La competencia digital del futuro docente: análisis bibliométrico de la productividad científica indexada en Scopus

The digital competence of the future teacher: bibliometric analysis of scientific productivity indexed in Scopus

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RESUMEN.
La competencia digital es una de las siete habilidades clave que cualquier ciudadano debe desarrollar al terminar la educación básica. Por su parte, los futuros docentes son los agentes esenciales que se van a encargar de desarrollar esa competencia en las generaciones futuras, por lo que poseer un gran nivel de competencia digital se ha convertido en un aspecto necesario para la sociedad del siglo XXI. En esta línea, la presente investigación tiene por objetivo analizar la producción científica de mayor impacto acerca de la competencia digital del futuro docente en la base de datos de Scopus. Para ello, se han considerado diez variables de investigación: año de publicación, publicaciones periódicas, autores, institución, país, tipo de documento, formato de publicación, áreas de conocimiento y artículos más citados. Por una parte, los resultados proyectan una línea de investigación que se encuentra en auge y cuya mayor producción científica se encuentra concentrada en el período 2014-2017. Por otra parte, aunque la temática ha sido estudiada a nivel internacional, España es el país que más investigación ha producido en esta línea, así como sus diferentes instituciones de Educación Superior. Finalmente, destaca una producción científica que se publica en revistas y en actas de congresos en formato artículo o de ponencia. Para concluir, se genera una visión ajustada del impacto de la investigación sobre competencia digital docente a nivel internacional en la actualidad para mostrarnos el estado de la cuestión.

PALABRAS CLAVE.
Competencia digital, docentes en formación, bibliometría, meta-análisis, Scopus, productividad científica

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ABSTRACT.
Digital competence is one of the seven key skills that any citizen must develop by the end of basic education. For their part, future teachers are the essential agents who will be responsible for developing that competence in future generations, so have a high level of digital competence has become a necessary aspect in the 21st society. In this line, the present research aims to analyze the scientific production with the greatest impact on the digital competence of the future teacher in the Scopus database. For this purpose, ten research variables have been considered: year of publication, source titles, authors, institutions, countries, document types, publication format, areas of knowledge and most cited articles. On the one hand, the results projected a research line that is booming. On the other hand, although the topic has been studied internationally, Spain is the country that has produced most research in this line, as well as its different institutions of Higher Education.

KEY WORDS.
Digital competence, teacher training, bibliometry, meta-analysis, Scopus, scientific production

1. Introduction.

The study of the digital competence has become a focal point that has created a special interest in the scientific community. This assertion can be observed through the numerous publications that have risen up on that topic, both in the national outlook (Ágreda Montoro, Hinojo Lucena & Sola Reche, 2016; Gutiérrez Castillo, Cabero Almenara & Estrada Vidal, 2017; Hervás Gómez, Real Pleah, López Mata & Fernández Márquez, 2016; Saorín *et al.,* 2017) and in the international one (Chan, Churchill & Chiu, 2017; Instefjord & Munthe, 2017; Roffeei, Kamarulzaman & Yusop, 2016; León-Urrutia, Cobos & Dickens, 2018; Ramírez Hernández & Maldonado Berea, 2015; Trejo-Quintana, 2017), especially after the proclamation of the digital competence as one of the basic skills to develop by every citizen once they have finished the basic levels according to the European Commission Recommendation 2006/926.

The digital competence, therefore, has become a key aspect for the teacher training that is demanded in the 21st century society (Reche, Martín y Vilches, 2016; Rodríguez-García, Martinez Heredia & Raso Sánchez, 2017). In this way, the teachers are in charge of training the future generations, therefore, they have in their hands a big responsibility to promote a quality training referring to their students' digital competence. We understand, then, that having a high teacher training in digital competence has to feed back into the projection of a training improvement and of an innovative character in the use, inclusion, management and critical use of the TIC (Pérez Escoda & Rodríguez Conde, 2016).

For this essential reason, from several national and international organizations were concerned to find a valid answer towards the delimitation of the term "digital competence", through the establishment of different indicators that intended to concrete each of the areas and dimensions it was composed of. With such purposes turned up a series of documents that have had an exponential relevance for the study of the digital competence and, more specifically of this topic applied to the future teachers. In this moment we are speaking about the TIC competence Standards for teachers proposed by UNESCO (2008), the DIGCOMP

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project (Ferrari 2013), the Common European Framework of digital teaching competence from the National Institute of Teaching Technologies and Teachers' Training (INTEF, 2017) or the Autodiagnosis of digital competences IKANOS from the Basque Institute of Qualifications and Professional Training (2014). All of them agreed with delimiting in detail each of the areas, dimensions, competences, skills, attitudes, abilities… that comprise the digital competence.

Despite not having unanimity either in the naming or the existence of an only Reference Framework, from our point of view and following the instructions of INTEF (2017), as well as the DIGCOMP project (Ferrari 2013), the main areas that comprise the digital competence would be five: information and informational literacy; communication and collaboration; creation of digital content; safety and problems resolution.

However, in that way searching to know more about the status of the issue, a curiosity came up that led us to wonder: *What impact is the research about the digital competence of the future teacher having in the scientific world?, Who are the authors, institutions and countries studying this topic?, Is it a productive research line?, what language are the results published in?...* To these and other questions we will give an answer in the next paragraphs.

2. Methodology.

The research we are carrying out is aimed to analyze the greatest impact of scientific production about the digital competence of the future teacher, following the action dynamics presented in other similar researches (López- Meneses, Vázquez-Cano & Román, 2015; Mengual–Andrés, Vázquez–Cano & López–Meneses, 2017). For this purpose, an accurate study of meta-analysis has been followed (Hernández Sampieri, Fernández Collado & Baptista Lucio, 2016) due to its suitability to give an answer to this kind of researches. At the same time, the quality indicators considered essential for the systematic reviews have been taken into account (Urrutia & Bonafill, 2010).

For this task ten research variables have been selected. We'll define them below:

- *Year of publication*: the moment the work was published.
- *Periodic publications*: we refer to the files origin (what books, what magazines, etc.).
- *Authors:* mentioning those authors who have a widest scientific production about the digital competence of the future teacher.
- *Institution:* finding out about the organizations that have a widest scientific production in the topic.
- *Country*: answering the question about the countries that have focused on this research.
- *Document type*: if we are referring to articles, book chapters, books, newspaper articles, etc.
- *Publication format:* if it is a research published in a book, magazine, etc.
- *Publication area:* Social Science, Computer Science, Engineering, Psychology, Arts and Humanities, etc.
- *Publication language*: referring to the language researches are written in.
- *Most cited articles*: mentioning the articles that have had a greatest impact in the scientific community.

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For this aim, the indexed publications in the Scopus database with acknowledged international prestige have been taken as a reference. Later, the most suitable key words were selected to respond to our research aim through ERIC Thesaurus. These were: "digital competence"; "digital skills"; "digital literacy" and "digital training (to refer to the training teachers).

The searching date started in September 2017 and finished in October 2017, moment in which a second search was made to guarantee the inclusion of those results that, because of any casuistry, hadn't been present in the initial research. Three different searches were made joint together with the connector "and": "digital competence" and "teacher training"; "digital skills and "teacher training" and "digital literacy" and "teacher training", opening the research field to the turning up of such concepts in the title, abstract or key words, and establishing a period of research from the creation of the database until now.

Finally, to make those more relevant results that contribute to a greatest impact about the scientific production in digital competence of the future teacher public, the following inclusion criteria were established (Table 2).

Table 1: Inclusion criteria.

Variable	**Criterion**
Year of publication	All the research works were considered
Periodic publications	They must have at least two references on the subject
Authors	They must have at least two references on the subject
Institution	They must have at least two references on the subject
Country	They must have at least two references on the subject
Document type	All the research works were considered
Publication format	All the research works were considered
Publication area	All the research works were considered
Publication language	All the research works were considered
Most cited articles	They must have at least two or more references

3. Results.

The sum coming from the results extracted through the three combined searches (Table 1) has given as a result a total of 76 documents (books, books chapters, articles, review articles, communications, lectures, etc.) indexed in the Scopus database. As can be seen in the table below, the biggest quantity of extracted references comes from the two first combinations: "Digital literacy" and "Teacher training", from now on DLTT, with a total of 31; and "Digital competence" and "Teacher training" (DCTT). Investigators have used the term "digital skills" to refer to the Education competences of the future teacher (13 out of 76) to a less extent.

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Table 2: Obtained results.

Combination	References found
"Digital literacy" and "Teacher training" (DLTT)	31
"Digital competence" and "Teacher training" (DCTT)	32
"Digital skills" and "teacher training" (DSTT)	13
Total	76

In the next figure we can see the percentage of each of the combined searches regarding to the analyzed references.

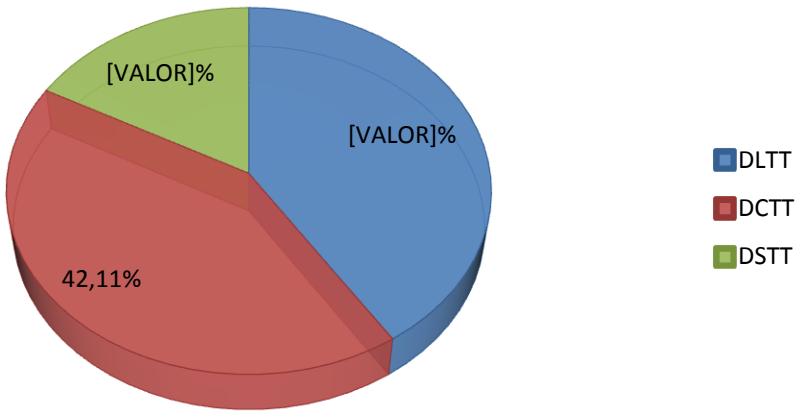

Figure 1: Percentage of the references belonging to each combination.

In Table 3 the obtained data according to the variable *year of publication* are presented for each of the combined searches, as well as the total for every year and percentage according to the total found references. We can see in it that the greatest scientific production is placed in 2016 and that the greatest concentration of publications appears in 2015–2017.

Table 3: Year of publication.

Year	Combination			Total	% of 76
	DLTT	*DCTT*	*DSTT*		
2003	1	-	-	1	1,31%
2004	-	-	-	-	
2005	-	1	-	1	1,31%
2006	1	-	-	1	1,31%
2007	2	1	-	3	3,95%
2008	2	-	-	2	2,63%
2009	-	-	-	-	-
2010	6	1	-	7	9,21%
2011	1	3	-	4	5,26%
2012	3	2	-	5	6,57%
2013	1	2	1	4	5,26%
2014	2	1	1	4	5,26%
2015	3	5	1	9	11,84%
2016	3	10	8	21	27,63%
2017	6	6	2	14	18,42%

In a visual way, in the following figure we collect the evolution that the study about the study of the digital competence in the future teachers has had from its beginning up to now.

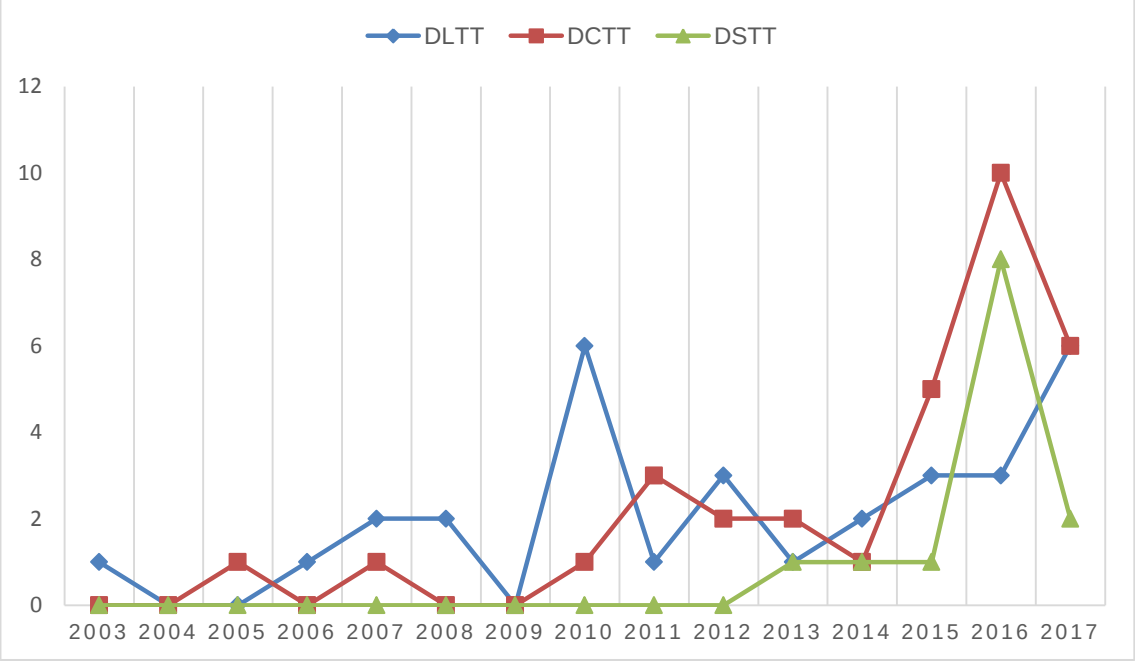

Figure 2: Evolution of the research on the digital competence of the future teacher.

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Regarding the variable which the periodic publications refer to, in the table above each of the titles corresponding to the references where the selected works in this research are, are presented. We can observe in it that *The Nordic Journal of Digital Literacy* is the one with more publications about the topic.

Table 4: Periodic publications.

Periodic publications	Combination			Total	% of 76
	DLTT	***DCTT***	***DSTT***		
Ceur Workshop Proceedings	3	-		3	3,95%
Communications in Computer and Information Science	2	-		2	2,63%
Nordic Journal of Digital Literacy	2	2		4	5,26%
Revista de Educación	2	-		2	2,63%
Profesorado	-	3		3	3,95%
IFIP. Advances in Information and Communication Technology	-	2		2	2,63%
Ocnos	-	2		2	2,63%
RUSC. Universities and Knowledge	-	2		2	2,63%

Regarding to the variable *Authors* in Table 5 we can observe those who have a higher number of references about digital competence in the future teachers, classifying the results according to the combined research.

Table 5: Author

Author	Combination			Total	% of 76
	DLTT	***DCTT***	***DSTT***		
Torrego Egido, L.	2	-		2	2,63%
Gutiérrez Martín, A.	2	-		2	2,63%
Palacios Picos, A.	2	-		2	2,63%
Tømte, C. K.	-	3		3	3,95%
Hardesen, B.	-	2		2	2,63%
Villalustre, L.	-	2		2	2,63%
Cabero Almenara	-	2		2	2,63%

In table 6 the results of the variable *Institution* are presented. In spite of observing a big variability in the organizations that study the digital competence in the future, we can easily work out that The University of Salamanca on the first place, the University of Granada on the second place and the Universities of Sevilla and Valladolid on the third place are the institutions that concentrate a higher scientific production about the topic in the Scopus database.

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Table 6: Institution.

Institution	Combination			Total	% of 76
	DLTT	*DCTT*	*DSTT*		
University of Valladolid	3	-	-	3	3,95%
University of Granada	3	2	-	5	6,57%
Hannam University	2	-	-	2	2,63%
University of Salamanca	-	4	2	6	7,89%
University of Sevilla	-	3	-	3	3,95%
The Norwegian Centre for ICT in Education	-	2	-	2	2,63%
University of Oviedo	-	2	-	2	2,63%
University Rovira I Virgili	-	2	-	2	2,63%

Regarding to the variable that deals with the *Country* of research, in Table 7 we can observe four main countries that are investigating about this topic in our national outlook. We also present a figure corresponding to the percentage of each country regarding the total analyzed references.

Table 7: Country.

Country	Combination			Total	% of 76
	DLTT	*DCTT*	*DSTT*		
Spain	9	20	8	37	48,68%
Hungary	2	-	-	2	2,63%
South Korea	2	-	-	2	2,63%
Norway	2	7	-	9	11,84%
Sweden	-	2	-	2	2,63%

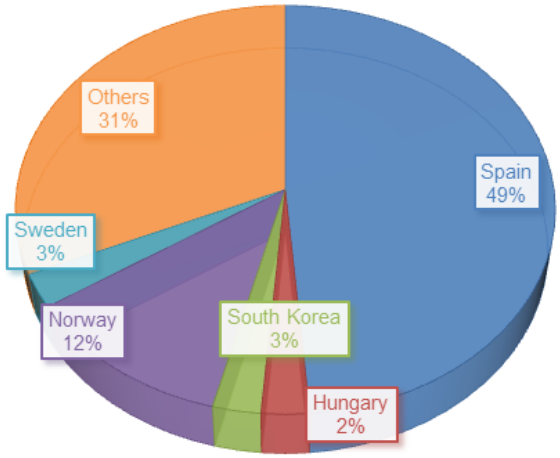

Figure 3: Country of publication.

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On the other hand, referring to the *Document type*, in the table above they are presented classified according to the function in the combination used and the type of document analyzed: article, conference paper, conference review, review article, newspaper article and book chapter.

Table 8: Document type.

Document type	Combination			Total	% out of 76
	DLTT	***DCTT***	***DSTT***		
Paper	16	22	6	44	57,89%
Conference Paper	7	5	5	17	22,37%
Conference Review	3	2	1	6	7,89%
Review	3	2	-	5	6,57%
Newspaper article	1	-	1	2	2,63%
Book chapter	1	1	-	2	2,63%

As we can see in the following figure, the biggest part of the analyzed documents corresponds to articles. On the second place the conference papers stand out, and on the third place the conference reviews do.

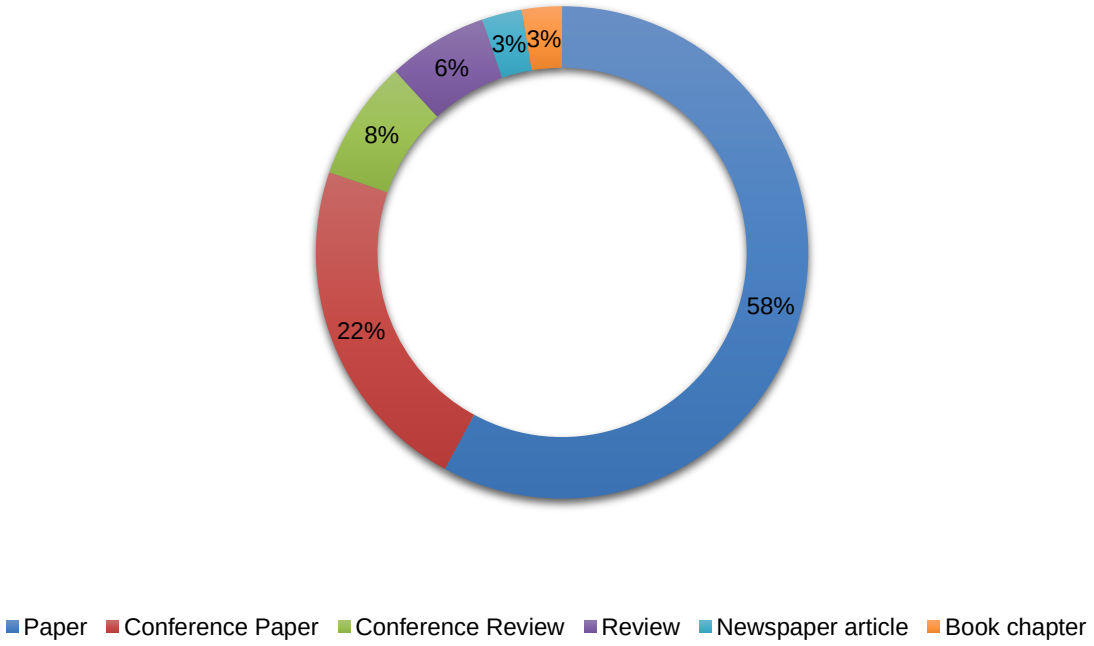

Figure 4: Publication type.

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In the following table, following the previous result, the results referred to *Publication format* are presented. The most found format, obviously, is the Scientific Journals, followed by the publications derived from conferences.

Table 9: Publication format.

Publication format	**Combination**			**Total**
	DLTT	***DCTT***	***DSTT***	
Journals	20	25	8	53
Conference Proceedings	7	3	4	14
Book Series	3	3	1	7
Book	1	1	-	2

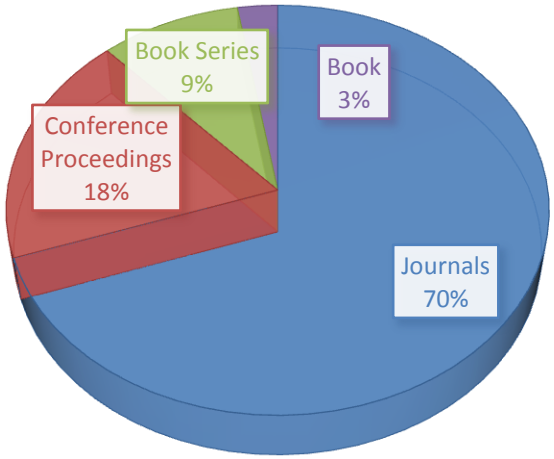

Figure 5: Publication format.

Regarding to the *Publication area*, as we can see in Table 10, the study area in Social Science stands out. Besides, the production of Computer Science area stands out.

Table 10: Publication area.

Publication area	**Combination**			**Total**	**% out of 76**
	DLTT	***DCTT***	***DSTT***		
Social Sciences	22	25	8	55	72,37%
Computer Science	14	11	5	30	39,47%
Decision Sciences	3	3	1	7	9,21%
Arts and Humanities	2	3	-	5	6,57%
Business, Management and Accounting	1	2	-	3	3,95%
Engineering	1	-	1	2	2,63%
Psychology	-	5	1	6	7,89%

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Referring to the *Publication language,* a scientific production that is mainly written in English, stands out. Nevertheless, the Spanish language appears as the second more used language to write about the topic, as we can see in Table 11 and Figure 6.

Table 11: Publication language.

Publication language	Combination			Total
	DLTT	***DCTT***	***DSTT***	
English	24	23	7	54
Spanish	7	11	5	23
Portuguese	1	-	1	2
Slovak	1	-	-	1

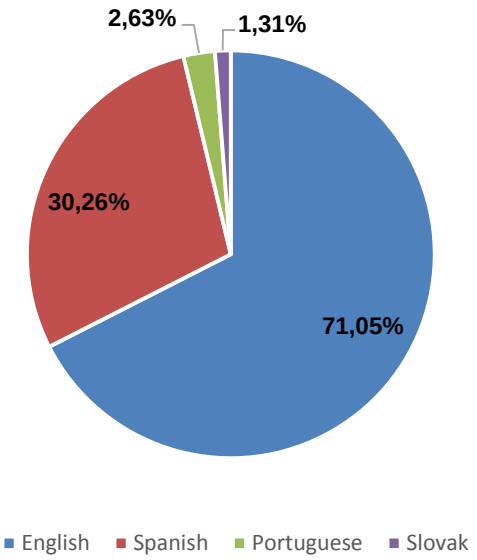

Figure 6: Publication language.

Last, referring to the variable that studies *The most quoted articles*, and to present each of the references and citations more clearly, we explain the results given distinguishing among the used searches.
In this line, as a result of the combination *DLTT* (*Digital Literacy and Teacher Training)*, the following references have been obtained:

Table 12: Most cited articles - DLTT

Reference	Citations
Sánchez, J., & Salinas, A. (2008). ICT & learning in Chilean schools: Lessons learned. *Computers & Education*, *51*(4), 1621-1633.	27
Uzunboylu, H. (2006). A review of two mainline e-learning projects in the European Union. *Educational Technology Research and Development*, *54*(2), 201-209.	22
Kirschner, P., & Davis, N. (2003). Pedagogic benchmarks for information and communications technology in teacher education. *Technology, Pedagogy and Education*, *12*(1), 125-147.	12
Prendes-Espinosa, M. P., Castañeda-Quintero, L., & Gutiérrez-Porlán, I. (2010). ICT competences of future teachers. *Revista Comunicar*, *18*(35), 175-182.	10
Turcsányi-Szabó, M. (2012). Aiming at sustainable innovation in teacher education-from theory to practice. *Informatics in Education*, *11*(1), 115-130.	9
Chik, A. (2011). Digital gaming and social networking: English teachers' perceptions, attitudes and experiences. *Pedagogies: An International Journal*, *6*(2), 154-166.	6
Martín, A. G., Picos, A. P., & Egido, L. T. (2010). School teacher training and ICT integration in education: anatomy of a mismatch. *Revista De Educacion*, *353, 267-293*.	5
Cortina-Pérez, B., Gallardo-Vigil, M. Á., Jiménez-Jiménez, M. Á., & Trujillo-Torres, J. M. (2014). Digital illiteracy: a challenge for 21st century teachers/El analfabetismo digital: un reto de los docentes del siglo XXI. *Cultura y Educación*, *26*(2), 231-264.	4

Referring to the combination *DCTT (Digital Competence and Teacher Training)*, the results have been:

Reference	Citations
Masats, D. & Dooly, M. (2011). Rethinking the use of video in teacher education: A holistic approach. *Teaching and Teacher Education*, *27*(7), 1151-1162.	38
Dąbrowski, M. & Wiśniewski, J. (2011). Translating Key Competences into the School Curriculum: lessons from the Polish experience. *European Journal of Education*, *46*(3), 323-334.	11
Tømte, C., Enochsson, A. B., Buskqvist, U. & Kårstein, A. (2015). Educating online student teachers to master professional digital competence: The TPACK-framework goes online. *Computers & Education*, *84*, 26-35.	8
Fernández-Cruz, F. J. & Fernández-Díaz, M. J. (2016). Generation Z Teachers and their Digital Skills. *Comunicar, 24*(46), 97-105.	7
Hardersen, B. & Guðmundsdóttir, G. B. (2012). The digital universe of young children. *Nordic Journal of Digital Literacy*, *7*(3), 221-226.	6
Pérez Escoda, A. & Rodríguez Conde, M. J. (2016). Evaluation of the self-perceived digital competences of the Primary School Teachers in Castilla and Leon (Spain). *RIE-Revista de Investigación Educativa*, *34*(2), 399-415.	3
Hepp, P., Fernández, M. À. P. & García, J. H. (2015). Teacher training: technology helping to develop an innovative and reflective professional profile. *International Journal of Educational Technology in Higher Education*, *12*(2), 30-43.	3
Maderick, J. A., Zhang, S., Hartley, K. & Marchand, G. (2016). Preservice teachers and self-assessing digital competence. *Journal of Educational Computing Research*, *54*(3), 326-351.	3
García-Pérez, R., Rebollo-Catalan, A. & García-Pérez, C. (2016). The relationship between teacher training preferences and their digital skills on social networks. *BORDON-Journal of Pedagogy*, *68*(2), 137-153.	2
Tømte, C. E. (2013). Educating Teachers for the New Millennium?. *Nordic Journal of Digital Literacy*, *8*(01-02), 74-88.	2

Lastly, through the *DSTT (Digital Skills and Teacher Training)* third combination, although fewer than in the previous ones, the following results have been derived considering the

inclusion criteria. In this case, the studies of Fernández-Cruz and Fernández-Díaz (2016) are repeated with seven citations in this database; inquiries of Pérez Escoda and Rodríguez Conde (2016) with three citations; and, finally, the work of García-Pérez, Rebollo-Catalán and García-Pérez (2016).

4. Discussion and conclusions.

The research of the greatest impact on digital competence of the future teachers in the Scopus database has been exposed through this research. As it can be observed, the study of the digital competence in this population has become a powerful research line today, given the need to train highly capable teachers with regards to digital issues (Rodríguez-García, Martínez Heredia & Raso Sánchez, 2017).

We have managed to capture specific dyes on the international research overview in digital teaching competence, restricting our attention to ten research variables. At this point, it should be noted that no similar studies on this topic have been conducted, but the one presented here follows the line of other similar studies, such as those carried out by Fernández & García (2017); López-Meneses, Vázquez-Cano & Román, 2015; Mengual-Andrés, Vázquez-Cano & López-Meneses, 2017; Olmedilla *et al.* (2017); or Villena Serrano, Zagalaz Sánchez, Castro López & Chacón Zagalaz (2017). All of them, like ours, come to bring substantial insight about the research overview in an area and in a particular topic.

The different tendency lines that show us the evolution of the research on the digital competence of the future teacher affirm the existence of a research field totally in boom; fact that has been motivated by the incessant evolution of technology and our continuous contact with it (Aznar Díaz, Raso-Sánchez, Hinojo-Lucena & Romero Díaz de la Guardia, 2016; García & Veyita, 2018; Galván-Fernández, Rubio-Hurtado, Martínez-Olmo & Rodríguez-Illera, 2017). It is therefore established as a powerful research line that concentrates the greatest number of its works in the last three years. In this line, it is worth mentioning the notable impulse that this research showed from the year 2009, when the published works began to multiply. Something that is not surprising if we consider that in the year 2008 it was published the first instrument measuring digital competence by UNESCO (2008) and only three years after the indications given by Europe in its Recommendation 2006/962.

As for the periodical publications that most research have enacted on the digital teacher training competence in the Scopus database have been the *Nordic Journal of Digital Literacy* (*JRS; SCImago Journal & Country Rank*), the Profesorado Journal (*Emerging Sources Citation Index*; *SJR; SCImago Journal & Country Rank*) and the papers published in *Ceur Workshop Proceedings*. It is not surprising, therefore, that the document type that has been most present in the bibliography analyzed was the article (57.89%), after the communications and papers (22.37%). At the same time, the majority of research in this field has been shown to be found in journals (70%) or in Conference Proceedings (18%).

If we refer to the national and international geography of the research on the digital competence of the future teacher it is easily detected that Spain is located as the leading country in this research field, producing a total of 49% of the research indexed in Scopus. To a lesser extent Norway stands at 11.84% and Hungary, Sweden and South Korea at 2,63% respectively. In this way, we deduce that the great attention focus is located in Spain, place

where different research lines are worked interested in investigating the impact of the digital competence in the training of future teachers. In this particular subject, the University of Salamanca has positioned itself as the Spanish institution that most references contains in the analyzed database (7.89%), followed by the University of Granada (6.57%) and the Universities of Valladolid and Sevilla, with 3.95% respectively. Therefore, we understand that in these universities the authors most concerned about the inquiry on this issue work. Despite this data, English has been set up as the preferred publication language on this research topic (71.05%).

As for the authors, the contributions of Cathrine Tømte of the *Nordic Institute for Studies in Innovation, Research and Education* (Oslo) highlight, firstly, positioning herself as the author who has most published in Scopus on this issue. The other authors who have published two references on the topic have been: Luis Torrego Egido and Andrés Palacios Picos of the University of Valladolid (Spain), Alfonso Gutiérrez Martín of the University of Segovia (Spain), Julio Cabero Almenara of the University of Sevilla (Spain), Lourdes Villalustre Martínez of the University of Oviedo (Spain), for example.

On the other hand, the large part of the research on digital competence of the future teacher is presented in article format (67.09%) so the journals are the publication format preferred by the authors interested in the topic (70%). They highlight, in turn, the several contributions that have been presented to Conferences during last years (30.26% of the research works), fact that demonstrates the boom aroused in the study of the digital competence. In this line, the Conference Proceedings have been positioned as the second most-published publication format by the authors (18%) and, to a lesser extent, research works have been carried out published as books or book chapters. Although focused on other topics, López-Meneses, Vázquez-Cano and Román (2015), as well as Mengual-Andrés, Vázquez-Cano and López-Meneses (2017) have similar results.

It is therefore not surprising that the citizens' digital competence, in general, and of the future teachers, in particular, has become an issue that has attracted the interest of several international agencies. In fact, the latest Horizon report (Adams *et al*., 2017) continues to mention digital competence as one of the outstanding topics in the field of Higher Education. Moreover, this scarce digital competence of the future professionals of different fields affects and hinders the adoption of new challenges to adopt technology in the classrooms and in the teaching-learning processes. Therefore it is necessary to implement, in turn, methodologies that promote the acquisition of this series of competences (Mingorance Estrada, Trujillo Torres, Cáceres Reche & Torres, 2017).

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