



E-learning y desarrollo de competencias clave: un estudio bibliométrico

E-learning and development of key competencies: a bibliometric study

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Resumen:

El aprendizaje electrónico (e-learning) es una modalidad educativa que vertebra, a través de diferentes herramientas y metodologías, el aprendizaje mediado por las tecnologías. Este estudio pretende, a partir de esta idea, revisar el impacto del aprendizaje electrónico en el desarrollo de las competencias clave desde un punto de vista bibliométrico y de contenido. Para ello, se analiza la producción científica relativa a estudios donde esta modalidad está al servicio del desarrollo de estas competencias, reflexionando así sobre los beneficios de los entornos flexibles y abiertos. Concretamente, se han analizado 255 artículos disponibles en la base de datos Scopus, bajo el criterio temporal de publicación en la última década. Los resultados muestran que ha habido un incremento de la producción científica sobre la modalidad e-learning en los últimos años (especialmente en España y Estados Unidos), habitualmente en coautoría y con un limitado impacto en cuanto al número de citas. Asimismo, los estudios suelen vincularse a la etapa de Educación Superior, donde este tipo de acciones formativas suelen ser más habituales. Por último, el análisis de contenido ha permitido identificar diferentes conceptos vinculados, así como el potencial del e-learning para el desarrollo de competencias como el pensamiento crítico y las habilidades comunicativas, mientras que se critica su capacidad para el desarrollo de competencias de índole social.

Palabras clave: Bibliometría; Aprendizaje en línea; Aprendizaje electrónico; Educación; Competencias.

Abstract:

The electronic-learning education model (e-learning) articulates technology-mediated learning using different tools and methodologies. Based on this idea, the present study aims at reviewing the impact of e-learning on the development of key competencies from a bibliometric and content point of view. To this end, we analyze the scientific production related to studies where this model is used to develop competencies, and reflect on the benefits of flexible and open environments. More specifically, we have analysed 255 papers available in the Scopus index, restricting the sample to texts published within the last decade. The results show that the scientific

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production about e-learning has increased in recent years (especially in Spain and the United States), usually in co-authorship and with a limited impact on the number of citations. Most studies are connected to higher education, where this sort of educational actions are much more common. Finally, the content analysis has allowed to identify different linked concepts, as well as the potential of e-learning for the development of competencies such as critical thinking and communicative skills. Conversely, its adequacy for the development of social competencies is often criticized.

Key words: Bibliometrics; Online education; E-learning; Education; Skills.

1. INTRODUCTION

It is an indisputable reality that we live in a technology-mediated society, a digital society integrated in every part of our lives. So much so that technologies currently play a fundamental role – sometimes even a prerequisite – in our communication, relationships, and even education.

The integration of ICTs in our educational system started a few decades ago with very different implementation efforts. In this sense, from the first approaches linked to the presence of physical equipment in education centers, to subsequent steps of curricular integration of technologies and their corresponding teachers' training, we now have a wide range of possibilities connecting technologies and teaching and learning processes in many different ways (Gabarda, 2015).

In this sense, we must note that many studies address the benefits of the use of technology to implement educational actions in which they play an ancillary or complementary role, contributing to the improvement of teaching and learning processes (Peine, Kabino, & Spreckelsen, 2016; Potkonjak et al., 2016). Under this perspective, the potential of using technologies as a resource in educational processes during every education stage has been made clear elsewhere; scientific literature is full of experiences showing their implementation in pre-compulsory, compulsory (McManis & McManis, 2016; Otterborn, Schönborn, & Hultén, 2019) or post-compulsory education, with a special focus on higher education (McManus & Aiken, 2016; Ruiz-Palmero, Sánchez, & Gómez, 2013; Tsai, Shen, & Lu, 2015). Likewise, there are multiple studies proving the benefits of using technologies to address special education needs (Cai, Chiew, Nay, Indhumathi, & Huang, 2017; Sánchez-Rivas, Ruiz-Palmero, & Sánchez-Rodríguez, 2017; Wang, Laffey, Xing, Galyen, & Stichter, 2017; Weisblatt et al., 2019), revealing that their potential is not limited to a specific education stage or student type. Technologies have also been used to implement teaching strategies that push the envelope of education innovation, like robotics (Jesse, 2006), virtual reality (Mystakidis & Berki, 2018), or gamification (Peirats, Marín, & Vidal, 2019).

However, we want to focus this study on the idea that, apart from the use of ICTs as a complementary resource in educational actions that take place in physical environments, their potential has contributed to the

emergence of new learning scenarios in which their importance goes beyond that of a support resource. This text therefore looks at a different context in which technology is the medium articulating the design, implementation, and evaluation of these processes, becoming a key and essential element of the educational action.

In short, this paper focuses on the contributions of technology to create flexible virtual environments based on digitized learning. The following lines will explore online education as a general model and the electronic, blended, and mobile models, offering specific examples of this new reality.

1.1 Online education: conceptualization and basic principles of operation

The progressive incorporation of technologies into the field of education has enabled, as we have mentioned above, the emergence of several models that include those technologies as core elements (Mohammadi, Grosskopf & Killingsworth, 2020; Moreno, Gabarda, & Rodríguez, 2018). The variety of possibilities makes it necessary to reflect on what the main differences between them are by identifying their defining characteristics.

We should first state that these models do not constitute a mere digitization of face-to-face teaching and learning processes; they require specific design, assigning radically different roles for the agents (both students and educators), resources, and spaces (Colomo, Gabarda & Rodríguez, 2018).

Under this premise, three main virtual education models can be identified: electronic or e-learning, blended or b-learning, and mobile or m-learning. These three approaches are associated to a very particular of how technology should be integrated in the educational action and therefore constitute three distinct processes.

First, the blended model (b-learning) proposes optimizing the benefits of each model by combining face-to-face actions and virtual presence and using different methodologies and tools to vertebrate the processes in both scenarios (Ariana, Amin, Pakneshan, Dolan-Evan & Lam, 2016; Rahmi & Mardin, 2019). The duplicity of scenarios makes it possible to articulate theoretical and practical competencies in a complementary way, providing each space with its own development potential (Mesh, 2016). In this sense, b-learning constitutes a new way to conceive teaching, learning, and research, one that makes sense of the processes developed in the model and is also associated to an

improvement in creativity and social and communicative skills, as well as other general thinking skills (Bajardi, Porta, Álvarez-Rodríguez & Francucci, 2015; Kim, Yi & Hong, 2020). In addition, it allows educators to implement different learning styles connected to the different situations in which it materializes. They can also impact academic success, as well as student motivation and satisfaction (Yağci, 2016). This contributes to generate a commitment with learning in the students with diverse needs and competencies, and also promotes collaboration and interaction in the development of wide range of skills (Krasnova & Shurygin, 2019).

Secondly, m-learning makes it possible to integrate devices that are already part of the everyday lives of a large number of users into teaching and learning. The advancements in operating systems and Internet access has turned mobile phones into small computers with remarkable potential for the development of several activities, among which we can highlight those with an academic aim (Lindsay, 2016; Pedro, Barbosa & Santos, 2018). Some perspectives consider m-learning an extension of e-learning (Ferreira, Klein, Freitas & Schlemmer, 2013). They defend that it just involves transferring all the potential of the electronic model to devices that allow students to learn in a more decentralized, flexible, and personalized way (Keegan, 2012). In addition, m-learning experiences have an impact on the improvement of the students' creative skills, and on the educators' predisposition to innovation in relation to learning formats (Smith, Grant, Conway & Narayan, 2016). However, and under the same perspective, it poses some difficulties derived from the device that vertebrates the process. Some of these are the screen size, the battery, or the limited storage capacity of current mobile phones (Shanthi & Al-Mukheini 2010).

Finally, e-learning considers technologies an indispensable condition for the development of the formative process. This implies that, without ICTs, the educational action would not be possible, because they are the essential medium structuring it. Thus, in line with conclusions drawn by Gabarda, Rodríguez & Romero (2016), they are included in the teaching and learning processes from the moment they are designed, and determine what will be included in the action (the content), with what aim (the goals), how to do it (methodology), where (virtual learning environments), what they should use (resources and materials), when (planning), and who will be involved (agents).

The dimensions that allow assessing the quality of the e-learning proposal are linked to the institution, the teacher, the learning system and the evaluation of the program (Ortiz-López, Olmos-Migueláñez & Sánchez-Prieto, 2021).

For Cabero (2006), conceiving the process in this way allows, among other things, constant content updating and the flexibility of space and time constraints, bringing the principle of individualization to its peak, in a “just in time and just for me” model (p. 3). Therefore, e-learning allows us to create learning communities made up of students from different parts of the world, promoting the development of cultural and social competencies beyond the curriculum itself (Jacobsen, 2019). In line with today's globalization, this model allows us to connect worlds and introduce students to different realities, contributing to richer educational actions (Reyes & Segal, 2019).

Lastly, several studies have tried to analyze which education model is most effective, contrasting each model with the traditional (face-to-face and synchronous) educational structure or comparing online models.

In one of the former cases, Fola-Adebayo (2019) showed that b-learning provided benefits compared to exclusively face-to-face learning. Specifically, he stated that ICTs contributed to consolidating learning, improving digital competency, and increasing their expression skills, as well as other more practical skills (Terry, Moloney, Bowtell & Terry, 2016). Meanwhile, Malik, Mathew, Al-Nauimi, Al-Sideiri & Coldwell-Neilson (2019) concluded that, although students positively evaluated technology-mediated educational processes, they considered m-learning the most valuable model.

However, we cannot incontestably accept that these models imply general improvements in formative actions. Some studies, like the one by Bredesen, Bjørro, Gunningberg & Hofoss (2016), concluded that there were no differences between the traditional and the online method.

This paper focuses on e-learning from the perspective that this model is the one that most explicitly materializes and demonstrates the potential of technologies to create virtual environments where learning is more closely related to the idea of flexibility.

1.2. Basic competencies: regulatory and conceptual analysis

Determining which are the main aspects an educational system must address to educate the citizenry has been a permanent concern throughout history.

The initial goals for the professional training of the workers necessary for productive and economic development in a particular geographical context has gradually transformed into an effort to define the fundamental skills that educational principles should pursue, which go beyond a merely economic or academic aim. Thus, supranational organizations and, later, the national educational systems have proposed a number of competencies that, while necessary for the exercise of citizenship throughout our lives, find their space in official education, where they can be better defined and developed.

From this approach, the European Commission (2006) identified eight key competencies for lifelong learning that translated to priority lines of action regarding education systems (Table 1):

Table 1. Key competencies for lifelong learning. Source: Adapted from European Commission (2006)

Competency	Definition
Communication in the mother tongue	Skills related to the expression and interpretation of concepts, thoughts, feelings, facts, and oral and written opinions.
Communication in a foreign language	Skills related to oral and written expression and interpretation, as well as mediation (i.e., summarising, paraphrasing, interpreting, or translating) and intercultural comprehension.
Mathematical, scientific, and technological competencies	Mastery of calculus, an understanding of nature, and the ability to apply knowledge and technology to what we perceive to be human needs (such as medicine, transport, or communication).
Digital competency	Safe use of – and a critical approach to – information and communication technologies (ICTs) at work, as well as in leisure and communication.
Learning how to learn	The ability to manage one's own learning effectively, both individually and in group work.
Social and civic skills	The ability to participate effectively and constructively in one's social and professional life, and commit to active and democratic participation, especially in increasingly diversified societies.
Entrepreneurship	The ability to realise ideas through creativity, innovation, and risk-taking, as well as planning and managing projects.
Cultural awareness and expression	The ability to appreciate the creative importance of ideas, experiences, and emotions in different fields such as music, literature, and performing or visual arts.

As the reader can see, competencies are quite different in nature and include academic and instrumental matters (languages, mathematics, digital literacy), but also other more personal ones applicable to any social or professional context, which constitute basic competencies for personal development in any field (learning how to learn, social and civic skills, entrepreneurship...).

Identifying these competencies, as noted above, was an important starting point so that the different educational systems could incorporate them in their own regulations, complying with community guidelines and explicitly stating the importance of working on aspects that can provide citizens with basic skills.

Thus, following the line set by the European Commission, the Spanish Organic Law on the Improvement of Educational Quality (La Ley Orgánica 8/2013, de 9 de diciembre, para la Mejora de Calidad Educativa, also known as LOMCE), redefined the proposal of competencies (reducing them to seven) and highlighted their essential nature, establishing them as the main axis in curricular design. These competencies are language communication, mathematical competency and basic skills related to science and technology, digital competency, learning how to learn, social and civic competencies, entrepreneurship, and cultural awareness and expression.

Based on this proposal, the regulations for each educational stage (pre-school, primary, secondary, vocational training, high school, and higher education) have incorporated competencies in different ways, always trying to address each competency specifically and according to the needs of each stage.

Looking at all these matters, the main objective of this paper is to perform a bibliometric review and content analysis of the online model, focusing on its potential to develop basic competencies. In the bibliometric review – whose objective it is to analyze specialized literature during a specific period and offer information about the development of a particular field of study and its patterns of authorship and publication (Aleixandre-Benavent, González, Castelló, Navarro, Alonso-Arroyo, Vidal-Infer & Lucas-Dominguez, 2017a) – we explore the different trends in scientific activity during the last decade regarding e-learning as a digital educational strategy in relation to key

competencies. In the content analysis, we study the main results obtained and the specific impact of this model and its environment in the process of learning and developing these competencies.

2. MATERIAL AND METHODS

This study is methodologically based on a bibliometric analysis linked to a scientometric approach. With this aim, we compute the scientific literature produced on a particular subject or field of study (Tomás-Górriz & Tomás-Casterá, 2018). In this case, our object of study is e-learning. This type of study is considered particularly relevant in fields with a high literature production. Following a proposal by Zulueta & Bordons (1999), in order to increase reliability, we considered it necessary to perform a mesoanalysis of scientific literature in the area of Social Sciences (King, 1978).

The analysis was made following specific bibliometric indicators that provide more validity to the study's data collection and management, because we consider scientific papers to be the main source of information for the study. In this sense, the first indicator was choosing the database itself from which we would extract the sources. Scopus was selected, both because of its position in the academic environment (based on criteria such as temporal coverage or number of publications included) and its use in previous studies of this type (Granda et al., 2013; Hernández, Sans, Jové & Reverter, 2016).

The final sample consisted of the total number of documents remaining after applying exclusion and inclusion criteria to the papers identified in Scopus. The analysis has been closed before March 2020 in order to exclude the period of socio-health emergency in which, at a global level, a series of measures related to the forced implementation of the E-learning modality have been taken. Excluding this period will allow an in-depth analysis to be made at a later date of what happened during these months and to be able to compare the use and implications of the implementation of this modality between the periods before, during and after COVID-19. This pandemic has meant an acceleration in the processes of technology integration and a forced transition towards online teaching (Hordatt & Haynes, 2021).

Figure 1 shows the process of selection of the papers analyzed in this study, separated in three phases.

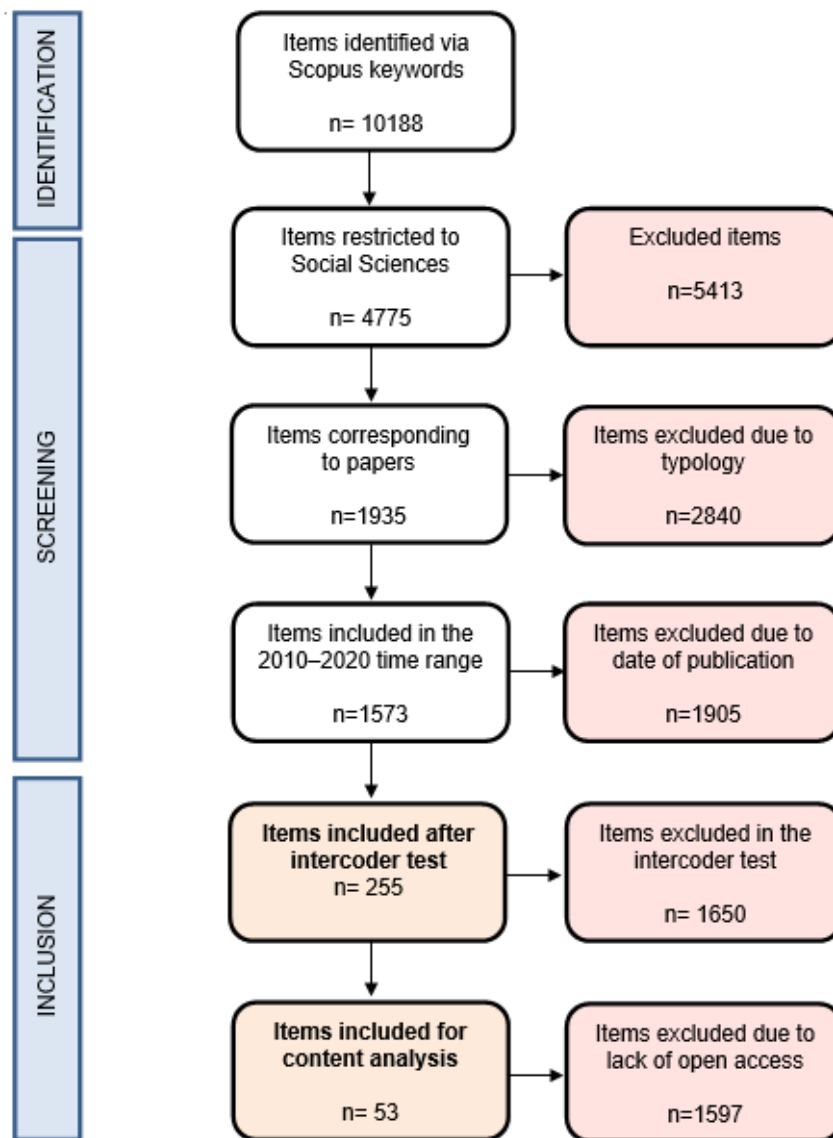


Figure 1. Flowchart. Source: created by the authors.

The first consisted in identifying texts in the Scopus database. This index was chosen due to its prestige in the scientific field (Martínez-Heredia & Bedmar, 2020). Second was the screening phase, in which those papers that did not correspond to the aims of the study were removed from the sample. The texts were subjected to several selection criteria such as relevance for the study, whether or not they belonged to Social Sciences, or the date of publication. Lastly, the inclusion stage implied deciding which studies were selected for the bibliometric and content analyses. After two researchers analyzed the documents, 255 were selected for the bibliometric study.

Intercoder reliability was high, as was their level of agreement (Altman, 1991), reaching a Cohen's kappa score of 0.8303.

Subsequently, one last screening of the documents was performed, limiting the results only to those that were openly accessible. The final number of documents subject to content analysis was 53. To carry out this analysis, we used registration sheets (Table 2), which included information about the educational stage, participants involved, related subjects or studies, and the development of competencies.

Table 2. Content analysis categories. Source: created by the authors.

Content registration sheet				
Paper	Educational stage	Participants	Studies	Competencies

The graphic representation was made using the VOSviewer software (Van Eck & Waltman, 2011) and the indicators of scientific collaboration proposed by Aleixandre (2010), using structural variables such as scientific productivity, collaboration, repercussion, and impact, and a content analysis based on the categories that emerged reading the texts.

3. RESULTS

The results of, on the one hand, the bibliometric analysis and, on the other, key information from the content analysis are presented below. To analyze scientific productivity, Scopus's function "analyze search results" was used. A total of 255 documents published in the last decade were selected, and those that were openly accessible were considered for the in-depth content analysis.

3.1. Bibliometric analysis

Figure 2 shows that the number of publications has increased in recent years. The year with the highest number of papers on this topic is 2018.

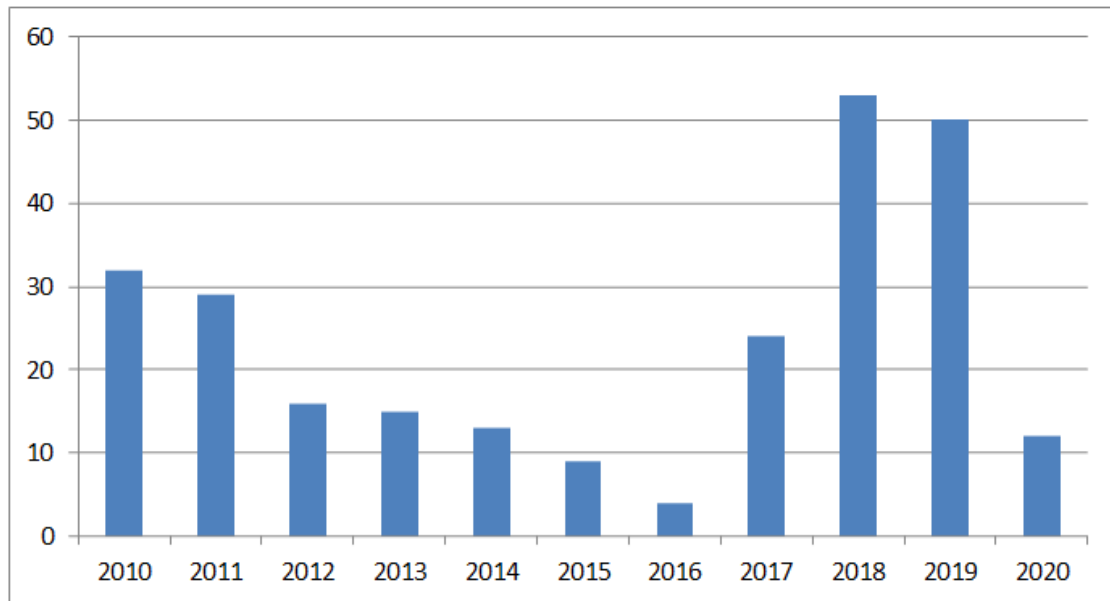


Figure 2. Publication frequency Source: created by the authors from Scopus data.

In relation with the bibliometric size of each country, in Figure 3, we can observe the predominance of the United States of America (with 33 documents), followed by Spain (29 documents) and the United Kingdom (19 documents). There are large differences between countries, but it is evident that the subject is studied in very distant places.

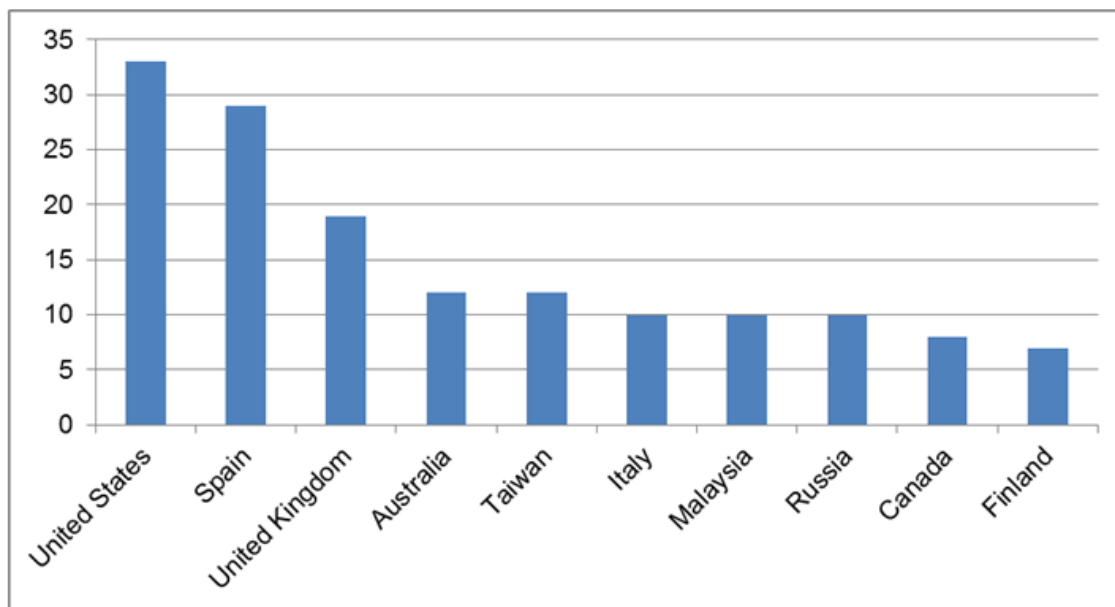


Figure 3. Number of publications per country. Source: created by the authors from Scopus data.

Regarding the institutions involved in the study of this field, several Spanish universities such as the Open University of Catalonia, the University of Oviedo, or the University of Extremadura stand out, as well as other international institutions like the University of Florida or the University of Salerno.

Concerning the level of scientific collaboration – understood as the social process in which several researchers share resources to create new knowledge (Aleixandre-Benavent et al., 2017) – Table 3 shows the number of authors signing each paper. It is noteworthy that most of the texts (80%) are written by more than one author, which evidences the importance of collaboration networks within the community of experts in this field. An example of this is the work by Adorni et al. (2010), with 10 authors from two Italian universities (Genoa and Salerno). That paper presents the results of the Content Automated Design & Development Integrated Editor (CADDIE) project of the University of Genoa and the Intelligent Web Teacher (IWT) project of the University of Salerno, focusing on the use of technology for instructional design, implementing personalized and contextualized learning processes to favor communication, cooperation, and content creation.

Table 3. Number of authors. Source: created by the authors.

Co-authorship	N	%
One	51	20%
Two	86	33,7%
Three	58	22,7%
Four	26	10,2%
Five or more	34	13,3%

According to Lotka's law of scientific productivity, all of them are occasional authors and, in this study, there are no average or productive authors. In other words, only a small number of authors sign two papers (Giovannina Albano, Montserrat Hernández-Solís, Teresa Herrador-Alcaide, Juan Francisco Martínez-Cerdá, Danielle Morin, Eugenia Smyrnova-Trybulska, Jennifer Thomas, or Joan Torrent-Sellens). Analyzing this information from a gender perspective, we can observe that 5 out of the 8 most productive authors in the field are women. In addition, it is also remarkable that 3 of the authors are Spanish.

Regarding the impact of the analyzed papers, taking as a reference the number of citations of each paper, Table 4 shows that 32,1%% have received no citations since they were published.

This information should be taken with caution, because, with the exception of approximately ten earlier documents, most papers with no citations were published fairly recently, between 2018 and 2020. Moreover, citation dynamics in Social Sciences are slow, and more time is necessary to reach a significant impact factor. Furthermore, the citation index informs about visibility or dissemination, but the absence of citations does not mean that the paper is low quality (Aleixandre-Benavent, González, Castelló, Navarro, Alonso-Arroyo, Vidal-Infer & Lucas-Dominguez, 2017c).

Most of the documents (38,8%) received between one and five citations. On the other hand, 50 documents received more than 11 citations, which are considered high impact figures. Among them is Petrakou (2010), which concludes that the virtual environment improves social competency providing interactivity and allowing students to communicate synchronously among them and with the teacher; Cheng (2010) states that e-learning is perceived as useful and satisfactory for work performance; and Cheng & Ye (2010) works on social competencies in students on the Autism Spectrum using virtual learning environments (these papers have 94, 83, and 81 citations respectively). Finally, one paper by Law, Lee & Yu (2010) deserves special mention. It has 164 citations, and concludes that e-learning environments can improve the students' motivation for learning, as well as their self-efficacy.

Table 4. Number of references per paper. Source: created by the authors from Scopus data.

References	N	%
None	82	32,1%
1 – 5	99	38,8%
6 – 10	24	9,4%
11 – 50	43	16,8%
51 – 100	6	2,3%
More than 100	1	0,4%

Table 5 shows impact factor data based on the “citation overview” function in Scopus. The impact factor of 37,2% of the papers analyzed is zero or lower than expected. On the other hand, according to Scopus, 116 documents have an impact factor between 0.1 and 1.99, which are adequate numbers. Also, 10,2% of the papers have an impact factor between 2 and 3.99, and 18 have very high impact factors (4 or higher). Among them, a work by Wahyuaji & Suparman (2019) stands out. With just 6 citations, it has the highest impact

factor (10.04), followed by Petrakou (2010), with 9.01, and Shubina & Kulakli (2019), with 8.64.

Table 5. Impact factor. Source: created by the authors from Scopus data.

Index	N	%
0	95	37,2%
0.1 – 1.99	116	45,5%
2 – 3.99	26	10,2%
4 or higher	18	7,1%

3.2. Content analysis

Several categories were established for the content analysis: educational stage, participants, subject, and key competencies. This analysis aimed at overcoming the limitations of previous studies (Aleixandre-Benavent, González, Castelló, Navarro, Alonso-Arroyo, Vidal-Infer & Lucas-Dominguez, 2017b). As their authors indicated, bibliometrics were useful to establish a corpus of publications, but did not inform about their quality or results, so this study has paired bibliometric and bibliographic analysis.

Prior to the analysis of each category's content, we must mention that, as noted in the theoretical framework section, prior scientific production confirms the idea that the development of e-learning actions requires a specific design process, must take into account different elements, and requires specific training for the educators implementing it (De Metz & Bezuidenhout, 2018; Eslaminejad, Massod & Ngah, 2010).

Regarding the first category, focusing on the educational stage in which the e-learning will be implemented, the most common stage is higher education (Cubero-Ibáñez, Ibarra-Sáiz, & Rodríguez-Gómez, 2018; Khlaisang & Koraneekij, 2019), although there is also activity for other educational stages such as pre-school (Si, 2015) or in other contexts like prison (Monteiro, Leite, & Barros, 2018).

As for the participants, the corpus included applications both in small groups (Devlin, Lally, Sclater, & Parussel, 2015), and with a high number of participants, as is the case with Tominaga & Kogo (2018), who worked with over 250 students, or Khlaisang & Koraneekij (2019), with more than 2000 university students.

Concerning the studies, e-learning applications in scientific fields predominate (Córdoba, Castelblanco & García-Martínez, 2018), as do other actions to update health professionals' knowledge (Downer, Shapoval,

Vysotska, Yuryeva & Bairachna, 2018) – most commonly in engineering (Ma, Kaber & Zahabi, 2020) and nursing or medicine (Saqr, Fors & Tedre, 2018).

Finally, while it is common to find works concluding that the e-learning model's good results are related exclusively to the acquisition of contents from the specific fields in which they are implemented, such as Physical Education (Yang & Meng, 2019), there is a limited number of studies stressing the importance of this model for the development of several key competencies. As for the developed competencies, on the one hand, there are works concluding that this model has great potential for the development of the field's own competencies, such as mathematical competency (Ortiz & Piña, 2018), and others that are more cross-sectional, like digital (Galikhanov & Khasanova, 2019) or communicative competency, as is the case in a paper by Kurucova, Medová, & Tirpakova (2018), focusing on language learning among journalism students. On the other hand, other texts point at e-learning as the most suitable model for lifelong learning. This is the case, for example, with educators in less populated rural areas (Ferreira & Cardoso, 2010), the use of metacognitive skills to develop the learning how to learn competency (Bataeva, 2019), or the social and civic competency (Alonso-Díaz, Cubo-Delgado, Gutiérrez-Esteban, Yuste-Tosina & Delicado-Puerto, 2018).

Keyword analysis highlighted terms such as *higher education*, which determines the main educational stage in the study, and *distance education* or *virtual learning environments* as relevant elements in the core educational process of our object of study, e-learning. Table 6 presents the 10 most common keywords, used more than 10 times in the corpus. The most frequent words, as can be observed in the table, are *e-learning*, *students*, and *teaching*.

Table 6. Most frequent keywords. Source: Personal compilation from VOSviewer data.

Keywords	N
<i>e-learning</i>	122
<i>Students</i>	48
<i>Teaching</i>	31
<i>Education</i>	28
<i>Learning</i>	14
<i>distance education</i>	14
<i>learning systems</i>	13

Motivation	12
higher education	12
virtual learning environments	10

Lastly, Figure 4 presents a co-occurrence map with the most recurring terms in the titles, abstracts, and keywords of the 255 selected papers, as well as their co-occurrence frequency. Four large clusters stand out. The first of them, in red, connects with one of the key aspects of our study: *competencies*, and correlates relevant concepts such as *challenge*, *communication*, *teacher*, *environment*, *technology*, *interaction*, or *tool*, among others. The second, in green, revolves around two axes: the *students*, key agents involved in this learning model, and *e-learning*, the most important term in the analysis and our object of study. Some of the concepts co-occurring with them are *ability*, *education*, *effectiveness*, *improvement*, *learning*, etc. The third cluster, in blue, focuses on skill and is connected to concepts such as *motivation*, *collaboration*, *MOOCs*, *strategies*, or *support*, among others. Finally, the fourth group connects the terms *engagement*, *knowledge*, *online learning* and *self-efficacy*.

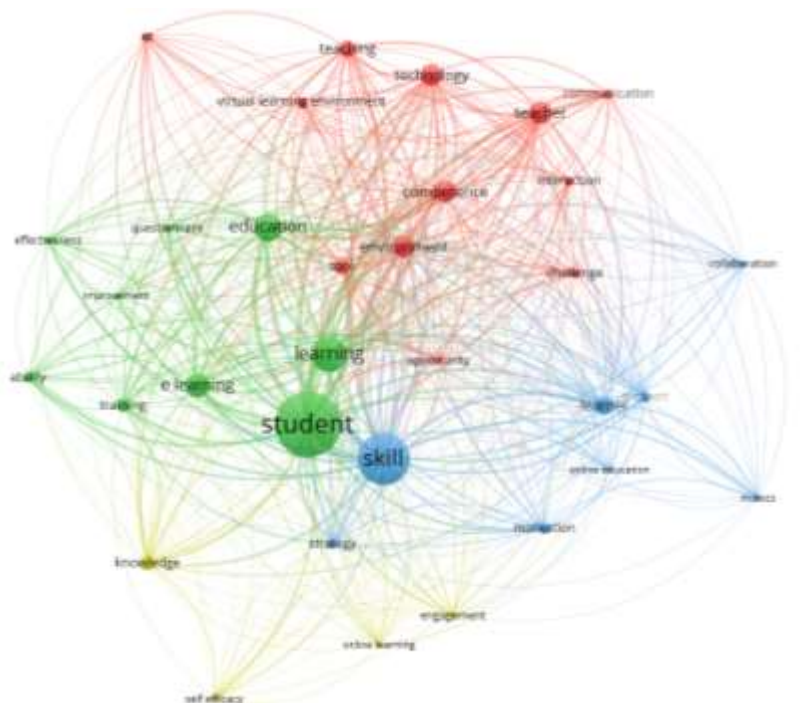


Figure 4. Co-occurrence map. Source: VOSviewer

In addition, thanks to the temporal analysis of concepts using the VOSviewer tool, we detected new terms emerging in 2017. Among them, we must mention the most recent in the co-occurrence map: *MOOCs, engagement, collaboration, or learner*.

4. DISCUSSION

The number of papers found that studied the subject of e-learning confirm the deep interest of researchers in this topic (Tibaná-Herrera, Fernández-Bajón & De Moya-Anegón, 2018), compared to other recent studies made from a scientometric approach, such as the one by Marín & Vidal (2019) on Learning and Knowledge Technologies, or one by Peirats, Marín & Vidal (2019) on gamification, in which the number of documents analyzed was much lower.

On the one hand, it is worth noting the increased interest in recent years, evidenced by the number of citations in recent papers such as Khan et al. (2018), with 31 citations, or Claro et al. (2018), with 18.

Spain stands out among the countries with the highest production, second only to the United States of America, as seen in prior studies such as Vidal, López & Peirats (2019). In addition, if sociodemographic and economic indicators such as population or Gross Domestic Product are considered (Aleixandre-Benavent, González, Castelló, Navarro, Alonso-Arroyo, Vidal-Infer, & Lucas-Dominguez, 2017b), Spain gains even more weight as a main producer of scientific content in this field.

On a different note, we observe that the level of collaboration among researchers is high, as noted in prior studies such as Vidal, Marín, Peirats, & Pardo (2019) or Marín & Vidal (2019). However, we did not find average or productive authors in this field, although it is possible to identify relevant institutions with productive groups that provide an important number of publications on this topic, like the University of Florida or the Open University of Catalonia.

Content analysis allowed us to identify Higher Education as the educational stage in which e-learning is being implemented most frequently – especially in scientific and health fields – and the potential of this model to provide learning in relation to key competencies has been made clear.

They are useful to teach key competencies from the specific field of application, but also other more general skills such as digital or communicative competency from a cross-sectional perspective.

In short, the results show that this model brings flexibility to the learning process and provides the students with autonomy, aiming towards self-regulation and self-reflection (Sanchez, Kuchah, Rodriguez & de Pietri, 2018) and, consequently, towards increasing the motivation for educational processes (Fryer & Bovee, 2016). This self-regulation is connected to the use of different learning styles that allow the students to address problem-solving processes using critical thinking (Emir, 2013). However, this model also has some limitations we must take into account, such as inequality in the access to technological devices or the apparent disappearance of social interaction arising from the virtualization of the formative process (Mumford & Dikilitas, 2020).

Lastly, this study allows us to compare the potential of each model. In the last decade, several studies have compared different models like e-learning, m-learning, or b-learning, or those new models and the traditional one. The results might even seem contradictory. One can find studies with apparently opposing conclusions. Some support the idea that the blended model has more positive impact on academic results, the skills development and the decrease of the dropout rate (García, Biencinto, Carpintero, Expósito & Ruiz, 2016; Lean, Ming, Wong, Neoh, Farroqui & Muhsain, 2020; Osorio & Castiblanco, 2019), while others, such as Malik et al. (2019) highlight the students' preference for m-learning. Likewise, we can find studies that assign greater benefits to the face-to-face formative process (Callister & Love, 2016), while others like Ariana et al. (2016) or Terry et al. (2016) advocate for complementary models and discuss the potential of different scenarios to develop specific competencies, and even studies concluding that there are no differences between the models (Quintas, Fernandez & Texeira, 2017). Therefore, there does not seem to exist a consensus among researchers in which model is more beneficial for promoting learning, so the most appropriate option would be to evaluate each particular situation in order to choose the model that better adjusts to the reality and context of the students.

5. CONCLUSION

In the analysis of the digital education strategies implemented in recent years in teaching and learning processes, e-learning was identified as one of the main trends. Especially in these times, where the population is confined due to the pandemic, teaching methods must be adapted for the requirements of the different educational levels. Based on that fact, we developed a bibliometric analysis of the scientific production indexed in Scopus – chosen due to its international prestige and recognition in the scientific field – with the aim to complement prior studies such as the one by Oliveira, Fontes, Collus & Cerisier (2019). Likewise, a number of indicators of scientific productivity, collaboration, use, and impact were used as reference, as were some structural variables. One of the main contributions of this study is the application of bibliometrics to the area of Social Sciences, which has traditionally been excluded from this sort of analyses (Uribe-Tirado & Alhuay-Quispe, 2017).






The key to the successful implementation of these new models lies, once again, in teacher training. As Muñoz, García & Valenzuela (2011) note, education policy should focus, among other aspects, on strengthening the competencies of university professors in the use of devices, resources, and tools related to e-learning, because the competency of the educators is the base for the design and support of any practice or educational change.

It would be interesting in further research to combine bibliometric indicators with altmetrics to obtain a more global and social perspective of the scientific production. Platforms such as Facebook, Twitter, ORCID, or Mendeley could be used to further our knowledge about the presence, productivity, and relevance of each author in social media, as suggested by Uribe-Tirado & Alhuay-Quispe (2017). This might be important, given the importance of science dissemination in the 21st century. We would thus be able to measure the impact of science from an alternative point of view, one focusing on social impact (Sixto-Costoya, Alonso-Arroyo, Lucas-Dominguez, González & Aleixandre-Benavent, 2019), or compare the information about the authors available in different sources such as Google Scholar and ResearchGate, which show differences in the number of citations or the amount of information they include about the authors.








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