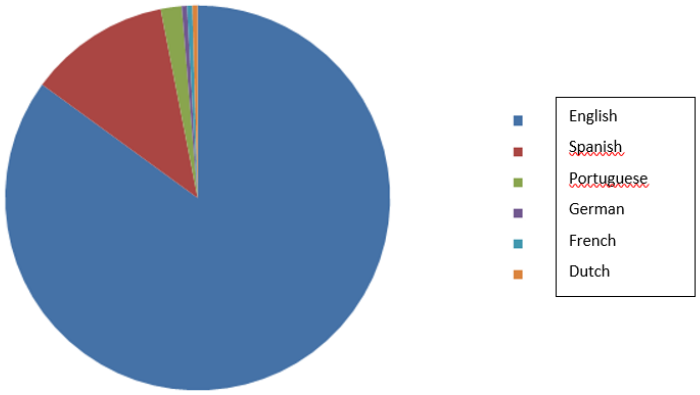


**Figura 3.** Document language.
**Source:** Created by the authors from Scopus data.

Secondly, concerning the information provided by the collaboration indicators, the existence of important research networks stands out. As Table 2 shows, most of the papers were written collaboratively (87.6%).

**Tabla 3.**

Number of authors per document

| Number of authors | N | % |
|---|---|---|
| 1 | 28 | 12,4 |
| 2 | 67 | 29,6 |
| 3 | 55 | 24,3 |
| 4 | 38 | 16,8 |
| 5 | 14 | 6,2 |
| 6-10 | 22 | 9,7 |
| More than 10 | 2 | 1 |
| Total | 226 | 100 |

There are two articles with more than 10 authors. The paper by Lanzotti, Vanacore, Tarallo, Nathan-Roberts, Coccorese, Minopoli, Carbone, d'Angelo, Grasso, Di Gironimo, & Papa (2020), written collaboratively by researchers from the United States and Italy, addresses worker safety training and concludes that video games are useful for improving attention and learning skills in work contexts. Meanwhile, the work with the highest number of authors is that by Dunbar, Jensen, Miller, Bessarabova, Lee, Wilson, Elizondo, Adame, Valacich, Straub, Burgoon, Lane, Piercy, Wilson, King, Vincent, & Schuetzler (2017), a total of 17 researchers from different universities in the United States. This work analyses a video game's effectiveness in reducing the students' cognitive biases.

Figure 4 shows the international collaboration network with the countries that have collaborated on any of the papers. One of the most recent examples is the work by Torres-Toukoumidis, Guerrero, Peñalva, & Carrera (2020), in which researchers from Ecuador, Spain, and Italy analyse the relationship between variables such as the level of education and the source of inspiration, the purpose of the designed video game and the skills it should develop, during the Global Game Jam. They conclude that there are no differences between young creators and top experts in terms of passion for the video game development process. They also point out that the source of inspiration depends on game type or mechanics, and that the aim is to learn a technical skill, such as design or programming, as well as player enjoyment.

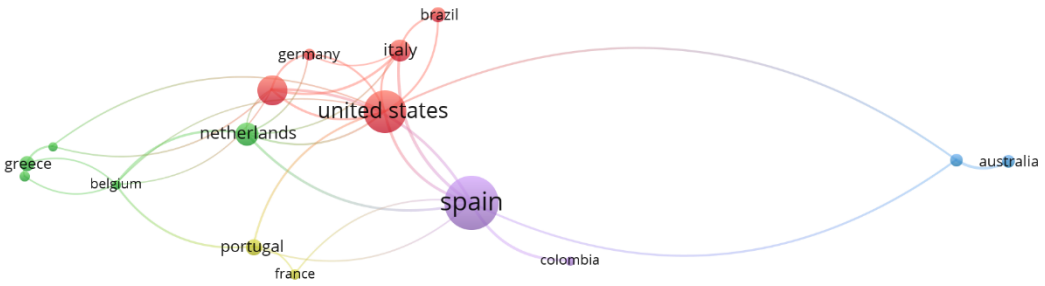


**Figure 4.** Co-authorship network.
**Source:** *VOSviewer*.

Thirdly, scattering is analysed using Bradford's law, which correlates the number of journals and the number of papers on a topic. In Figure 5, three groups can be observed. The core group consists of a small number of journals (n=18) that published half of the analysed articles (n=112). In group 1, a larger number of journals (n=37) concentrate around a smaller production (n=56). Lastly, group 2 contains 58 journals that have published only one paper on video games in education.

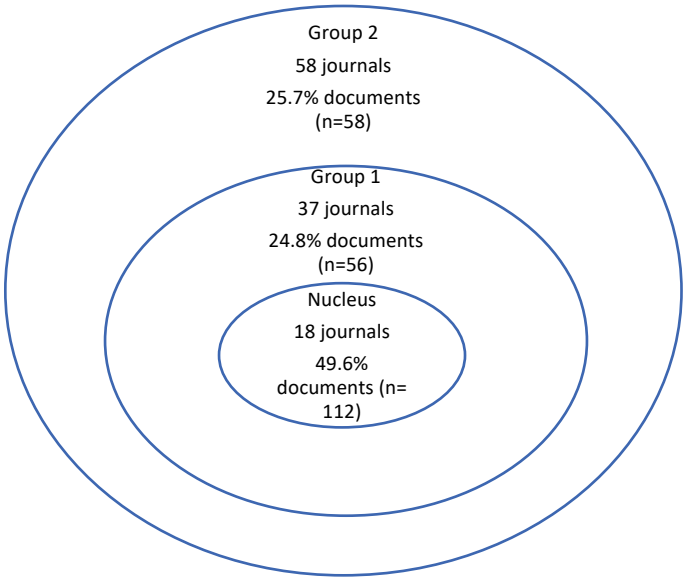


**Figure 5.** Literature scattering.
**Source:** Created by the authors.

The journals that have published the largest number of papers on the implementation of video games in education are: Computers and Education (9%), British Journal of Educational Technology (6%), International Journal Of Emerging Technologies In Learning (5%), and International Journal Of Game Based Learning (5%).

For the final section of the bibliometric analysis, impact indicators such as geographical origin, institutions, number of citations, and the cross-citation network were considered.

As for the weight of each country (Figure 6), Spain's predominance stands out, with around a quarter of the total number of articles published on video games in education (26.1%), followed by countries like the USA (18.6%) or the United Kingdom (10.2%). There are important differences in the bibliometric size of each country, but we find papers from 48 countries, from places as far apart as Cuba (López, Avello, Avello, Baute, & Vidal, 2018), India (Saravanan & Balasaravanan, 2018), Malta (Khaled & Vasalou, 2014), or Thailand (Sipiyaruk, Gallagher, Hatzipanagos, & Reynolds, 2017), with only one article each.

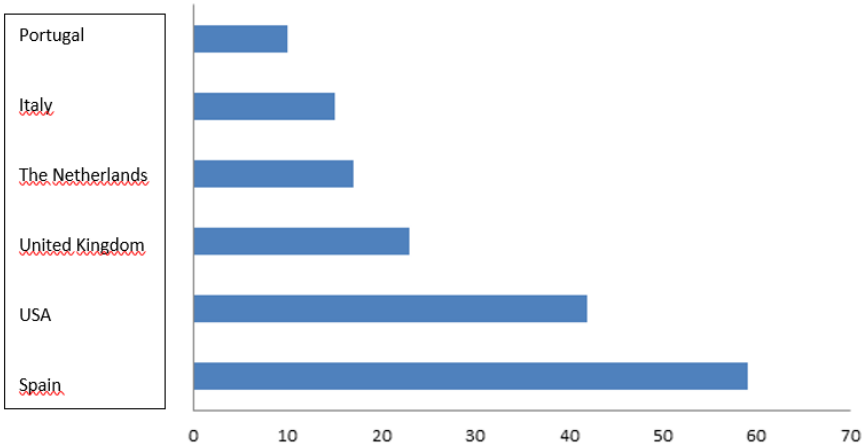


**Figure 6.** Publications by country

**Source:** Created by the authors from Scopus data.

Regarding the institutions working on this issue, Spanish universities such as the Universidad Complutense de Madrid, Universidad Autónoma de Madrid, Universidad de Granada, Universitat de València, Universidad de Córdoba, and Universitat Rovira i Virgili stand out, as well as other foreign universities such as Utrecht University, Coventry University, Università degli Studi di Genova, and Universidade do Porto.

On the other hand, if we consider the impact of the articles in terms of the number of citations received, Table 3 shows that most of them have zero or little impact, with 68.1% receiving between zero and five citations.

**Table 3**

Number of citations per document

| Number of citations | N | % |
|---|---|---|
| 0 | 57 | 25,2 |
| 1-5 | 97 | 42,9 |

| | | |
|---|---|---|
| 6-10 | 22 | 9,7 |
| 11-20 | 18 | 8 |
| 21-30 | 11 | 4,9 |
| 31-50 | 8 | 3,5 |
| More than 50 | 7 | 3,1 |
| More than 100 | 6 | 2,7 |
| Total | 226 | 100 |

Table 4 below presents the key data for the most cited articles, including those with more than a hundred citations.

**Table 4**

Most cited articles

.

| Autor/año | Título | Revista | Número de citas |
|---|---|---|---|
| Carvalho, M. B., Bellotti, F., Berta, R., De Gloria, A., Sedano, C. I., Hauge, J. B., Rauterberg, M. (2015). | An activity theory-based model for serious games analysis and conceptual design. | *Computers and Education* | 104 |
| Arnab, S., Lim, T., Carvalho, M. B., Bellotti, F., De Freitas, S., Louchart, S., De Gloria, A. (2015 | Mapping learning and game mechanics for serious games analysis. | *British Journal of Educational Technology* | 242 |
| Mayer, I., Bekebrede, G., Harteveld, C., | The research and evaluation of serious games: Toward a comprehensive methodology. | *British Journal of Educational Technology* | 112 |

| | | | |
|---|---|---|---|
| Warmelink, H., Zhou, Q., Van Ruijven, T., Wenzler, I. (2014) | | | |
| Erhel y Jamet (2013) | Digital game-based learning: Impact of instructions and feedback on motivation and learning effectiveness. | *Computers and Education* | 212 |
| Abramovich, S., Schunn, C., y Higashi, R. M. (2013) | Are badges useful in education? It depends upon the type of badge and expertise of learner. | *Educational Technology Research and Development* | 169 |
| Guillén-Nieto, V., y Aleson-Carbonell, M. (2012) | Serious games and learning effectiveness: The case of it's a deal! | *Computers and Education* | 134 |

Concerning impact, 58.8% of the documents analysed have a lower index than expected, but it should be noted that 41.2% have a higher than expected weighted impact index. There are a total of 9 papers with an index higher than 10. In this field, the work by Arnab et al. (2015) on the design and evaluation of a serious game (taking into account not only the elements of the game itself, but also the importance of pedagogy) stands out with an index of 39.70.

Finally, Figure 6 shows the cross-citation network, highlighting the presence of medium-sized producers, which reinforces their weight in the area of video games in education.

**Figure 7.** Cross-citation map.

**Source:** VOSviewer.

# Content analysis

The first level of analysis focused on the most commonly used terms in the title, abstract, and keywords of the selected documents and the relationship between them. Figure 7 shows the keyword co-occurrence map, which uses fractional counting (Perianes, Waltman, & Van Eck, 2016) and shows 5 clearly distinguishable clusters. The first of them identifies the largest concept, *serious games*, related to *game based learning* and *gamification*, and identifies terms that are sometimes used as synonyms to address the study of this topic. The second cluster includes key elements in the educational process, with terms such as *learning*, *curriculum*, *pedagogy*, *student*, or *educational technology*. The third cluster contains words related to the potential of technologies in the field of education, such as *video games*, *simulation*, *recreation*, or *software design*. There fourth cluster is directly related to education and learning, with terms like *computer aided instruction*, *e-learning*, *education computing*, *interactive learning environments*, *learning system*, or *media in education*. The last cluster shows the weight of studies focused on higher education contexts.

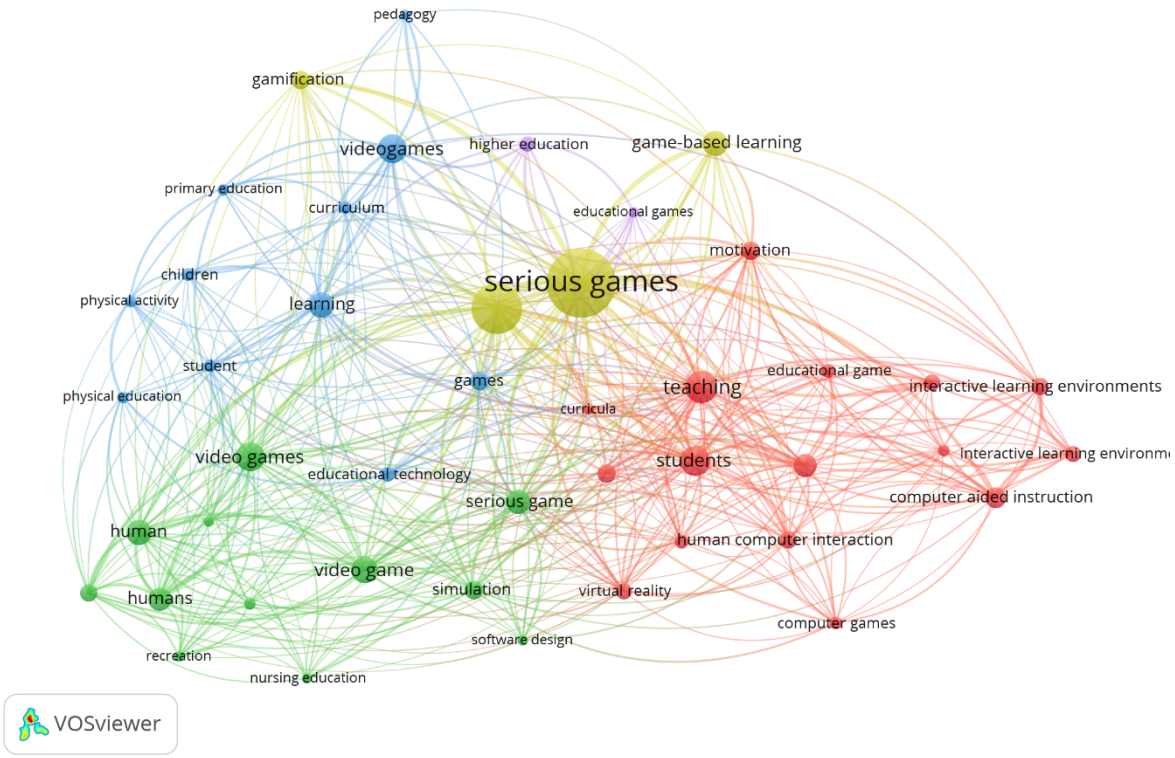


**Figure 8.** Keyword co-ocurrence map

**Source:** VOSviewer.

The second level of analysis went deeper into the content of the 62 documents available in open access, with the following categories of analysis: sample, educational stages, areas in which video games are used, and main results.

Regarding the participants, there are large differences in terms of age (participants aged 5 to 28 years old) and sample size, ranging from 577 students (González-Valero, Ubago-Jiménez, Zurita-Ortega, Chacón-Cuberos, Castro-Sánchez, & Puertas-Molero, 2018) to six (Castro, Raposo-Rivas, & Martínez-Figueira, 2018), even though both studies were carried out in primary education. There are also gender differences in terms of video game preferences. According to some results, in secondary education, boys prefer computers and girls favour mobile phones, and girls show greater responsibility both in terms of time devoted and in video game choice (Ricoy, 2016). Boys spend a greater amount of time playing video games with violent content and girls prefer strategy games, and boys are more attracted to narratives involving characters participating in criminal activities and fighting (Schwarz, Mertens, Simons, Spook, Thompson, Cardon, De Bourdeaudhuij, Chastin, & Desmet, 2019). Women perform better in activities involving teamwork and communication tasks (Cela-Ranilla, Esteve-Mon, Esteve-González, & Gisbert-Cervera, 2014). In general, both men and women prefer human characters as protagonists and non-human characters only as antagonists. Men play more games both on weekdays and weekends and report playing video games that are not recommended for their age more than women (Marín-Díaz, Morales-Díaz, & Reche-Urbano, 2019).

In terms of educational stage, only 3.22% of the documents focus on early childhood education. These studies recognise the importance of video games for learning by doing, in groups, and in a challenging environment in which pupils can experiment by trial and error (Papanastasiou, Drigas, & Skianis, 2017) when they are not too young. Almost a quarter of the studies (22.58%) are related to primary education. Among all of them, we should highlight a study that relates problem video game use with decreased levels of physical activity and well-being (González-Valero, Ubago-Jiménez, Zurita-Ortega, Chacón-Cuberos, Castro-Sánchez, & Puertas-Molero, 2018) and, conversely, the study by Castro, Raposo-Rivas, and Martínez-Figueira (2018), which confirms that video games can increase students' level of attention, autonomy, self-management, teamwork, scientific curiosity, and motivation. In secondary education, interventions aimed at sex education in the classroom stand out (Arnab, Brown, Clarke, Dunwell, Lim, Suttie, Louchart, Hendrix, & De Freitas, 2013), as does the promotion of a culture of educational success, attention to diversity, inclusion and coexistence, and civic and political education (Saldanha, Pinto, & Ferreira, 2018), the development a more active and efficient citizenship (Marín-Díaz, Sampedro-Requena, & Mac Fadden, 2019), a better understanding of human migrations (Su, 2018), and other actions focusing on the obstacles and dangers that refugees must overcome (Gabriel, 2018), as well as other issues considered fundamental for life, such as emotional intelligence and emotional regulation (Cejudo & Latorre, 2015). Concerning higher education, video games are considered a didactic strategy that can make it easier to adapt to university life, to understand new academic concepts, promote good study habits, a healthy lifestyle, and a better knowledge of the campus (Moreno & Álvarez, 2020). Other investigations encourage the use of video games to develop entrepreneurial skills, management and leadership skills training (Almeida & Buzady, 2019), to foster teamwork and self-management (Cela-Ranilla, Esteve-Mon, Esteve-González, & Gisbert-Cervera, 2014), or to be used in the computer science classroom (Prinsloo & Jordaan, 2014).

The areas in which educational video games are used are very diverse. They include the use of video games to teach/learn English (Hansbøl & Meyer, 2011), and in an interdisciplinary approach to bioengineering or natural sciences (Strawhacker, Bers, Verish, Sullivan, & Shaer, 2018). Likewise, students are faced with the creation of video games to foster empathy and cognitive processes (Di Tore, 2014), or to address different topics such as music, astronomy, and cultural heritage, providing creative, collaborative, and inclusive learning environments and taking into account auditory interaction (Rovithis, Floros, Moustakas, Vogklis, & Kotsira, 2019).

Regarding the results in general, some studies identify the benefits of using video games to improve digital literacy and identify fake images and news by detecting traces of visual manipulation (Katsaounidou, Vrysis, Kotsakis, Dimoulas, & Veglis, 2019). Others highlight the importance of video games for literacy, mathematics, cognitive and motor skills, creativity, communication, and special education (Kokkalia, Drigas, Economou, Roussos, & Choli, 2017). Particularly noteworthy are studies concluding that video games can develop linguistic-communicative, theoretical, and technical competences, or develop instrumental competence – i.e., managing different translation software – (Esqueda & Fernandes, 2019) and reading skills (Torres-Toukoumidis, Romero-Rodriguez, Amor & Bjork, 2016). In addition, video games are used to improve personal risk perceptions and manage feelings of panic in adverse conditions (Bosschaart, van der Schee, & Kuiper, 2016), and can also be used to develop

anticipatory skills, systemic and critical thinking, integrated problem-solving competence, conscious decision making, and responsible action according to the principles of sustainability (Peña, Corral, & Mata, 2020). Similarly, some papers discuss the benefits of providing a fully immersive and interactive storytelling experience and allowing players to navigate the game freely, which has a positive effect on engagement (Ferguson, van den Broek, & van Oostendorp, 2019) and takes advantage of multimodal interaction. Recreational aspects such as entertainment, socialisation, competitiveness, and the establishment of challenges that influence participation can also be observed in the studies in the sample – some identify the elements and mechanics of a game (Gonzalo-Iglesia, Lozano-Monterrubio, & Prades-Tena, 2018). In terms of pre-service teacher training, video games have proven useful for improving linguistic competence, learning concepts in natural sciences and mathematics, fostering caring behaviours, gender equality, and school coexistence (Marín-Díaz, Morales-Díaz, & Reche-Urbano, 2019), and learning foreign languages (Alyaz, & Genc, 2016). The role of the teacher as an active designer of classroom activities and resources is key. They are expected to combine video games with other tools and materials, building a holistic learning situation (De Sousa, & Rasmussen, 2019) and developing a game-based assessment process whose content value is at least equal to traditional assessment and with lower risks of subjective and arbitrary evaluations (Hummel, Joosten-ten Brinke, Nadolski, & Baartman, 2017). Other works are connected to pre-professional contexts, like those that carry out experiments in a virtual clinic space (Peery, & Pasalar, 2018), enhance education in healthcare settings (Kron, Gjerde, Sen, & Fetters, 2010), focus on medical practice (Hannig, Kuth, Özman, Jonas, & Spreckelsen, 2012) or in the field of Psychology, or on the development of new skills (McGregor & Bartle, 2019).

There are also studies focusing on technical issues such as game design, production, development (Shi, Kaneko, Ma, & Okada, 2019; Hanes & Stone, 2019), evaluation (Borji & Khaldi, 2014; Galván-Pérez, Ouariachi, Pozo-Llorente, & Gutiérrez-Pérez, 2018), or on programming language improvement (Yassine, Chenouni, Berrada, & Tahiri, 2017).

# Conclusions

Regarding the first objective of the bibliometric study, the increase in the number of papers in recent years is noteworthy. There is extensive collaboration between authors from the same institution or from the same country. Lotka's law of scientific productivity and Bradford's law are met. There is a clear predominance of English as the language of dissemination, despite the fact that Spain ranks first in the study of video games in the field of education. The impact index of almost half of the articles is higher than expected considering the year of publication, the type of document, and the number of citations received.

In terms of content analysis, the research reviewed reveals that video games combine the efficiency of computer processing and data storage with high levels of appeal (Bellotti, Berta, & De Gloria, 2010), can increase the engagement with the learning process through their consideration of content, technical features, the mood of the users, and characteristics that facilitate the learning process (Fokides, Fokides, Kaimara, & Deliyannis, 2019), the source of inspiration and purpose of the game, and the competences to be developed (Torres-Toukoumidis, Salgado, Peñalva, & Carrera, 2020).

Future lines of research in this field include examining the perceived usefulness and potential obstacles to the application of video games in the classroom (Calabor, Mora, & Moya, 2019), the importance of teacher training to implement increasingly active methodologies (Galindo-Domínguez, 2019), the need to know and choose appropriately among the wide variety of products available, and taking advantage of the different challenges and cognitive skills that each one of them can develop (Sedeño, 2010). These issues have been underexplored in the past, so it would be interesting to have more extensive research on them.

# Acknowledgements

This text is part of the results of the emerging project *Análisis de las estrategias docentes ante la digitalización de los contenidos del currículum de Educación Infantil y Primaria* (GV/2018/074) funded by the Education, Research, Culture, and Sport Department of the Valencian Regional Government. The translation of the text, by Manuel Gil Fernández, was funded by the Department of Education and School Management, University of Valencia.

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