

Digital competence in higher education: analysis of the impact of scientific production indexed in Scopus database

La competencia digital en la universidad: análisis del impacto de la producción científica indexada en Scopus

RODRÍGUEZ-GARCÍA , Antonio M. [1](#); AZNAR DÍAZ , Inmaculada [2](#); CÁCERES RECHE, Pilar [3](#) & GÓMEZ GARCÍA, Gerardo [4](#)

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Contents

[1. Introduction](#)

[2. Methodology](#)

[3. Results](#)

[4. Conclusions](#)

[Bibliographic references](#)

ABSTRACT:

We present a bibliometric study that provides a specific vision about the impact of research in digital competence in teacher training. Four combined studies were carry out through the union of keywords. 112 documents have been analyzed that project a steady line of research whose major scientific production is concentrated in recent years, published mostly in English through articles and papers at conferences and indexed in the area of Social Sciences.

Keywords: digital competence, higher education, teacher training, scientific production

RESUMEN:

Presentamos un estudio bibliométrico que aporta una visión específica sobre el impacto de la investigación en competencia digital de los futuros docentes. Se realizaron cuatro búsquedas combinadas mediante la unión de palabras clave. Se analizaron 112 documentos que proyectan una línea de investigación potente. Encontramos una gran mayoría de trabajos publicados en años recientes, en inglés y a través de artículos, fundamentalmente, así como comunicaciones en congresos e indexados en el área de Ciencias Sociales.

Palabras clave: competencia digital, educación superior, profesores en formación, producción científica

1. Introduction

Digital competence has become a focus that has received special interest since it was conceived as one of the basic skills that any citizen should develop at the end of the compulsory educational stage. Developing it has become an indispensable requirement to function effectively in the new information and knowledge society, and also as an

indispensable skill that is needed for lifelong learning. In fact, this competence has been one of the most studied and debated in recent years (Roffeei, Kamarulzaman and Yusop, 2016; Salinas, de Benito and Lizana, 2014; UNESCO, 2008).

The concern was such that, at the international level, several European moves were carried out to improve digital citizenship. Among all of them, we highlight the "Rethink Education" strategy launched by the European Commission in 2012. It indicates the need to take full advantage of the potential of technology, the need to be effectively integrated into schools, and acting for the benefit of improving education in all areas. To this end, a series of open resources is made available to teachers, students and ordinary citizens through online platforms that offer and extend learning opportunities, which encourage collaboration, the ability to resolve problems and, ultimately, that contribute to improved educational quality. At the same time, in an attempt to define and clarify what was understood by digital competence, what were its indicators and in what areas was it composed. The DIGCOMP Project was launched by the European Union in 2010 (Ferrari, 2013). As a result, a European frame of reference for the development of citizen digital competence was born.

In Spain, the National Institute of Technology and Teacher Training of the Ministry of Education, Culture and Sports of the Government of Spain published a framework about digital competences that every teacher should develop in their practice. This cooperation began to work in 2012 on the creation of a common frame of reference on digital teaching competence. Although in 2013 the first draft was published, it was not until January of the year 2017 when this work was completed, giving rise to the creation of the Common Framework of Digital Teacher Competence (INTEF, 2017).

As we have already mentioned, digital competence has become a key concept in 21st century society, where -whether we like it or not- we must be capable, competent and skilled in our relationship with technology. For this reason, when a teacher introduces himself to his students, he has a great responsibility, because his knowledge will become the reference element of the new generations to be trained in digital skills and competences.

Now, in our interest in the subject we ask ourselves: in what year did one began to study the digital competence? Has the study of this field grown? Is it a powerful research line? Who is investigating it? Where do they investigate it? What institutions seem specialized in this research topic? We will try to answer this and other questions in the following pages.

2. Methodology

The study that we present corresponds to a meta-analysis research that aims at analyzing the scientific production with the greatest impact, focusing on the investigation of digital competence in higher education in the Scopus database, making a special allusion to the training of future teachers. For this, a rigorous process of systematic review of the literature found in Scopus has been used from its creation until the year 2017. From this general objective, a series of specific objectives emerge which, in turn, are configured as the different research variables taken into account for the realization of the same and are the following:

- Analyze scientific production according to the year of publication;
- Examine the source of the files;
- Know the authors that have the most scientific production on the subject;
- Find out in which institutions more research is done on the subject;
- Know which countries publish more about digital competence;
- Study the typology of the recovered scientific document;
- Distinguish the different areas of publication;
- Detail the articles that have received the highest number of citations.

To this end, a research process has been followed, which is presented in detail below. First, we delimited the key concepts of the research through ERICThesaurus, with the following selected: "Digital Competence " (Digital Competence); " Teacher Training" ; "Digital Skills "

(Competence/Digital Skills); and " Higher Education " (Higher Education).

The start of the study began in September, 2016. Subsequently, it was carried out in May, 2017 to guarantee the inclusion of the results obtained. On the other hand, the process that we followed was governed by the indicators of the Prism Declaration (Urrutia and Bonfail, 2010) for studies of this type, carrying out four combined research projects which were a product of the union of the key words, and aided by the connector "and". In this way, four different studies were established: "Digital competence " and " teacher training" (DCTT); "Digital skills " and " teacher training" (DSTT) ; "Digital competence " and " higher education "(DCHE) ; and "Digital skills " and " higher education "(DSHE) . In a more specific and detailed way, the process followed is shown in the following table.

Table 1
Search procedure

Database	Scopus (https://www.scopus.com/)
Search period	All search years were considered until 2017.
Appearance of the thesaurus	Title, summary, keywords or body of full text.
Type of files	All types of possible references indexed in the database were included (periodicals, books, conference proceedings, review articles, etc.).
Publication areas	All areas of publication were considered.

On the other hand, with the objective of knowing the impact of research in this field, a series of specific inclusion criteria were established for each of the variables taken as a reference. In the following table we can contemplate it in a specific way.

Table 2
Inclusion criteria

Variable	Inclusion criteria
Year of publication	All investigations are considered.
Origin of the archives	2 or more investigations converge in the same resource (journal, book, etc.).
Authors with more scientific production	At least two references on the subject.
Institutions	At least two references on the subject.
Countries	At least two references on the subject.
Document type	All references found are contemplated.
Publication area	All references found are contemplated.
Most cited articles	At least two citations.

3. Results

The sums of the results found by the four possible combinations gave 112 documents indexed in the Scopus database with the aforementioned keywords. As shown in the following table, the greatest scientific production concentrates on the combination "Digital competence " and " higher education " (digital competence and higher education) followed by those documents rescued from the combination " digital skills " and " higher education " (digital skills/digital competence and higher education).

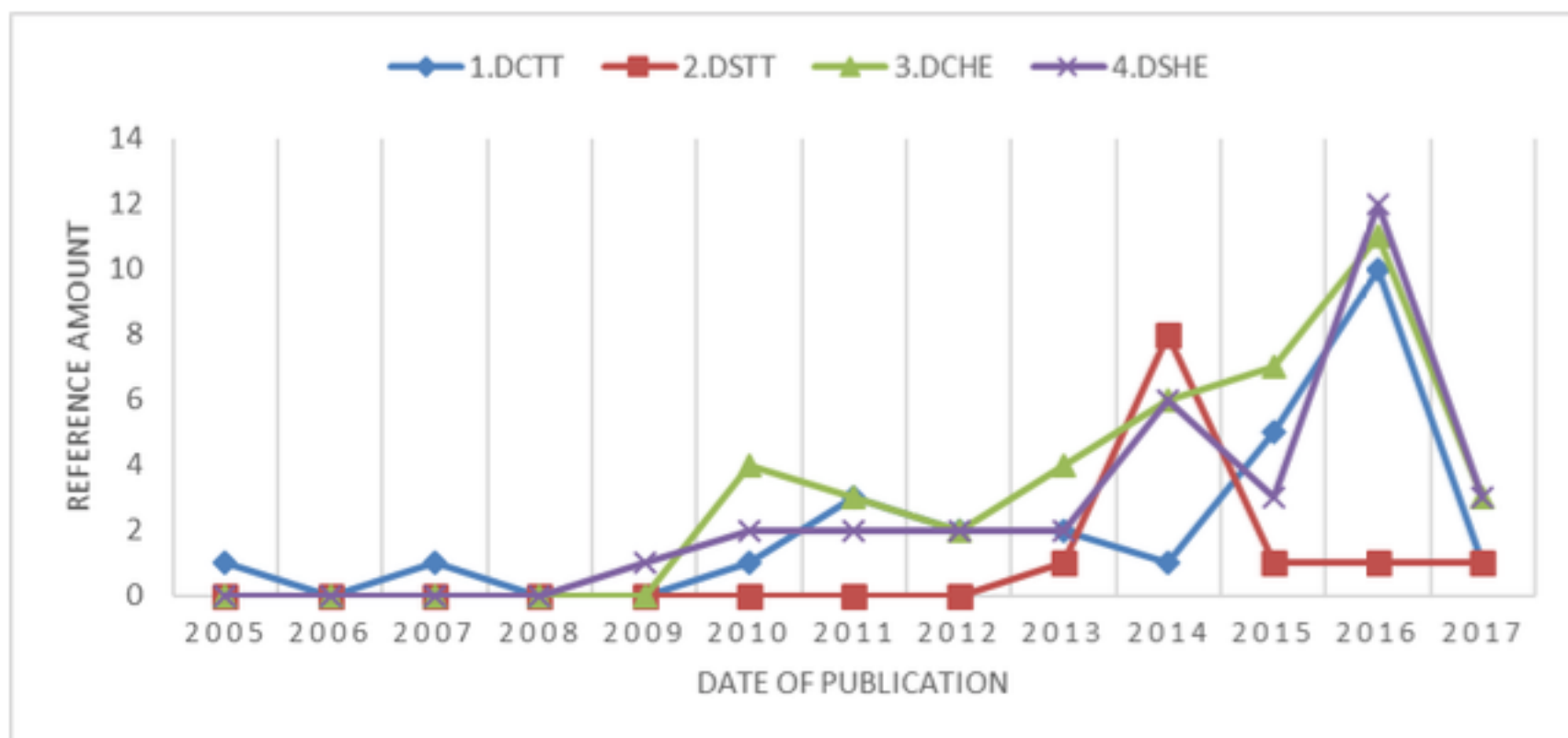
Table 3
Results obtained based on the keywords

Combination	References found	% of 112
"Digital competence" and "teacher training"	27	24.11 %
"Digital skills" and "teacher training"	12	10.71 %
"Digital competence" and "higher education"	40	35.71 %
"Digital skills" and "higher education"	33	29.46 %

3.1. Analysis of scientific production according to the year of publication

First, we analyzed the 112 publications indexed in Scopus according to the variable: year of publication. As one can see in Figure 1, the year that has received the most scientific production on digital competence has been 2016, concentrating 30.36% of the publications analyzed. In turn, 2014 and 2015 stand out, and are in the second and third place. Thus, we note that most research production is concentrated in this area, especially in the period comprising the years 2014-2016, representing 63.4% of all research this subject.

Figure 1
Amount of publications per year
based on the combination of keywords



3.2. Source files

The second variable analyzed corresponds to the *origin of the archives*, that is, the periodicals that have concentrated the most research on the subject of study.

As previously mentioned, with the aim of providing a more accurate view of the impact of research in digital competence and the journals indexed in Scopus, which have more references on research in digital competence, established as a discriminatory criterion the fact of not having two or more references of the same object of study. For this reason the results from the crossing of the terms " *digital skills* " and " *teacher training*" have not been included, because their combination has not yielded any results in which two or more documents converge in the same source or resource. In this way, it is understood that, of the twelve references found, each of them belongs to a different journal or book, for example.

This entire process has resulted in the inclusion of eight source files that have the most research on digital competence (Table 4).

Table 4. Source files that have produced the most on digital competence's research

Source files	DCTT	DCHE	DSHE	Total	% de 112
	Results				
<i>ACM International Conference Proceeding Series</i>	-	5	2	7	6,25%
<i>Electronic Journal of E Learning</i>	-	-	2	2	1,79%
<i>IFIP. Advances in Information and Communication</i>	2	-	2	4	3,57%
<i>Journal of Educational Technology in Higher Education</i>	2	2	2	6	5,36%
<i>Nordic Journal of Digital Literacy</i>	5	-		5	4,46%
<i>Ocnos</i>	2	-	-	2	1,79%
<i>Profesorado</i>	2	-	-	2	1,79%
<i>Revista Complutense de Educación</i>	-	-	2	2	1,79%
Total:	13	7	10	30	26,80%

3.3. Authors with more scientific production on the subject

In order to follow the objective of knowing who are the authors that are producing the most in this database on digital competence, they should have at least two references on the subject. In this way, the combination of " *digital skills* " and " *teacher training*" is excluded from the following table because there is no inclusive result with respect to these criteria.

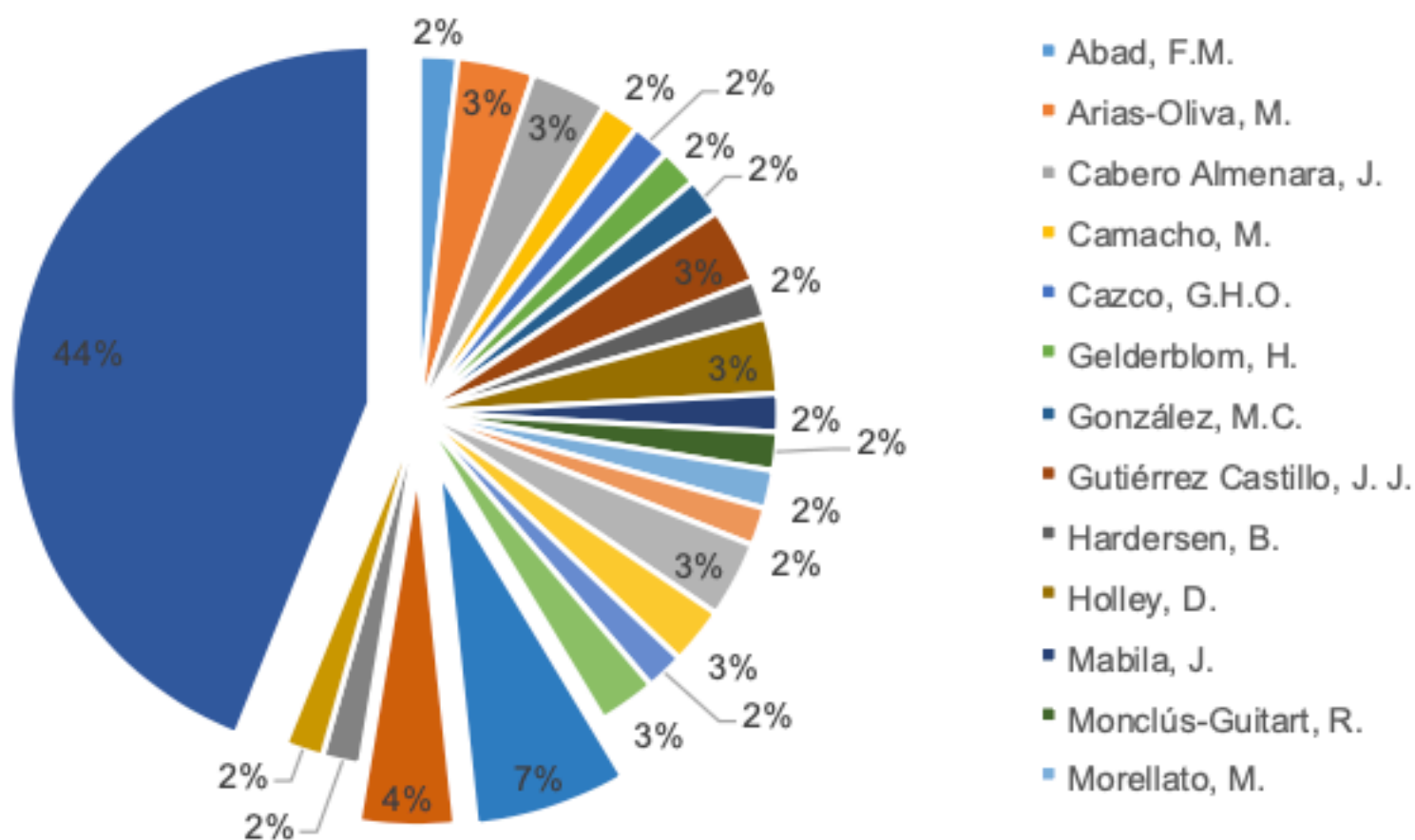
Table 5. Authors with more scientific production

Author	DCTT	DCHE	DSHE	Total	% de 112
	Resultados				
<i>Abad, F.M.</i>	-	2	-	2	1,79%

<i>Arias-Oliva, M.</i>	-	2	2	4	3,57%
<i>Cabero Almenara, J.</i>	2	2	-	4	3,57%
<i>Camacho, M.</i>	-	-	2	2	1,79%
<i>Cazco, G.H.O.</i>	-	2	-	2	1,79%
<i>Gelderblom, H.</i>	-	2	-	2	1,79%
<i>González, M.C.</i>	-	2		2	1,79%
<i>Gutiérrez Castillo, J. J.</i>	2	2	-	4	3,57%
<i>Hardersen, B.</i>	2	-	-	2	1,79%
<i>Holley, D.</i>	-	2	2	4	3,57%
<i>Mabila, J.</i>	-	2	-	2	1,79%
<i>Monclús-Guitart, R.</i>	-	2	-	2	1,79%
<i>Morellato, M.</i>	-	2	-	2	1,79%
<i>Olmos-Migueláñez, S.</i>	-	2	-	2	1,79%
<i>Peña-López, I.</i>	-	2	2	4	3,57%
<i>Rodríguez-Conde, M.J.</i>	-	3	-	3	2,68%
<i>Ssemugabi, S.</i>	-	2	-	2	1,79%
<i>Tomte, C. E.</i>	3	-	-	3	2,68%
<i>Torres Coronas, T.</i>	-	5	3	8	7,14%
<i>Vidal-Blasco, M.A.</i>	-	5	-	5	4,46%
<i>Villalustre, L.</i>	2	-	-	2	1,79%
<i>Yáñez Luna, J.C.</i>	-	-	2	2	1,79%

As we can see, the author *Torres Coronas, T.* accumulates eight publications rescued by the different combinations of key words, which supposes a 7.14% of the analyzed investigation and becomes, therefore, the author with more scientific production on digital competence indexed in Scopus. *Vidal-Blasco, M.A.* are in the second place with 5 references and 4.46% of the total. The third place is shared by several authors with 4 references and 3.57% each one of them (*Arias-Oliva, M.*; *Cabero Almenara, J.*; *Gutiérrez Castillo, JJ*; *Peña-López, I.*). We can observe the scientific production of each author with respect to the total in the following figure.

Figure 2
Most important authors in this topic



3.4. Institutions

The fourth variable that was taken into account corresponds to the institution from which the investigation originates and, therefore, the place of work of the authors. In this way, through the analysis of this issue, the reader is allowed to obtain a more detailed view about the organizations that have the greatest scientific production on digital competence in the Scopus databases. In Table 6, we can see it in detail:

Table 6
Institutions with more scientific production

Institutions	DCTT	DCHE	DSHE	Total	% de 112
	Results				
Norwegian Centre for ICT in Education (Norway)	2		-	2	1,79%
Autonomous University of San Luis Potosi (Mexico)	-		2	2	1,79%
University of Granada (Spain)	2		-	2	1,79%
University of Oviedo (Spain)	2	-		2	1,79%
University of Salamanca (Spain)	2	5	-	7	6,25%
University of Sevilla (Spain)	3	3	-	6	5,36%
Internacional University of La Rioja (Spain)	-	2		2	1,79%
National University of Chimborazo		2	-	2	1,79%

(Ecuador)					
National University of Distance Education (Spain)		2	2	4	3,57%
Oberta University of Catalonia (Spain)	-	3		3	2,68%
Rovira i Virgili University(Spain)	2	5	5	12	10,71%
University of South Africa (South Africa)	-	2	-	2	1,79%

Based on these data, the Rovira i Virgili University is ranked first with a total of 12 publications of the totals rescued, representing 10.71% of the total percentage. In second place, the scientific production of the University of Salamanca stands out with 7 publications and 6.25% and, thirdly, the University of Seville with 6 publications and 5.36%.

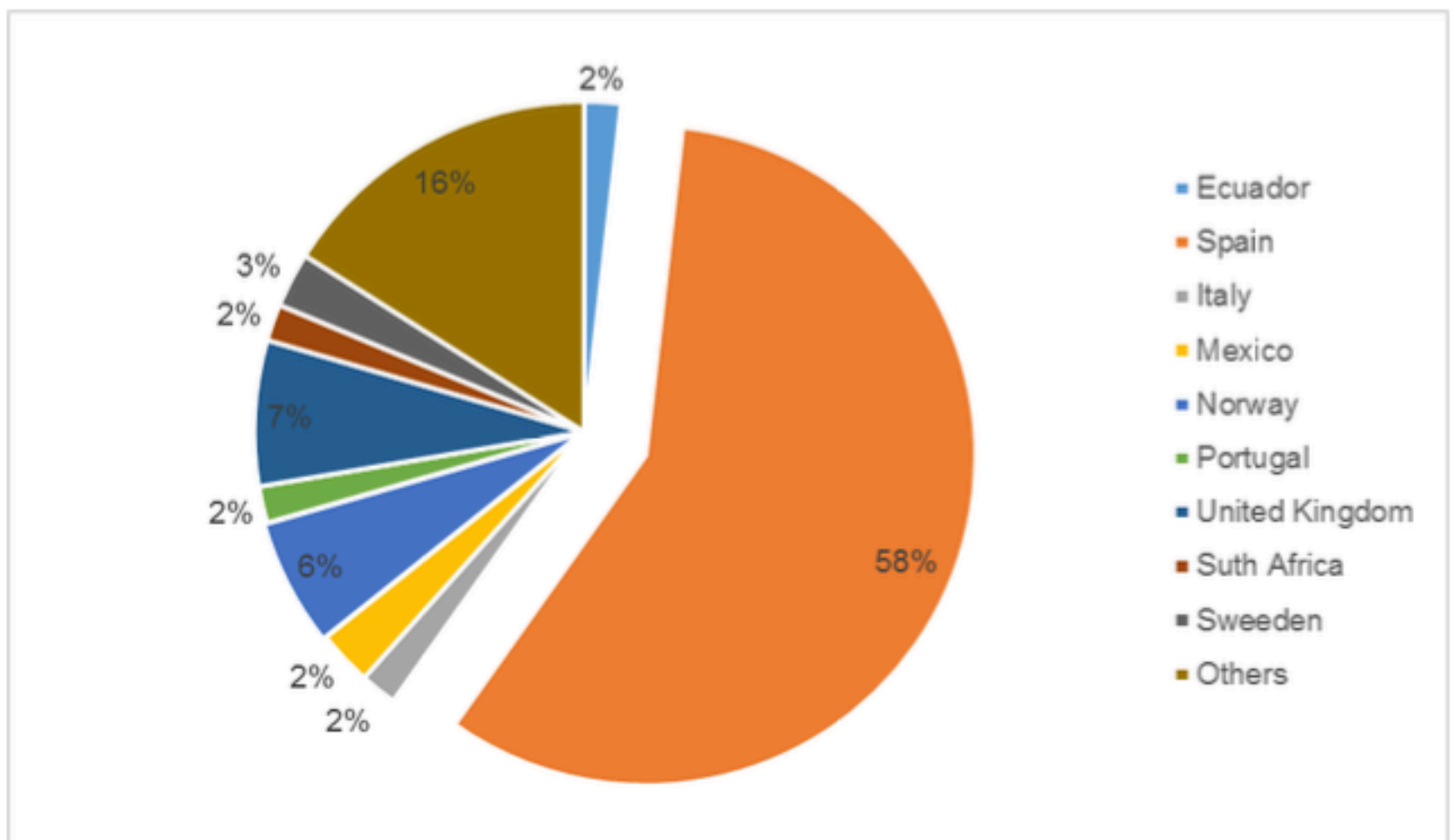
3.5. Countries

This variable was taken in order to know where the research focus is located worldwide. Thus, those countries whose scientific production is equal to or greater than the two references have been considered, in order to meet the inclusion criteria established above.

This process has resulted in the extraction of nine different countries, safeguarding that in three of the investigations the country was not defined. Ninety-four references have been extracted from the 112 possible ones that are distributed in the following way according to the combination made: 23 for DCTT, 8 for DSTT, 38 for DCHE and 25 for DSHE.

Spain becomes the country that does the most digital competence research in the field of higher education, with 65 publications and 58.04%. The second and third place is for United Kingdom (7.14%) and Norway (6.25%). This information is presented in the next Figure.

Figure 3
Countries with highest scientific production



3.6. Document type

In the sixth study variable, we refer to the type of document, that is, if the publication format corresponds to a research article, a review article, a book, book chapter, congress communication or conference review; these having been all the possible categories found, as we can see in Table 7.

Tabla 7
Document type

Document type	DCTT	DSTT	DCHE	DSHE	Total	% de 112
	Results					
Article	18	6	22	18	64	57,14%
Review article	2	-	-	3	5	4,46%
Book chapter	-	-	3	3	6	5,36%
Conference paper	5	5	14	8	32	28,57%
Book	-	-	1	-	1	0,90%
Conference review	2	1	-	1	4	3,57%
Total:	27	12	40	33	112	100%

3.7. Publication area

Analyzing the seventh research variable, that is, the publication area where the references are indexed, we had as a result the inclusion of 11 different areas or fields of publication (Social Sciences, Psychology, Computational Sciences, etc.), as we can see more in detail in Table 8.

Since this variable did not attempt to measure the impact or relevance of the area, and given that the results are more grouped among the different areas mentioned, in this research variable the set of references found was included. In turn, it is worth mentioning that some references are indexed in more than one field, although, as one can see, research in Social Sciences predominates, which groups 73.1% of production.

Table 8
Publication area

Field	DCTT	DSTT	DCHE	DSHE	Total	% de 112
	Resultados					
Arts and Humanities	2	-	5	3	10	8,93%
Business, Management and Accounting	1	-	3	1	5	4,46%
Computer Science	10	4	20	12	46	41,07%

Decision Sciences	3	1	1	3	8	7,14%
Economics, Econometrics and Finance	-	-	2	-	2	1,76%
Engineering	-	1	2	1	4	3,57%
Mathematics	-	-	2	-	2	1,76%
Medicine	-	-	-	1	1	0,89%
Physics and Astronomy	-	-	1	-	1	0,89%
Psychology	4	1	1	-	6	5,36%
Social Sciences	21	8	28	25	82	73,21%

3.8. Most cited papers

Finally, the ninth variable that we held in consideration to analyze the impact of scientific production on digital competence refers to the extraction of the most cited articles in the Scopus database, that is, those that have been referenced in other works. Therefore, they can be considered as the most relevant in this area due to the endorsement they have received from the scientific community that has referenced them in their publications.

In line with the previous paragraph, to consider only the most relevant references, the fact that the reference should have at least two citations received in the Scopus database was established as a discriminatory limit.

In a more detailed way, we can see all this information in the following table, which includes the name of the authors, the year of publication, the title of the work, the location (journal, book, chapter ...) and the number of appointments received.

Table 9
Most cited papers

Author	Year	Title	Journal	Cites
Camacho, M., Guilana, S.	2011	From personal to social: Learning environments that work	<i>Digital Education Review</i> , (20), 24-36.	4
Dabrowski, M., Wiśniewski, J.	2011	Translating key competences into the school curriculum: Lessons from the Polish experience	<i>European Journal of Education</i> , 46(3), 323-334.	11
Evangelinos, G., Holley, D.	2014	A qualitative exploration of the EU digital competence (DIGCOMP) framework: A case study within healthcare education	Lecture Notes of the Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering, LNICST 138, pp. 85-92	2
Fernández-Cruz, F.-J., Fernández-Díaz, M.-J.	2016	Generation z's teachers and their digital skills	<i>Comunicar</i> , 24(46), 97-105	6

Gros, B., Garcia, I., Escofet, A.	2012	Beyond the net generation debate: A comparison of digital learners in face-to-face and virtual universities	<i>The International Review of Research in Open and Distributed Learning</i> , 13(4), 190-210.	12
Hepp K., P., Fernández, M.À.P., García, J.H.	2015	Teacher training: Technology helping to develop an innovative and reflective professional profile	<i>International Journal of Educational Technology in Higher Education</i> , 12(2), 30-43.	3
Jeffrey, L., Hegarty, B., Kelly, O., Penman, M., Coburn, D., McDonald, J.	2011	Developing digital information literacy in higher education: Obstacles and supports	<i>Journal of Information Technology Education</i> , 10(1), 383-413.	15
Joly, M.C.R.A., Da Silva, B.D., Da Silva Almeida, L	2012	Evaluation of teaching competencies for using digital technologies in communication and information	<i>Curriculo sem Fronteiras</i> , 12(3), 83-96	2
Leahy, D., Wilson, D.	2014	Digital skills for employment	<i>IFIP Advances in Information and Communication Technology</i> 444,178-189	3
Maderick, J.A., Zhang, S., Hartley, K., Marchand, G.	2016	Preservice Teachers and Self-Assessing Digital Competence	<i>Journal of Educational Computing Research</i> , 54(3), 326-351.	3
Masats, D., Dooly, M.	2011	Rethinking the use of video in teacher education: A holistic approach	<i>Teaching and Teacher Education</i> , 27(7), 1151-1162.	35
Mcnaught, C., Lam, P., Ho, A.	2009	The digital divide between university students and teachers in hong kong	ASCILITE 2009 - The Australasian Society for Computers in Learning in Tertiary Education pp. 654-664.	6
Mengual-Andrés, S., Roig-Vila, R., Mira, J.B.	2016	Delphi study for the design and validation of a questionnaire about digital competences in higher education.	<i>International Journal of Educational Technology in Higher Education</i> , 13(1), 1-12.	2
Peña-López, I.	2010	From laptops to competences: Bridging the digital divide in education.	<i>RUSC. Universities and Knowledge Society Journal</i> , 7(1), 21-33.	7
Pérez-Mateo, M., Romero, M., Romeu-Fontanillas, T.	2014	Collaborative construction of a project as a methodology for acquiring digital competences.	<i>Comunicar</i> 21(42), 15-23.	5
Pérez Escoda y Rodríguez Conde, M. J.	2016	Evaluation of the self-perceived digital competences of the Primary School Teachers in Castilla and Leon (Spain) .	<i>Rie-Revista de Investigacion Educativa</i> , 34(2), 399-415.	3

Scuotto, V., Morellato, M.	2013	Entrepreneurial Knowledge and Digital Competence: Keys for a Success of Student Entrepreneurship.	<i>Journal of the Knowledge Economy</i> , 4(3), 293-303	5
Tomte, C., Enochsson, A.-B., Buskqvist, U., Kårstein, A.	2015	Educating online student teachers to master professional digital competence: The TPACK-framework goes online.	<i>Computers & Education</i> , 84, 26-35.	6
Tomte, C.E.	2013	Educating teachers for the new millennium?	<i>Nordic Journal of Digital Literacy</i> , 8(01-02), 74-88.	2
Torres-Coronas, T., Vidal-Blasco, M.A.	2011	Adapting a face-to-face competence framework for digital competence assessment.	<i>Learning Tools and Teaching Approaches through ICT Advancements</i> (pp. 313-323). IGI Global.	2
Torres-Coronas, T., Vidal-Blasco, M.-A.	2015	Students and employers perception about the development of digital skills in higher education.	<i>Revista de educación</i> , 367(1), 63-89.	3
Valverde, J.	2014	MOOCS: A critical view from the Education Sciences.	<i>Profesorado. Revista de Currículum y Formación de Profesorado</i> , 18(1), 93-111.	2

4. Conclusions

The research on digital competence has established itself as one of the focal points of interest of several researchers a fact that has been demonstrated by conducting this investigation. Following the findings presented above, a number of implications on the impact of scientific production on the subject of digital competence as shown below are deducted:

The results show an increase in research on digital competence during the last years, being especially relevant the period that comprises the last five years (2013-2017), a stage in which 78.6% of the researches analyzed are concentrated. All this can be justified by the establishment of a new need of society that has been created in the era digitalis, where all citizens and, in particular, future teachers have to acquire a series of skills and abilities that enable them the active and precise development in the knowledge society (Rodríguez-García, Martínez y Raso, 2017). In this way, we understand that digital competence has regained a special relevance from a present time, so it becomes a hot topic in education and a thriving line of research.

There are several journals indexed in the database Scopus that have an established line of interest and research in digital competence. They emphasize especially journals which focus on a field related to technology, its impact on society, and thus, in education, in teacher training and the students themselves.

The authors who have more scientific production in the database analyzed, and therefore have contributed to scientific and academic knowledge in this field, come from Spain. In this regard, we have established several lines of research concentrated on the training of future teachers in digital competence, analyzing their digital skills or establishing improvement processes to acquire the skills necessary for proper development in society.

In line with this conclusion, one highlights a scientific production carried out in institutions of higher education in various Spanish provinces (Tarragona, Seville, Salamanca, etc.). This result supports, together with the previous stated above, that the country that is generating

greater scientific production, and whose investigations are forging a greater impact on the Scopus scientific community, is Spain. In fact, it has positioned itself in first place in the ranking of countries, accounting for 58.04% of the research generated on digital competence until today. However, even though Spain is the country that has done more research on this subject, most of the publications are written in English, not surprising if we consider that it is the most used language in scientific texts that have the greatest impact.

The publication area most noted for its higher level of digital competence references corresponds to research in Social Sciences, which picks up a 73.21% of the publications analyzed. However, it turns out to be a curious fact that the second publication area is computer science, especially when we are emphasizing the training of future teachers. However, it is understood that technology has created a large - scale impact on all societies, so it has become a focus of research that manifests itself in different areas.

Regarding keywords most used research gathered in their references, expected that " higher education " has been the most widely repeated, because this has been the focus of our research, as "digital competence ". Similarly, they have outstanding references convergence between the concepts concerning "education", "teacher training" and "teaching".

Finally, the articles that have generated more impact on the Scopus scientific community, that is, those who have received a greater number of citations, correspond to research conducted between 2009-2012, which is understandable because they have been available longer for consultation compared with others.

As we have shown, the study of digital competence has become a landmark today, worrying national and international agencies. In fact, in the latest Horizon (Adams -Becker et al., 2017) reported the formation of citizenship in this competence as one of the challenges to solve for full integration and utilization of technological potential in the field of education, both for skills improvement of future and current teachers (Torres-Coronas and Vidal Blasco, 2015) and for the implementation of new active learning methodologies based on the use of ICT (Aznar, Raso, Hinojo and Romero, 2017 ; Mingorance, Trujillo, Cáceres and Torres, 2017).

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1. Department of Didactics and School Organization. Faculty of Education. University of Granada (Spain). arodrigu@ugr.es

2. Department of Didactics and School Organization. Faculty of Education. University of Granada (Spain). iaznar@ugr.es

3. Department of Didactics and School Organization. Faculty of Education. University of Granada (Spain). caceres@ugr.es

4. Department of Didactics and School Organization. Faculty of Education. University of Granada. (Spain) gerardoacci@correo.ugr.es

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[\[Index\]](#)

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