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Research Competencies Mediated by Technologies: A Systematic Mapping of the Literature

Competencias de investigación mediadas por tecnologías: un mapeo sistemático de la literatura

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ABSTRACT

This study starts from the need to identify which are the research competencies mediated by technologies, required to support the acquisition of knowledge in higher education institutions. The work developed here aims to analyze the scientific production related to the subject with the intention of identifying current research trends. To achieve this, the method of systematic review of literature adjusted to social sciences was used, taking as a source of information the Scopus database. The results indicate that most of the scientific texts have been produced in English, and that the treatment of the topic has been constantly developed since 2016, mostly from the approach of the relationship between research strategies with digital literacy, information literacy, access to digital library databases and the development of critical thinking.

Palabras clave:
Competencia profesional
Alfabetización
Enseñanza superior
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RESUMEN

El presente estudio parte de la necesidad de identificar cuáles son las competencias investigativas mediadas por tecnología, requeridas para fomentar la adquisición de conocimiento en las instituciones de educación superior. El trabajo que aquí se desarrolla tiene como objetivo analizar la producción científica relacionada con el tema con la intención de identificar las tendencias investigativas actuales. Para lograrlo, se empleó el método de revisión sistemática de literatura ajustado a las ciencias sociales, tomando como fuente de información la base de datos *Scopus*. Los resultados indican que la mayor parte de los textos científicos han sido producidos en inglés, y que el tratamiento del tema se ha desarrollado de forma constante desde el año 2016, mayormente desde el enfoque de la relación entre las estrategias de investigación con la alfabetización digital, la alfabetización informacional, el acceso a las bases de datos de bibliotecas digitales y el desarrollo del pensamiento crítico.

1. Introduction

Research to generate knowledge at the university level has become a priority (Buendía, Zambrano & Insuasty, 2018); hence, teachers and students must develop critical inquiry skills that allow them to access and reconstruct information and share it as a means to confront successfully the professional demands that currently prevail in the knowledge society. Note that the development of research competencies is not a synonym for the training of scientific researchers, but rather for professionals from the various disciplines who

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are devoted, qualified, and capable of searching for knowledge, curating bibliographic material, and constructing theoretical solutions for complex problems that arise.

In scientific literature, exploratory studies performed regarding the development of research competencies in the university have been published in the last ten years (Estrada, 2014; Murillo & Perines, 2017; Perines & Murillo, 2017). Many authors (Dana & Yendol, 2014; Rubio, Torrado, Quirós, & Valls, 2018) have agreed that strengthening these types of competencies impacts the academic development of professionals and empowers students to perform activities related to the selection, structuring, and analysis of information for the production and sharing of knowledge.

Conceptually, research competencies are linked to the ability to manage bibliography critically (Thongsong, Yamtim, & Jai-Areesuthiwa, 2020) and to broaden knowledge, skills, and attitudes. College students must learn to apply research methods and techniques to interpret, argue, and propose alternative solutions to the disciplinary problems that are posed to them in their training (Nakamura, Rivero, & Velasco, 2019).

In accordance with George and Salado (2019), research competencies in college include the sets of strategies that function to retrieve bibliography efficiently, develop skills in problem identification, and suggest creative solutions that are theoretically validated. Also, students must learn to generate and update disciplinary knowledge and to promote research as a means of learning (Campos & Ramírez, 2018). Therefore, the development of research competencies must be understood as a process oriented toward strengthening the habit of permanent inquiry, thinking critically, and developing specific research skills (Mas, 2016; Leonard, 2020).

It is noteworthy that an increasingly strong bond between the development of research competencies and digital competencies has developed because the use of digital technologies facilitates methodologies to access learning and knowledge (Albareda, Vidal, Pujol, & Fernández, 2018; Anisimova, Sabirova, & Shatunova, 2020; Castañeda, Esteve, & Adell, 2018; García-Peñalvo, 2018; Tourón, Martín, Navarro, Pradas, & Iñigo, 2018). Also, the technologies are increasingly an important part of day-to-day educational practice (Batane & Ngwako, 2017; Gudmundsdottir & Hatlevik, 2018; Domingo, Bosco, Carrasco, & Sánchez, 2020). Millard, Baldassar and Wildingb (2018) acknowledge that digital competency entails, among other meanings, knowing how to find and be critical of the available information in digital media, as well as use it responsibly in academic life. Therefore, the development of digital competencies alongside research competencies implies not only the effective use of technologies but also skills in managing information. In other words, it is not enough to make a digital device work; it is also necessary to develop intentional processes using digital tools to store, manage, and analyze bibliographical data.

Likewise, Márquez, Santamaría and Acosta (2016) point out that to strengthen these competencies, the students must grasp information and communication technologies (ICT) well and have a complete understanding of digital, bibliographic consultation processes. So, the literature shows that research competencies (RC) are closely linked to digital competencies, and these are crucial for the successful completion of professional programs in higher education. The development of these skills highly impacts international scientific production.

Consequently, in this investigation, the relationship between both competencies (DRC) was examined through a bibliometric analysis using the Scopus[1] database and the VOS Viewer software[2]. The methodology followed was the one laid out by López, Vázquez and Roman (2015), and Pérez and Vladimirovna (2017), which suggests performing these types of studies by analyzing titles, keywords, and abstracts of scientific texts. The objective was to characterize scientific production to define the background of the research, its current landscape, and the points of interest for further investigation.

2. Method

2.1. Research design

The objective of this study was to perform a quantifiable data analysis of scientific literature that has had the greatest impact on the subject of digital and research competencies (DRC); the source was data stored in the Scopus bibliographic database. We intended to identify the different dimensions and trends in international research in this subject and, thus, have a more certain understanding of the conceptual perspectives of the relationship between the development of research processes and the use of technologies.

1. www.scopus.com
2. https://www.vosviewer.com

To achieve this objective, we performed a systematic mapping of the literature based on the proposed methodology by Petersen, Robert, Shahid and Mattson (2008) and adjusted by García and Ramírez (2019) and García-Holgado, Marcos-Pablos and García-Peñalvo (2020). Many authors have used this methodology (López et al., 2015; Pérez & Vladimirovna, 2017; Van Eck & Waltman 2017; Howard, Wood & Stonebraker, 2018; Aydoğdu, 2020; Whalley & Barbour, 2020) and agree that the following stages must be carried out: 1) definition of the guidance questions, 2) location of scientific production, 3) refinement of identified scientific production, 4) design of the bibliographic database, and 5) analysis of the bibliographic information.

2.2. Definition of guidance questions

To begin the systematic mapping, we defined some questions that would help guide the study toward analyzing the evolution and characteristics of scientific production that has had the greatest impact on the development of research competencies and their connection with technological scenarios. Based on this, we formed the following questions:

- Q1) What is the distribution of publications per year?
- Q2) What has been the diachronic evolution on the link between research competencies and digital competencies?
- Q3) What is the distribution of scientific publications per country?
- Q4) What jounals and research papers have had the greatest influence on Research Competencies Mediated by Technologies?
- Q5) Which research areas have emerged because of the systematic mapping of the identified literature?

2.3. Obtaining scientific production

As a source of information, Scopus from Elsevier Editorial was selected because it is one of the main international databases of peer-reviewed academic information. It offers an exhaustive summary of the results of extensive world research in multiple scientific fields, and finally, it also allows searches of metadata for the most significant publications in different areas of knowledge (Matcharashvili, Tsveraidze, Sborshchikovi, & Matcharashvili, 2014).

Our searches took place from March through May of 2020 and considered the following criteria for inclusion: 1) temporal restrictions were not imposed, that is, a historical analysis on the researched subject was sought; 2) key terms were identified relevant to the investigation's purpose; 3) the key terms were adjusted to the conceptual criteria of UNESCO's thesaurus; 4) the keywords used were digital competencies because is the main approach, and researcher or investigative process as articulating terms; 5) combined searches were performed with the keywords; and 6) the search was narrowed to articles published in scientific journals. The search operators were assembled in the following query:

Table 1. Original search string

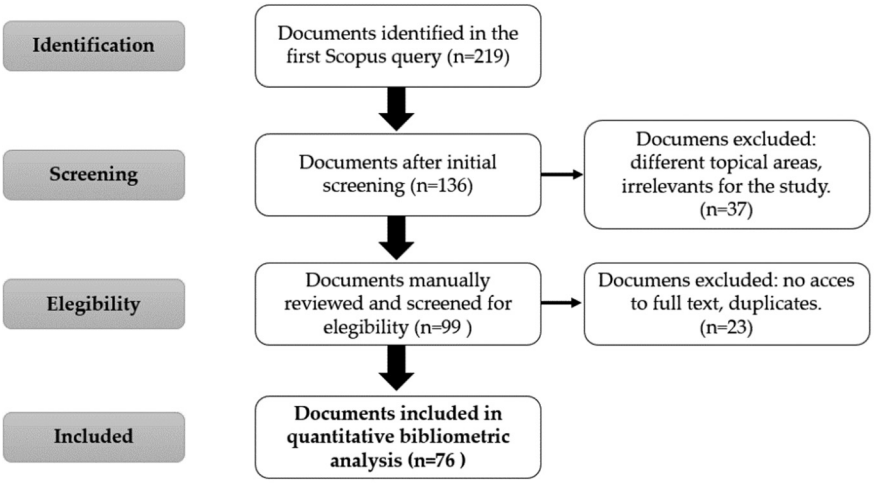
(TITLE-ABS-KEY (digital AND competencies) AND TITLE-ABS-KEY (researchers) OR TITLE-ABS-KEY (investigative AND process))

Source: Prepared by the authors.

2.4. Refinement of the identified scientific production

The strategy to refine the search process was informed by PRISMA guidelines for conducting systematic reviews of research (Moher, Liberati, Tetzla, Altman, & The PRISMA Group, 2009), consisting in 4 phases: identification, screening, elegibility and inclusion (see Figure 1). After obtaining the first results, the thematic not related to social sciences were eliminated. Also, keywords that approximated other study areas were excluded, and those that were associated with higher education and the use of technology were selected. Finally, conference proceedings and book reviews were excluded to focus the search on peer-reviewed publications.

Figure 1. Diagram with the review phases



Source: Prepared by the authors.

As observed in Table 2, at least 4 refinements were performed on the information using the result selection tools on Scopus, which meant modifying the search query several times. This was done to refine the information source precisely. Finally, the titles and summaries of each of the publications were read to eliminate those that did not fulfill the initial considerations and would lead to false positives (documents irrelevants for the study because in its content the term digital literacy is not conceptualized).

Table 2. Result of refinement of the search query

Refinement	Number of documents	Documents excluded
First refinement (identification).	219 documents	83
Second refinement (screening).	136 documents	37
Third refinement (elegibility).	99 documents	23
Fourth refinement (included).	76 documents	-

Source: Prepared by the authors.

2.5. Designing the bibliographic database

After refining the bibliographic search, we constructed the database using Excel software (see Appendix A), pinpointing the following fields: 1) author, 2) working title, 3) year, 4) source data (name of the journal, volume, year, article number, pages, DOI, abstract, keywords, references, editorial), 5) country, 6) language, 7) type of document, and 8) type of access. Finally, we assigned a sequential identifier to each document.

2.6. Analysis of the bibliographic information

To perform the analysis of the results, we used the VOSViewer software because it allows the construction of bibliometric networks. It is a practical tool to know the trends of scientific production because it allows the visualization, structuring, and taxonomical grouping of concepts and keywords (Pérez & Vladimirovna, 2017). Various authors have widely used this tool in the education area (Abad, González, Luque de la Rosa, & Gallardo, 2020; Bornmann, Thor, Marx, & Schier, 2016; Moreno, 2019; Peirats, Marín, & Vidal, 2019; Rodríguez, Raso, & Ruiz, 2019; Yang, Liu, & Chen, 2020) and, on a smaller scale, to evaluate research activity (Velasco, Eiros, & San Román, 2012; Hallinger & Chatpinyakoop, 2019).

As a research strategy, bibliometric maps were constructed on a bidimensional plane to locate the relationship between several analysis units and the density of their presence in the addressed subject. For this, the following studies were performed, 1) regarding the information on the number of publications per year and country; 2) regarding the co-occurrence of keywords, and 3) regarding the co-occurrence of titles and abstracts. The co-occurrence studies were performed automatically by the software by calculating the frequency of the keywords, titles, and abstracts. To define the results, we used groupings with a minimum of ten entries, and we refined the items (terms) to cleanse the database of grammatical connectors. Two types of maps were drawn up: 1) item density and 2) cluster density (groups of words). The former was constructed from characteristics of publications such as year, country of origin, and keywords. The cluster density considered data from the titles and abstracts. These maps allowed the visualization of trends related to the subject of research and digital competencies. These trends reflect the impact of a specific term and its relationship to associated investigations (Rodríguez, Trujillo, & Sánchez, 2018).

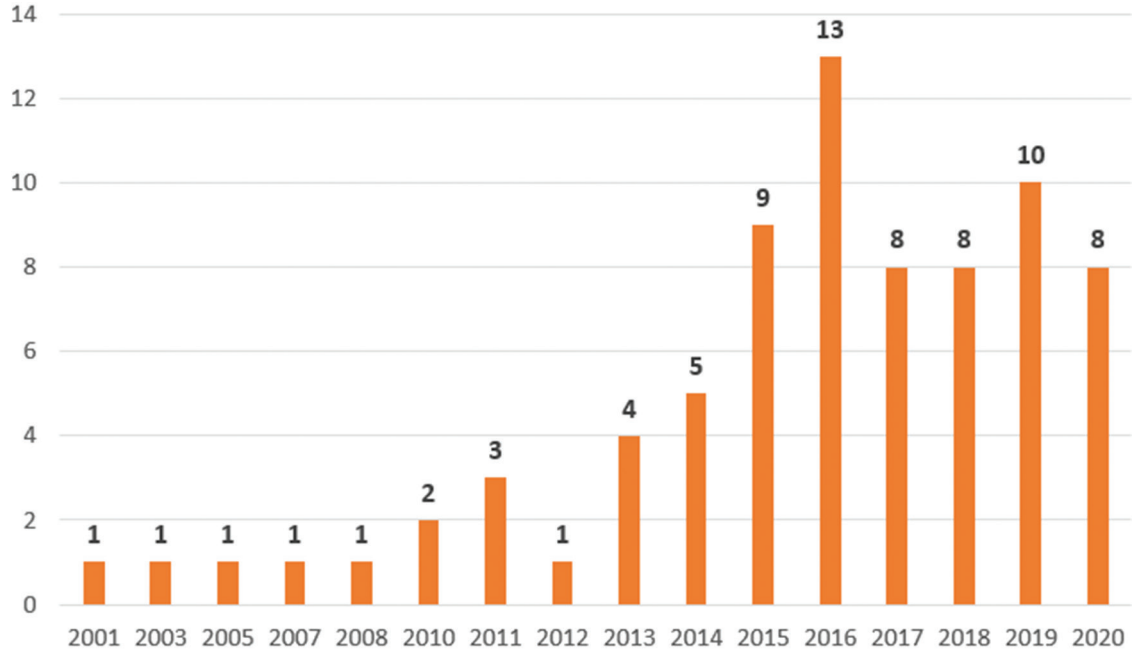
3. Results

Q1. Distribution of publications per year

The first analysis identified the number of publications per year. It was not limited by a specific time to gather knowledge on the origins of the research topic or its chronological evolution. It is noteworthy that the number of publications has increased over the years; nevertheless, there is a contradiction regarding the postulated Price Law (1986), in the sense that scientific production has not doubled every ten years. On the contrary, Figure 2 shows that between 2001 and 2011, there were fewer than four articles published every 12 months, even in the period from 2001 to 2008 there was only one high impact article in each year.

It is not until 2015 that we observe an increase in the production of articles. In that year, 9 documents were published (11.84% of the total number); in 2016, 13 (17.11%); in 2017 and 2018, 8 (10.53%), and in 2019, 10 (13.16%). The explanation for this could be that in 2014 an era of internet stability arrived in universities with acceptable connection speeds (Ramírez, Martínez, Aguilar & Rodríguez, 2018), allowing access to large bibliographic databases. We infer that this fact sparked a link between the competencies that are necessary to participate in scientific research processes with the use of digital technologies. The seeming drop in production observed in 2020 is because, at the time of this document, the year had not ended.

Figure 2. Scientific production by year of publication



Source: Prepared by the authors.

Q2. Diachronic evolution between digital competencies and research competencies (DRC)

Regarding the conceptual evolution of DRCs, between 1962 and 1998, the relationship between research skills and digital approaches was already being described. There were affirmations about the great potential of computers in universities to be a tool to classify, store, and retrieve documents swiftly to meet the growing information requests made by library users (Baker, 1962).

From 2014 on, during the boom and expansion of the digital era, it became apparent that the growth of research data required a much more robust technological infrastructure to provide the storage, preservation, and open access to information demanded (Kruse & Thestrup, 2014). The need to strengthen digital literacy, with a focus on critical skills to search, manage and examine the vast amount of information available online, came to attention (Green, Yu, & Copeland, 2014). It also became important to evaluate the impact of the emerging reading formats based on virtual scenarios (Mizrachi, 2014).

In recent years, the strengthening of DRC can be observed, since it is understood that the handling of data processing skills is essential to young academic researchers, regardless of their disciplinary field (Maer, Mocanu, Zamfir, & Georgescu, 2019). Works like the one produced by Kammerer, Brand, and Jaroska (2018) state that technological developments such as mobile devices and digital assistants are changing how people search for information, acquire knowledge, learn, and create research agendas. In another study, Quyyum and Smith (2018) state that the affinity to use digital technologies among more experienced college students has led, in some cases, to changes in research skills such as knowing how to use digital libraries, complement searches with the use of advanced features in specialized databases, and working with keywords.

Based on this analysis, the evolution of DRC as a concept may be located diachronically in three stages. The first one, from 1962 to 2004, came about due to the urgent need of universities to store and categorize large sets of data to preserve scientific literature and expedite its consultation, for both scientists and students. The second one, from 2005 to 2014, occurred because universities began to have an increasingly adequate technologic infrastructure to expand the access to scientific production databases. In this period, digital literacy became a critical training need for functional skills to seek, find, filter, categorize, and use relevant information to achieve educational objectives successfully and meaningfully.

Finally, in the third stage from 2015 to the current day, DRCs result from the demands of an increasingly large and complex informational environment that requires acquiring knowledge about new cognitive mechanisms for finding and using relevant information, making use of digital devices that can be multiconnected to articulated networks, and disseminating knowledge. Research also shows that digital skills now require continuous improvement of research processes where professors play a leading role as mentors who influence the strengthening of digital research competencies in their students (Soltovets, Shigisheva, & Dimitrova, 2020).

Q3. Distribution of scientific publications per country

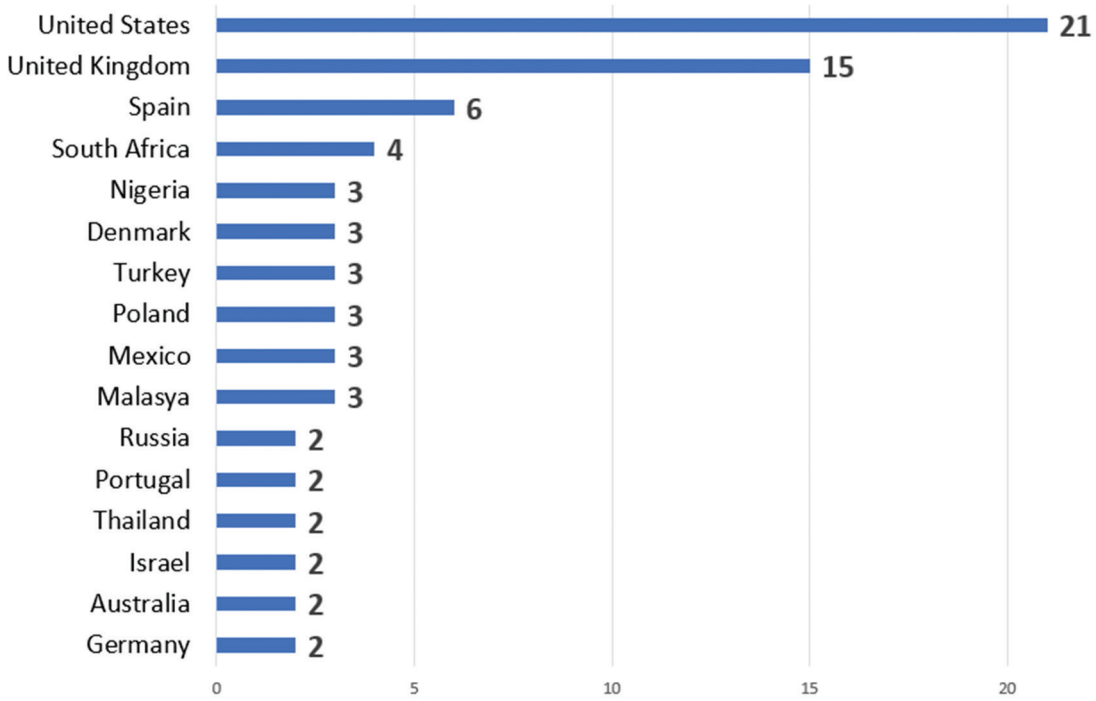
In Figure 3, we observe that the United States leads the countries with the greatest production on the subject with 21 articles (27.63%), followed by the United Kingdom with 15 (19.74%), and South Africa with 4 (5.26%). In Iberoamerica, Spain is the country with the most scientific production, with 6 documents published (7.89%).

VOSViewer software was used to identify co-citations between authors, the United States, being the country with the most scientific production, has the largest number of citations (126), followed by the United Kingdom (76) and Germany (34) (see Table 3). Countries like South Africa (31 citations, 4 documents) and Denmark (12 citations, 3 documents) surpass 10 citations. In Iberoamerica, Spain stands alone at the top of the list with 6 published documents and 52 related citations followed by México (9 citations, 9 documents) (see Figure 4).

Q4. Influential Journals and Documents

The fourth research question sought first to understand how contributions to the Research Competencies Mediated by Technologies (RCMT) knowledge base were distributed across journals, and then to identify influential authors and documents. The 76 journal articles included in the review database were published in 152 diferent journals. The list of the top 5 journals ranked by total articles published can bee seen in Table 4.

Figure 3. Scientific production per country



Source: Prepared by the authors.

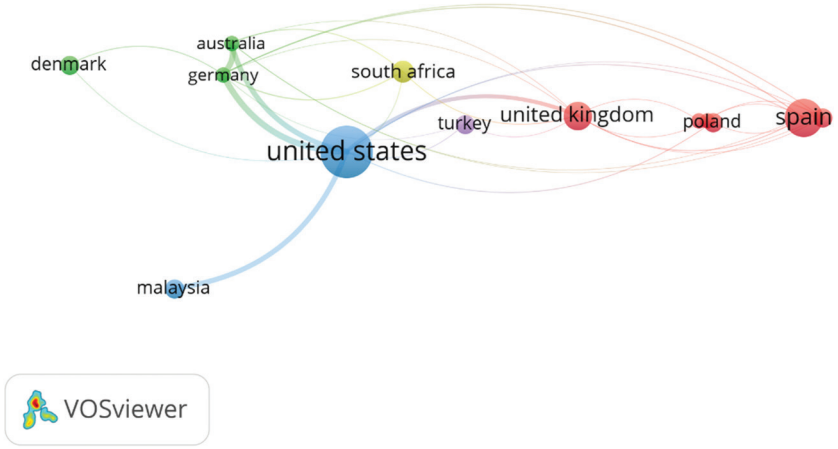
Table 3. Documents and citations

Country	Documents	Citations	Total link strength
United States	21	126	302
United Kingdom	15	76	54
Spain	6	52	69
Germany	2	34	209
South Africa	4	31	9
Denmark	3	12	3
Mexico	3	9	65
Australia	2	9	173
Nigeria	3	7	0
Thailand	2	6	2
Turkey	3	5	4
Israel	2	5	5
Malasya	3	3	71
Poland	3	1	4
Portugal	2	0	0
Russia	2	0	0

Source: Prepared by the authors.

The results indicate that the study that has been cited the most (51 times) is related to research a preliminary study which is part of a wider study aimed at developing a comprehensive skills statement which would provide an objective framework against which professional practitioners in the modern academic library environment (see Appendix A). In Table 5, the articles ordered by identification number and the number of times that each of them has been cited is shown.

Figure 4. Scientific production per country



Source: Prepared by the authors.

Table 4. The 5 most active journals publishing about RCMT

Rank	Journal	Count	Scopus citations	Scopus Quartile
1	Electronic Library	3	54	Q2
2	Electronic Journal of e-Learning	3	10	Q2
3	British Journal of Educational Technology	2	1	Q1
4	International Journal of Continuing Engineering Education and Life-Long Learning	2	1	Q3
5	International Journal of Media and Information Literacy	2	0	Q4

Source: Prepared by the authors.

Table 5. The most cited authors and articles

Number of citations	Cited articles
51	[48]
28	[28]
27	[24], [32]
26	[60]
20	[51]
15	[64]
14	[5]
13	[58]
11	[12]
10	[34]
9	[38]
8	[21]
7	[33]
6	[39], [50], [76]
5	[1], [11], [61]
4	[17], [26], [30], [41], [69], [73]
3	[10], [13], [23], [35], [44], [54], [56], [62], [67], [74]
2	[8], [15], [27], [36], [37], [40], [52], [65]
1	[3], [9], [45], [47], [53], [72], [75]
0	[2], [4], [6], [7], [14], [16], [18], [19], [20], [22], [25], [29], [31], [42], [43], [46], [49], [55], [57], [59], [63], [64], [66], [68], [70], [71]

Source: Prepared by the authors.

Q5. Emerging lines of research

To identify the emerging lines of research, first, 467 keywords belonging to the 76 selected articles were analyzed. With this information, the inference was made as to which are the current trends in the subject. The keywords with the most co-occurrences (the number of times that a term is repeated) are Digital Literacy (23), Research (18), and Informational literacy (17). There also exists a group of co-occurrences linked to the terms Media literacy (10), Digital/Media literacy (10), and New literacies (10). This suggests that, from some authors' point of view, the DRCs are part of several different types of digital literacies (see Table 6).

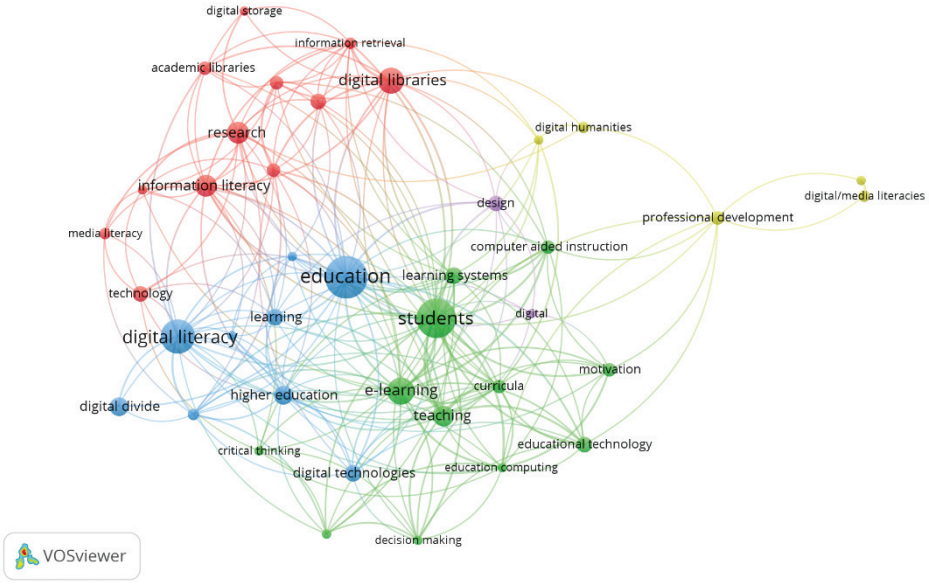
Table 6. Co-occurrences of Keywords

Keywords	**Co-occurrences**	**Total link strength**
Education	28	70
Students	26	91
Digital literacy	23	48
e-learning	21	64
Digital libraries	19	37
Research	18	26
Informational literacy	17	30
Teaching	17	32
Digital divide	17	13
Higher education	16	7
Digital technologies	16	17
Collaboration	16	12
Learning	16	28
Learning systems	15	8
Technology	14	9
Internet	14	24
Educational technology	14	17
Knowledge management	13	11
Professional development	12	26
Information management	11	9
Digital humanities	11	22
Media literacy	10	39
Digital/media literacy	10	24
Digital storage	10	6
New literacies	10	21
Critical thinking	10	31

Source: Prepared by the authors.

In Figure 5, the underlying relationships of the co-occurrence of keywords in the selected articles from the Scopus database can be seen. Six clusters or groupings around the subject are observed, the most relevant by the number of words agglomerated are three. The first one, colored blue, is centered on the relationship of digital literacy to education, which, as previously mentioned, is placed as a meta-concept that integrates DRC among its elements. In it, there is a close conceptual link between the terms digital divide, digital literacies, digital literacy, and digital technologies. The second important cluster, colored green, revolves around students and is linked to terms like educational technology, teaching, and, especially, critical thinking, which addresses the need to analyze, organize, evaluate, and process information that people have around them. In the case of education, it means adequately managing the learning processes (Sánchez, Farrán, Baiges, & Suárez, 2019).

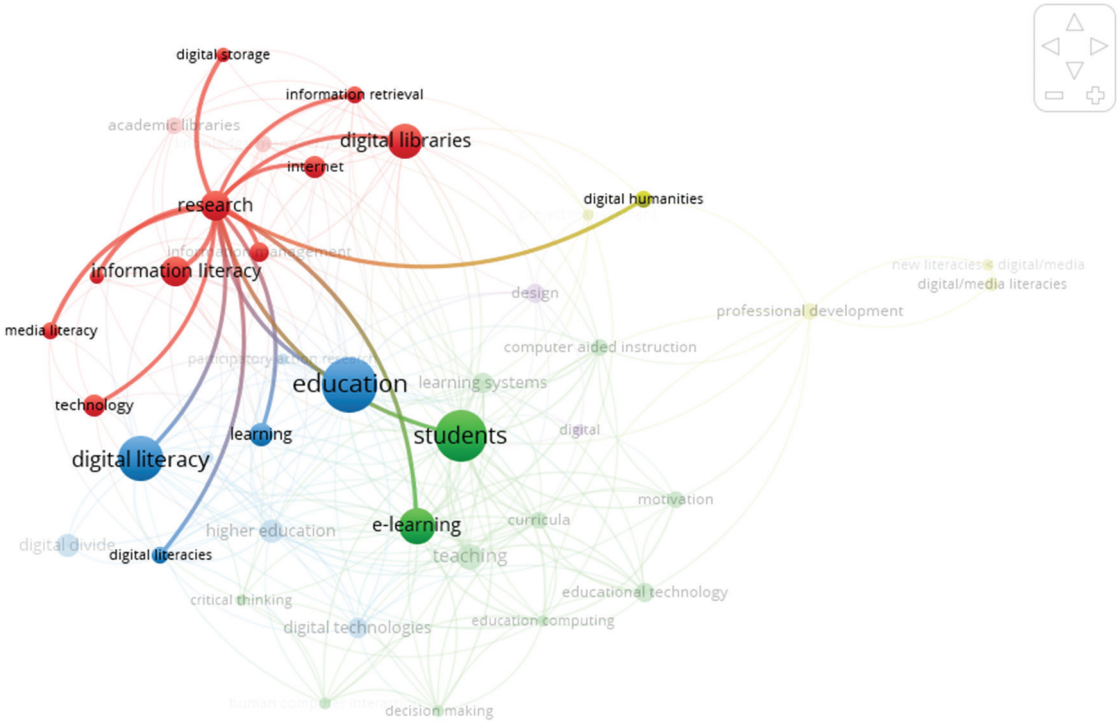
Figure 5. Bibliometric map by Keywords



Source: Prepared by the authors.

Finally, the third cluster, colored red, is of greater interest in this investigation, as it is where the articulation of terms such as digital literacy and research can be found. As observed in Figure 3, the network of keywords is intertwined with other contributions found in the articles, like information literacy, learning, digital literacies, technology, and the internet. Something that stands out is the relationship that emerges with the item digital humanities, as shown in Figure 6. It is a concept that seeks to understand the impact that digital technology has on the skill to analyze the large amounts of data that exist in cyberspace, as well as the ability to develop and prepare digital resource databases (Given & Willson, 2018) for accessing, storing, preserving and disseminating large masses of information (Tsatsou, 2018).

Figure 6. Focus on Item Relationship: *Research*



Source: Prepared by the authors.

In this step, to understand the nature of the studies, keywords, concepts and research contexts are identified to create a classification scheme to classify the studies. In the case of this analysis, the articles' classification was conducted considering thre categories to describe the potential lines of research: 1) education, and learning, 2) University libraries and digital resources, and (3) Higer education digital divide and computers. In Table 7, a counting of each of these categories is shown.

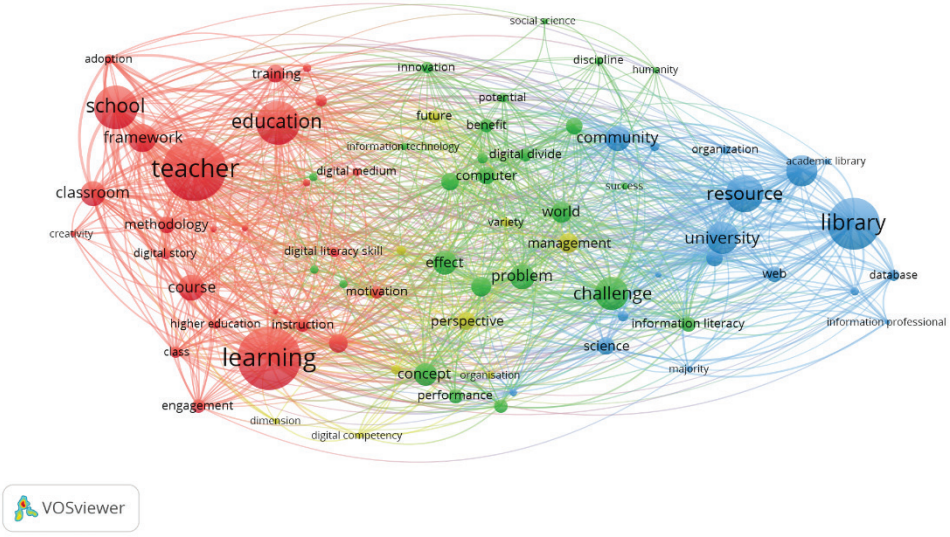
Table 7. Lines or research on RCMT

Lines of research	Articles
LR1. Education and learning	[3], [6], [8], [11], [13], [14], [16], [17], [19], [20], [23], [26], [27], [29], [30], [33], [35], [39], [42], [43], [45], [47], [55], [56], [57], [59], [61], [62], [68], [70], [71], [74].
LR2. Universtiry libraries and digital resources	[1], [4], [5], [7], [9], [12], [18], [24], [25], [34], [36], [38], [48], [49], [50], [53], [54], [58], [60], [64], [65], [72], [76].
LR3. Higher education, digital divide and computers	[2], [10], [15], [22], [28], [31], [32], [37], [40], [41], [44], [46], [51], [52], [66], [67], [69], [73], [75].

Source: Prepared by the authors.

Subsequently, an analysis of the titles and abstracts of the articles was carried out using the full count mapping method in VOSViewer (see Figure 7). The analysis confirmed the presence of the three lines of research. The information was filtered to consider only those documents with an item co-occurrence greater than 10, to select the most significant texts. With this criterion, out of a total of 250 documents, 181 were regarded as relevant. The results showed that the most important terms coming from DRC research could be grouped in three lines of research (LR): 1) the DRCs as a part of the triad, teacher-education-learning; 2) the DRCs to make efficient use of libraries and bibliographic resources, and 3) the DRCs as a means to decrease the digital gaps and provide access to computers efficiently.

Figure 7. Bibliometric map by abstracts



Source: Prepared by the authors.

LR1. Education and learning: The red cluster is based on 26 items, among them literacy skill, digital medium, educational technology, and higher education. As with keywords, the term critical thinking arises once again in this analysis, with 27 co-occurrences and a total link strength of 74, which indicates that there exists a strong link between DRCs and the development of skills to manage information critically. Works such as those produced by Albisua, Ruíz, Nogueira, Turnes and Carrasco (2018) and Buckingham (2019) support this inference, since they underpin that it is an essential competence linked to questioning and decision making that allows people

to act efficiently in innovative knowledge ecosystems. In the same manner, studies by Arévalo, Del Prado and Ramírez (2016) confirm that digital abilities and efficient management of technology are transversal objects in the education of researchers.

LR2. Universtiry libraries and digital resources: The second important cluster is shown in blue with 25 co-occurrences. There is a tendency here to link DRCs to skills people have to access resources held in universities' databases and make critical use of retrieved information (Hartsell, Lawton & Roear, 2020). There is a great strength with links related to digital divide represented by the lack of skills to perform advanced searches on digital bibliographic media (Arshad & Ameen, 2018), as well as with informational literacy, understood as the technical and experiential skills of researchers to process information with the use of technology (Tsatsou, 2018).

LR3. Higher education, digital divide and computers: Colored purple, the highlighted idea is that the study of DRCs is closely linked to the challenges faced by university library users to retrieve academic and scientific information. One of these challenges is again linked to the digital divide and access to computers. Concerning this, the discontinuous access to technology translates into inequalities, either to access resources mobilizing the internet or to achieve the development of digital skills (Van Ingen & Matzat, 2018). Other co-occurrences in this cluster are linked to the use of databases, resources, and science.

4. Discussions and Conclusions

Using systematic bibliometric mapping offers the possibility of identifying the landscape of the progress of a scientific field. Its main strength is that it allows descriptions from a great volume of digital documents, and through search refinement processes, delimited information can be obtained on a specific topic in a certain period. Thus, performing these types of studies represents a contribution to the state of knowledge.

The results of this investigation represent an approximation of the characterization of scientific production of high international impact in the area of research competencies supported by technology, emphasizing the importance of developing competencies for research (Avalos & Sevillano, 2018). One can observe chronological development, with stagnation until 2014, and a period of growth since 2016, which suggests that the growth will continue to rise and be explored in-depth in the coming years. Equally, we observe a strong trend to link research competencies to digital literacy, the development of critical thinking, digital humanities, and means of access to information in digital libraries (Green, Copeland, Deekens & Yu, 2018).

Concerning territorial evolution, the United States is the country with the largest scientific production and the greatest impact due to the concentration of citations, followed by the United Kingdom; therefore, in a large proportion, the main language is English. On the other hand, scientific production in Spanish is dominated by the journals located in Spain, outshining the contributions coming from Latin America.

As far as the method employed to perform the bibliometric study, note that, even though all the steps suggested by other authors were followed and the information was selected from a trustworthy and internationally prominent database, the search logic may have limitations that come from human refinement. For example, the use of operators, the term inclusion/exclusion criteria, the individual analysis of each article, language barriers, and technical restrictions may affect the search logic and, therefore, the outcomes. Another factor could be that important contributions hosted on high impact national catalogs that are not indexed on Scopus were excluded.

The results that came from the bibliographic maps served as inputs to profile the qualitative analysis. Through interpretation, the analysis showed three contemporary research lines that are linked, namely, teaching and learning, access to bibliographic resources on digital libraries, and the digital divide and computers. Also, dominant items such as literacy skill, digital medium, educational technology, higher education, digital humanities, critical thinking, informational literacy, and digital divide were identified.

As mentioned previously, the limitations of this investigation could result from the selection of Scopus as the sole source of information, and similar studies could be replicated using other databases. Many international impact publications were not considered because they were not in the Scopus index; certainly, there could be important studies on the subject of the development of research competencies as well as researchers who have done outstanding work.

Prospectively, there is now an open invitation to examine the impact of indexed contributions in other databases such as Web of Science, ERIC, SAGE Journals, Google Scholar[3], or the several other classification systems that exist for high-impact, international and national journals in many different countries. Also, the inclusion of

3. Databases collection of bibliographic references and citations of scientific publications.

complementary analysis criteria that can be used with the VOSViewer software must be considered, for example, collaboration among authors, individual productions by one author, and citations shared among authors.

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References

Abad E., González, M., Luque de la Rosa, A., & Gallardo, J. (2020). Management of the digital economy in higher education: trends and future perspectives. *Campus Virtuales*, *9*(1), 57-68.

Albareda, S., Vidal, S., Pujol, M., & Fernández, M. (2018). Holistic approaches to develop sustainability and research competencies in pre-service teacher training. *Sustainability*, *10*(10). https://doi.org/10.3390/su10103698

Albisua, M., Ruíz, M., Nogueira, D., Turnes, S., & Carrasco, L. (2018). Critical Thinking from the Perspective of University Teachers. *Estudios Pedagógicos*, *44*(1), 89-113. https://doi.org/10.4067/S0718-07052018000100089

Anisimova, T., Sabirova, F., & Shatunova, O. (2020). Formation of design and research competencies in future teachers in the framework of STEAM education. *International Journal of Emerging Technologies in Learning*, *15*(2), 204-217. https://doi.org/10.3991/ijet.v15i02.11537

Arévalo, R., Del Prado, R., & Ramírez, R. (2016). Institutional education of communication researchers and media literacy. The case of the PhD in communication research. *Revista Latina de Comunicación Social*, *71*, 800-817. https://doi.org/10.4185/RLCS-2016-1121en

Arshad, A., & Ameen, K. (2018). Academic scientists' scholarly use of information resources in the digital environment: Perceptions and barriers. *Global Knowledge, Memory and Communication*, *67*(6), 467-483. https://doi.org/10.1108/GKMC-05-2018-0044

Avalos, C., & Sevilllano, M. (2018). The development of research competences through the Lean Startup methodology in students training at the State Distance University in Costa Rica. *Educatio Siglo XXI*, *36*(3), 417-442. https://doi.org/10.6018/j/350071

Aydoğdu, Ş. (2020). Educational data mining studies in turkey: a systematic review. *Turkish Online Journal of Distance Education*, *21*(3), 170-185. https://doi.org/10.17718/tojde.762046

Baker, F. (1962). Information Retrieval Based upon Latent Class Analysis. *Journal of de ACM (JACM), 9*(4), 512-521. https://doi.org/10.1145/321138.321148

Batane, T., & Ngwako, A. (2017). Technology use by pre-service teachers during teaching practice: Are new teachers embracing technology right away in their first teaching experience? *Australasian Journal of Educational Technology*, *33*(1), 58-61. https://doi.org/10.14742/ajet.2299

Bornmann, L., Thor, A., Marx, W., & Schier, H. (2016). The application of bibliometrics to research evaluation in the humanities and social sciences: An exploratory study using normalized Google Scholar data for the publications of a research institute. *Journal of the Association for Information Science and Technology*, *67*(11), 2778-2789. https://doi.org/10.1002/asi.23627

Buckingham, D. (2019). Teaching media in a 'post-truth' age: fake news, media bias and the challenge for media/digital literacy education. *Culture and Education*, *31*(2), 213-231. https://doi.org/10.1080/11356405.2019.1603814

Buendía, X., Zambrano, C., & Insuasty, E. (2018). Development of Research Skills in Pre-Service Teachers in the Context of the Teaching Practice. *Folios*, *47*, 179-195.

Campos, H., & Ramírez, M. (2018). ICT in the educational processes of a Public Research Center. *Apertura*, *10*(1), 56-70. https://doi.org/10.32870/Ap.v10n1

Castañeda, L., Esteve, F., & Adell, J. (2018). Why rethinking teaching competence for the digital world? *RED. Revista de Educación a Distancia*, *56*, 2-20. https://doi.org/10.6018/red/56/6

Dana, F., & Yendol, D. (2014). *The Reflective Educator's Guide to Classroom Research: Learning to teach and teaching to learn through practitioner inquiry*. Corwin Press.

Domingo, M., Bosco, A., Carrasco, S., & Sánchez, J. (2020). Fostering teacher's digital competence at university: The perception of students and teachers. *Revista de Investigación Educativa*, *38*(1), 167-782. https://doi.org/10.6018/rie.340551

Estrada, O. (2014). Theoretical Systematization of Research Competence. *Revista Electrónica Educare*, *18*(2) 177-194. https://doi.org/10.15359/ree.18-2.9

García, A., & Ramírez, M. (2019). Systematic Mapping of Scientific Production on Open Innovation (2015–2018): Opportunities for Sustainable Training Environments. *Sustainability*, *11*, art1781. https://doi.org/10.3390/su11061781

García-Holgado, A., Marcos-Pablos, S., & García-Peñalvo, F. J. (2020). Guidelines for performing Systematic Research Projects Reviews. *International Journal of Interactive Multimedia and Artificial Intelligence, 6*(2), 136-144. https://doi.org/10.9781/ijimai.2020.05.005

García-Peñalvo, F. J. (2018). Identidad digital como investigadores. La evidencia y la transparencia de la producción científica. *Education in the Knowledge Society, 19*(2), 7-28. https://doi.org/10.14201/eks2018192728

George, C., & Salado, L. (2019). Research competences with ICT in PhD students. *Apertura*, *11*(1), 40-55. https://doi.org/10.32870/Ap.v11n1

Given, L., & Willson, R. (2018). Information technology and the humanities scholar: Documenting digital research practices*. Journal of the Association for Information Science and Technology*, *69*(6), 807-819. https://doi.org/10.1002/asi.24008

Green, J., Copeland, D., Deekens, V., & Yu, S. (2018). Beyond knowledge: Examining digital literacy's role in the acquisition of understanding in science. *Computers and Education*, *117*, 141-159. https://doi.org/10.1016/j.compedu.2017.10.003

Green, J., Yu, S., & Copeland, D. (2014). Measuring critical components of digital literacy and their relationships with learning. *Computers and Education*, *76*, 55-69. https://doi.org/10.1016/j.compedu.2014.03.008

Gudmundsdottir, G., & Hatlevik, O. (2018). Newly qualified teachers' professional digital competence: implications for teacher education. *European Journal of Teacher Education*, *41*(2), 214-231. https://doi.org/10.1080/02619768.2017.1416085

Hallinger, P., & Chatpinyakoop, C. (2019). A Bibliometric Review of Research on Higher Education for Sustainable Development, 1998–2018. *Sustainability*, *11*, art2401. https://doi.org/10.3390/su11082401

Hartsell, A., Lawton, K., & Roear, H. (2020). Seven librarians and one big undertaking: creating a digital project from start to finish. *Journal of Electronic Resources Librarianship*, *32*(1), 19-28. https://doi.org/10.1080/1941126X.2019.1709730

Howard, H., Wood, N., & Stonebraker, I. (2018). Mapping information literacy using the business research competencies. *Reference Services Review*, *46*(4), 543-564. https://doi.org/10.1108/RSR-12-2017-0048

Kammerer, Y., Brand, S., & Jarodska, H. (2018). The future of learning by searching the web: Mobile, social, and multimodal. *Frontline Learning Research*, *6*(2), 81-91. https://doi.org/10.14786/flr.v6i2.343

Kruse, F., & Thestrup, J. (2014). Research libraries' new role in research data management, current trends, and visions in Denmark. *LIBER Quarterly*, *34*(4), 310-335. https://doi.org/10.18352/lq.9173

Leonard, B. (2020). Development of teacher research competency training system in indonesia: A need analysis. *Universal Journal of Educational Research*, *8*(5), 2064-2070. https://doi.org/10.13189/ujer.2020.080544

López, E., Vázquez, E., & Román, P. (2015). Analysis and Implications of the Impact of MOOC Movement in the Scientific Community: JCR and Scopus (2010-13). *Comunicar: Revista científica iberoamericana de comunicación y educación*, *22*(44), 73-80. https://doi.org/10.3916/C44-2015-08

Maer, M., Mocanu, C., Zamfir, A., & Georgescu, T. (2019). Skill Needs for early career researchers-A text mining approach. *Sustainability*, *11*(10), art2789. https://doi.org/10.3390/su11102789

Márquez, A., Santamaría, D., & Acosta, R. (2016). Validación del perfil de competencias Investigativas para estudiantes de la carrera Licenciatura en Cultura Física. *Revista de Lecturas de Educación Física y Deportes*, *21*(215).

Mas, O. (2016). The influence of experience on the research competencies of university professors. *Revista Complutense de Educación*, *27*(1), 13-34. https://doi.org/10.5209/rev_RCED.2016.v27.n1.44706

Matcharashvili, T., Tsveraidze, Z., Sborshchikovi, A., & Matcharashvili, T. (2014). The importance of bibliometric indicators for the analysis of research performance in Georgia. *TRAMES*, *18*(68). https://doi.org/10.3176/tr.2014.4.03

Millard, A. Baldassar, L., & Wildingb, R. (2018). The significance of digital citizenship in the well-being of older migrants. *Public Health*, *158*, 144-148. https://doi.org/10.1016/j.puhe.2018.03.005

Mizrachi, D. (2014). Online or print: Which do students prefer? *Communications in Computer and Information Science*, *492*, 733-742. https://doi.org/10.1007/978-3-319-14136-7_76

Moher, D., Liberati, A., Tetzla, J. Altman, D., & The PRISMA Group (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Plos Medicine*, *6*, e1000097. https://doi.org/10.1371/journal.pmed.1000097

Moreno, A. (2019). Estudio bibliométrico de la producción científica en Web of Science: Formación Profesional y blended learning. *Píxel-Bit. Revista de Medios y Educación*, *56*, 149-168. https://doi.org/10.12795/pixelbit.2019.i56.08

Murillo, F., & Perines, H. (2017). How non-university teachers perceive educational research. *Revista Complutense de Educación*, *28*(1), 81–99. https://doi.org/10.5209/rev_RCED.2017.v28.n1.48800

Nakamura, P., Rivero, C., & Velasco, A. (2019). Eveloping research competencies in education students through situated learning. *Aula de Encuentro*, *21*(1), 182-197. https://doi.org/10.17561/ae.v21i1.10

Peirats, J., Marín, D., & Vidal, M. (2019). Bibliometrics applied to gamification as a digital learning strategy. *RED. Revista de Educación a Distancia*, *60*. https://doi.org/10.6018/red/60/05

Pérez, M., & Vladimirovna, N. (2017). The scientific production on social innovation for local development: a bibliometric review. The structure and evolution of the field of scientific domain. *Prisma Social. Revista de Ciencias Sociales*, *19*, 146-182.

Perines, H., & Murillo, F. (2017). How toimprove educational research? Suggestions from teachers. *Revista de Educación Superior*, *46*(181), 89-104. https://doi.org/10.1016/j.resu.2016.11.003

Petersen, K., Robert F., Shahid, M., & Mattsson, M. (2008). Systematic Mapping Studies in Software Engineering. *EASE*, *8*, 68-77. https://doi.org/10.14236/ewic/EASE2008.8

Price, D. (1986). *Little Science, big science, and beyond*. Columbia University Press.

Quyyum, D., & Smith, D. (2018). Changing Research Behaviours of University Students with Progression throughout a Course. *Journal of the Australian Library and Information Association*, *67*(3), 256-277. https://doi.org/10.1080/24750158.2018.1502243

Ramírez, A., Martínez, K., Aguilar, J., & Rodríguez, M. (2018). The presence of ict in Revista de la Educación Superior *(ANUIES). Revista De La Educación Superior*, *47*(187), 133-162. https://doi.org/10.36857/resu.2018.187.422

Rodríguez A., Trujillo, J., & Sánchez, J. (2018). Impact of scientific productivity on digital competence of future teachers: bibliometric approach on Scopus and Web of Science. *Revista Complutense de Educación*, *30*(2), 623-646. https://doi.org/10.5209/RCED.58862

Rodríguez, A., Raso F., & Ruiz, J. (2019). Competencia digital, educación superior y formación del profesorado: un estudio de meta-análisis en la Web of Science. *Píxel-Bit. Revista de Medios de Comunicación*, (54), 65-81. https://doi.org/10.12795/pixelbit.2019.i54.04

Rubio, M., Torrado, M., Quirós, C., & Valls, R. (2018). Self-perception of investigative competences in final-year students of Pedagogy of the University of Barcelona to develop the Final Grade Work. *Revista Complutense de Educación*, *29*(2), 335-354. https://doi.org/10.5209/RCED.52443

Sánchez, J., Farrán, X., Baiges, E., & Suárez, C. (2019). Critical processing of information on university students from personal learning environments. *Educacao e Pesquisa*, *45*, e193355. https://doi.org/10.1590/S1678-4634201945193355

Soltovets, E., Chigisheva, O., & Dmitrova, A. (2020). The role of mentoring in digital literacy development of doctoral students at British universities. *Eurasia Journal of Mathematics, Science and Technology Education*, *16*(4), em1839. https://doi.org/10.29333/ejmste/117782

Thongsong, B., Yamtim, V., & Jai-Areesuthiwa, A. (2020). Research competency enhancement process based on knowledge management procedures for developing routine to research of support staff at thaksin university. *Kasetsart Journal of Social Sciences*, *41*(2), 441-448. https://doi.org/10.34044/j.kjss.2020.41.2.15

Tourón, J., Martín, D., Navarro, E., Pradas, S., & Íñigo, V. (2018). Construct validation of a questionnaire to measure teachers' digital competence (TDC). *Revista Española de Pedagogía*, *76*(269), 25-54. https://doi.org/10.22550/REP76-1-2018-02

Tsatsou, P. (2018). Literacy and training in digital research: Researchers' views in five social science and humanities disciplines. *New Media and Society*, *20*(3), 1240-1259. https://doi.org/10.1177/1461444816688274

Van Eck, J., & Waltman, L. (2017). Citation-based clustering of publications using CitNetExplorer and VOSviewer. *Scientometrics*, *111*(2), 1053-1070. https://doi.org/10.1007/s11192-017-2300-7

Van Ingen, E., & Matazat, U. (2018). Inequality in mobilizing online help after a negative life event: the role of education, digital skills, and capital-enhancing Internet use. *Information, Communication, and Society*, *21*(4), 481-498. https://doi.org/10.1080/1369118X.2017.1293708

Velasco, B., Eiros, J., & San Román, J. (2012). La utilización de los indicadores bibliométricos para evaluar la actividad investigadora. *Aula abierta*, *40*(2), 75-84.

Whalley, R., & Barbour, M. (2020). Collaboration and Virtual Learning in New Zealand Rural Primary Schools: A Review of the Literature. *Turkish Online Journal of Distance Education*, *21*(2), 102-125. https://doi.org/10.17718/tojde.727983

Yang, K., Liu, X., & Chen, G. (2020). Global research trends in robot education in 2009-2019: A bibliometric análisis. *International Journal of Information and Education Technology*, *10*(6), 476-481. https://doi.org/10.18178/ijiet.2020.10.6.1410

APPENDIX A

Access link to the database created for the analysis of the literature systematic mapping: https://cutt.ly/Ig5qbtP