TEACHERS’ DIGITAL COMPETENCE: BIBLIOGRAPHIC ANALYSIS OF THE PUBLICATIONS OF THE WEB OF SCIENCE SCIENTOMETRIC DATABASE

Abstract. With the Online Emergency Remote Teaching (OERT) practices emerged during the outbreak of the pandemic, teachers’ digital competence (TDC) has gained growing attention in educational ICT research realm. In view of this context, the present review study aimed at illuminating the current state of TDCs literature by identifying the volume, growth trajectory, geographical distribution of TDC research. It also aimed at mapping highly influential TDC scholars, documents, and journals. Retrieved from the educational research category in the Clarivate Analytics Web of Science (WoS) core collection database, the metadata of 406 articles were analyzed by employing bibliometric performance and science mapping techniques in VOSviewer 1.6. The timeframe for the study was the last two decades (from 2002 to 2021). Findings illustrated that there has been a growing increase in the number of studies focusing on TDCs. This increase is more evident in the Covid-19 pandemic period, particularly in the last two years. More specifically, more than half of all studies were published in the years 2020 and 2021. Findings also illustrated that there is a dominance of Spanish scholars and organizations in TDC research since 2 out of every 3 studies were carried out by researchers affiliated to Spanish Universities. Additionally, co-citation analysis purported the intellectual structure of TDC knowledge base by identifying the most influential authors and documents. Finally, co-occurrence analysis revealed the concept analysis topical foci of TDC research. These topics are concentrated on “teachers’ digital competence”, “higher education studies”, teacher training programs”, and “ICT in education”. As a result, based on the findings of the study some recommendations were proposed that will contribute into the ICT research community by reflecting the intellectual structure of existing TDC research, thus highlighting the future research direction.

Keywords: digital competence; teachers; TDC; teacher training; science mapping; bibliometric analysis.

1. INTRODUCTION

The problem statements. Teachers Digital Competence (hereinafter referred to as TDC) has a pivotal role in the construction of 21st century society, and thus it is a key competence that teacher training programs should incorporate. In line with this, there is a growing interest in TDC in the last two decades. The concept of digital competence was first documented in the “2006 Recommendation of the European Parliament and of the Council”, and it has been listed as one of the eight key competences that individuals should master to become effective and active citizens in the digital age [2], [3]. Particularly in the field of education, TDCs have become prominent with the publication of “The European Framework for the Digital Competence of Educators” (DigCompEdu) in 2017 [4]. The DigCompEdu framework has become a reference document for policy makers and researchers in the field of education in European and pro-European countries. In line with this context, “Digital Education at School in Europe Report” well documented that in nearly two-thirds of 43 countries, including Spain,
Norway and Ukraine, TDC is a core competence that teachers should master by the end of teacher training programs [5]. More recently, with the OERT practices implemented during the Covid-19 pandemic, TDCs have become under scrutiny as never before [6], [7].

**Analysis of recent studies and publications.** There is an established research literature on TDC, and it is growing at a fast and steady pace as mentioned previously. The rapid increase in the volume and diversity of digital competence research is also evident in the previous review studies [1], [8] - [13]. However, rather than presenting a broad picture of TDCs, these studies are mainly focusing on teacher training and higher education area, [1], [8], [10], [12] - [14], and some other specific areas like science teaching and ICT [10], online courses and SPOC (the small private online courses) [9], preschool and nursery [11], and teachers’ digital competence [14]. Amongst them, there is only one review study focusing on TDCs conducted by [14], yet it is limited in contextual and geographical coverage since it only covers the publications in six prestigious educational sciences journals in Spain between 1983-2019. Another limitation of the previous review studies is that the number of included papers is very low varying from 56 to 286, except for the study by [9] focusing on online courses and SPOC and including 677 studies. Thus, there is a need for comprehensive review studies on TDC research that will include update studies and cover more studies to present a global perspective on TDC research.

There are three features that distinguish the present study from the previous review studies aiming at mapping TDCs research literature. First, it maps the TDC literature from the birth of the concept of digital competence to its current state, including the recent increase in volume of studies due to the Covid-19 pandemic period. Second, unlike the previous studies, the present study addressed the general teacher competences by including the keywords "digital competence" AND "teachers". Finally, it covers larger number of journal articles than used in past reviews of TDC literature. It also highlights the current state of intellectual structure of TDC knowledge base unlike the previous reviews. Despite the previous review studies addressing TDC research, there is a need for periodical review studies that will contribute in TDC literature in order to develop its theoretical and practical aspects. On the theoretical side, the present review will provide a better understanding of the TDC literature by highlighting the intellectual structure of the TDC literature. On the practical side, it will help researchers to identify research trends in TDC knowledge base and will also shed light policy makers to address TDCs as a core competence in teacher training programs.

The **present study aimed at** reviewing the publications between 2001-2021 on teachers’ digital competence included in the Web of Science by employing bibliometric analysis method. Thus, the following research questions (RQ) were addressed within the scope of the study:

RQ1: What is the volume and distribution of the relevant studies (a) by years (2002-2021), (b) by authors (authors with at least five articles), (c) by organizations (organizations with at least 10 studies), (d) by countries (top 10 countries that have the highest study count) (e) by journals (top 10 journals with the highest published study count)?

RQ2: What authors and documents have the greatest influence on TDC literature over the past two decades?

RQ3: What are the topical foci of the TDC literature over the past two decades?

The first two (RQ1 and RQ2) provide a broad but clear picture of the state-of-the art of the TDC studies, which will help researchers to better understand the growth volume and trajectory of the TDC literature. Likewise, RQ3 will provide insightful results for researchers and policy makers to identify research trends and gaps, as well as setting future research and policy directions.
2. RESEARCH METHODS

The present study employed bibliometric analysis as a methodological approach in order to identify research evolution in TDC literature. The rationale for employing bibliometric analysis is that it allows researchers to explore, classify and analyze a large body of scientific output on a specific research topic by making it possible to retrieve entire collection of research from an objective, quantitative perspective, and evaluate the growth of literature and scientific exquisite in a particular research realm [15]. A bibliometric analysis reviews and discloses entire collection of studies in a specific area without any intervention of researcher caused biases [16]. In the basic bibliometric content analysis, researchers adopted descriptive statistics to present the “topographical” developments in knowledge base. Yet in time bibliometric analysis tools have transformed into more powerful tools that enable more comprehensive analysis including structural identification of knowledge base and advanced citation analysis tools based on social network analysis [17], [18]. In line with this the present study employed both descriptive and advanced bibliometric analysis strategies in the present review.

2.1. The Procedure

Prior to identifying the studies to be included in the bibliometric analysis, a number of inclusion and exclusion criteria were established. The inclusion criteria of the study were identified as: (1) Studies that have been published between 2001 and 2021 and in journals included in the indexes within the scope of WoS, (2) Studies under Education and Educational research category in WoS, (3) Published articles, (4) Studies published in the journals indexed in the SSCI, ESCI, SCI-E and AHCI indexes. On the other hand, the exclusion criteria were: (1) Studies published before 2000 and in 2022, (2) Studies conducted in some fields other than Education and Educational research, (3) Studies other than articles (books, book chapters, conference papers, dissertations, etc.), (4) Publications in the journals indexed other than SSCI, ESCI, SCI-E and AHCI indexes.

![Figure 1. PRISMA flow chart of identification and selection of studies included in the bibliometric analysis](image-url)
The search was conducted by entering TS= (digital competence AND teachers) in the topic search filed under the document search interface of WoS core collection. The preliminary search resulted in 831 studies. After the application of inclusion and exclusion criteria, a total of 406 studies were obtained, published between 2001-2021 in the education and educational survey categories and indexed in SSCI, ESCI, SCI-E and AHCI. Bibliometric data of these 406 studies formed the dataset of this study. Figure 1 illustrates the flow chart of the PRISMA statement [19], which depicts the process of the identification and the inclusion of the studies to be included in bibliometric analysis.

2.2. Data Extraction and Analysis

Data analysis is two strands. In the first strand, the descriptive bibliometric analysis has been conducted with the MS excel output of the "analyze results" tool in the WoS database. The excel file and analyze results menu in the WoS data base was used to identify the research trends (i.e., distribution of publications by years, authors, countries, and journals) without any intervention of the researchers.

In the second strand, the studies accessed via the WoS database for the bibliometric analysis were downloaded by selecting "full record and cited references" and "tab delimited file" under the "export" menu. The analysis of bibliometric data of the 406 studies was carried out by uploading all the records to the VOSviewer 1.6 software. In order to identify the most influential authors, documents and journals, the author co-citation analysis (ACA), document co-citation analysis (DCA), sources co-citation analysis (SCA) were conducted in VOSviewer 1.6. [20]. Additionally, in order to identify the topical trends in TDC literature co-occurrence of common keywords analysis was employed.

3. THE RESULTS AND DISCUSSION

3.1. Performance Analysis

3.1.1. Publication Trends by Year

As the distribution of the relevant publications by year is examined, we identified that there is a sharp increase in the number of publications particularly as of 2017, and this increase has been exponential especially after 2019. As can be seen in Figure 2, the number of the studies focusing on the TDCs was the highest in 2021. A total of 122 publications in 2021 counted for 30% of the total publications. On the other hand, the lowest number of studies were published in 2006 (0.2%) with only one publication. In addition, no publications were identified before 2006 in the descriptive analysis.

The first stream of the growth in the TDC literature can be linked with the publication of the DigCompEdu in 2017 [8]. DigCompEdu is an influential policy document in the realm of teachers’ digital competence. On the other hand, there is an exponential increase after 2019 and this can be noted as the second stream of growth. Thus, this increase can be attributed to teachers’ widespread use of online, distance and digital education tools within the OERT practices that were put into practice due to the outbreak of Covid-19 pandemic. Consequently, the TDCs have been under debate and discussion as never before.
3.1.2. Top Performing Authors in TDC Literature

The author distribution was accessed through the "analyze results" menu in the WoS database to present the distribution of the relevant publications by authors. Figure 3 shows the distribution of authors that have five or more publications within the 406 studies reviewed within the scope of bibliometric analysis.

As can be seen in Figure 3, amongst the top performing authors in TDC literature, Guillien-Gamez F. D. (f=12, 3%), Cabero-Almenara J. (f=11, 3%), Palacios-Rodriguez A. (f=10, 2.5%) and Mayorga-Fernandez M. J. (F=8, 2%) outperformed all other authors. Those four authors have made some significant contributions into the development of TDC literature since they have produced 41 papers (10%) out of 406 publications in TDC literature. On the other hand, Lopez-Belmonte J., Mcgarr, O., and Rodriguez-Garcia, A. M. (f=15, 1.2%) were the bottom of our list although they produced at least five publications. All these top performing authors are very important for novice researchers interested in the TDC research realm since they have produced a significant number of publications that will provide a clear and updated picture of the TDC research. Although these are the authors with most study counts, this does not mean that they are the most influential authors. In the following sections we conducted authors co-citation analysis (ACA) the results of which can be a stronger indicator for the most influential authors in TDC literature.
3.1.3. Publications by Organizations (with at least 10 publications)

In order to identify the distribution of the relevant publications by organizations, the corresponding authors’ affiliations were accessed through analyzing the bibliometric data of 406 studies included in the bibliometric analysis. Figure 4 illustrates the distribution of organizations that have 10 or more publications.

With a closer look at Figure 4, when the top performing organizations in the TDC research realm are examined, there is a dominance of Spanish universities in the list. The University of Granada with a total of 27 publications (7%) outperformed all other organizations in the list. The only non-Spanish organization in the list is the Institute for Digitalisation of Education of the National Academy of Educational Sciences of Ukraine with a total of 13 publications, thus taking the fifth place in the list. On the other hand, the lowest number of publication counts were by the Complutense University of Madrid (f=10, 2.5%) and Internacional de la Rioja Unir (f=10, 2.5%).
3.1.4. Publications by Countries (the top 10 countries with the highest study count)

The distribution of the publications by countries was accessed through the "analyze results" menu in the WoS database. Figure 5 illustrates the distribution of 406 studies included in the bibliometric analysis by the top 10 countries with the highest number of study counts.
As can be seen in Figure 5, Spain, Norway and Ukraine were the top performing countries in TDC research. Spain solely produced 250 publications out of 406 studies, and this means more than half of all publications (62%) were produced by Spanish scholars and organizations. This also indicates that Spanish scholars are dominating the TDC research realm with a total of 250 publications. Norway (f=36) and Ukraine (f=25) were also other top performing countries taking the second and third place in the list, respectively. Approximately 77% of total publications were originated from the first three countries. On the other hand, Chile (f=9), Ireland (f=9), Turkiye (f=9), and Brazil (f=7) are amongst the top 10 countries regarding the total publication counts although they were ranked at the bottom.

3.1.5. Publications by Journals

The bibliometric data of journals that published at least 10 studies out of 406 were analyzed. The findings retrieved through the bibliometric analysis were presented in Table 1 and Figure 6.

Table 1

| №  | Journal                                                      | %    | f     | H-index | Quartile | JCI Score (2021) | Publisher                                      |
|----|--------------------------------------------------------------|------|-------|---------|----------|------------------|------------------------------------------------|
| 1  | Information Technologies and Learning Tools                  | 4.926| 20    | N/A     | N/A      | 0.46             | Institute for Digitalisation of Education, NAES of Ukraine |
| 2  | Pixel Bit Revista de Medios y Educacion                      | 4.680| 19    | 10      | Q2       | 0.95             | Universidad de Sevilla                           |
| 3  | Nordic Journal of Digital Literacy                           | 4.187| 17    | 16      | Q2       | 0.66             | Universitetsforlaget AS                         |
| 4  | Revista Latino Americana de Tecnologia Educativa Relatec     | 4.187| 17    | 18      | Q3       | 0.29             | Univ Extremadura                                 |
| 5  | Education and Information Technologies                      | 3.695| 15    | 69      | Q1       | 1.87             | Springer                                       |
| 6  | Profesorado Revista de Curriculum y Formacion de Profesorado| 2.956| 12    | 35      | Q2       | 0.42             | Universidad de Granada                          |
| 7  | Education Sciences                                           | 2.709| 11    | 30      | Q2       | 1.20             | MDPI AG                                        |
| 8  | Computers & Education                                       | 2.463| 10    | 197     | Q1       | 3.75             | Elsevier                                       |
| 9  | Comunicar                                                   | 2.463| 10    | 45      | Q1       | 2.94             | Grupo Communicar                                |

As illustrated in Figure 6 and Table 1, the Information Technologies and Learning Tools journal published by the Institute for Digitalization of Education of the NAES of Ukraine outperformed all other journals with 20 published articles addressing TDCs. In the second place, Pixel Bit Revista de Medios y Educacion published by the University of Sevilla took place with a total of 19 publications. These two journals accounted for about 10% of total 406 publications included in the bibliometric analysis.
3.2. Bibliometric Science Mapping of TDC Research

In the previous section, we presented the results of comprehensive performance analysis of teachers’ digital competence literature. In this section, the results of our science mapping to enable a better understanding of the research dynamics of the TDC literature will be presented based on the co-citation, co-authorship, and co-occurrence of keywords analysis.

3.2.1. The most influential authors (with the highest number of studies, citation scores and total link strength)

Of the 8582 authors 66 met the threshold value of 20 citations. The top 20 of these 66 authors were presented in Table 2.

Table 2

| Rank | Authors                  | Clusters | Links | Total link strength | Citations |
|------|--------------------------|----------|-------|---------------------|-----------|
| 1    | Ferrari, A.              | 1        | 65    | 1219                | 129       |
| 2    | UNESCO                   | 2        | 64    | 1102                | 122       |
| 3    | Krumsvik, R. J.          | 1        | 65    | 1336                | 113       |
| 4    | Cabero, J.               | 2        | 60    | 861                 | 106       |
| 5    | Tondeur, J.              | 1        | 63    | 1039                | 93        |
| 6    | INTEF                    | 2        | 62    | 835                 | 93        |
| 7    | Cabero-Almenara, J.      | 2        | 63    | 800                 | 90        |
| 8    | Area, M.                 | 2        | 55    | 380                 | 69        |
| 9    | Redecker, C.             | 3        | 63    | 573                 | 67        |
| 10   | Mishra, P.               | 1        | 65    | 657                 | 65        |
| 11   | European Commission      | 3        | 60    | 553                 | 64        |
| 12   | Gudmundsdottir, G. B.    | 1        | 64    | 630                 | 58        |
| 13   | OECD                     | 1        | 58    | 525                 | 56        |
| 14   | Hatlevik, O. E.          | 1        | 64    | 624                 | 53        |
| 15   | Prensky, M.              | 1        | 58    | 316                 | 48        |
In order to address the second research question, the co-authorship and co-citation analysis were employed in the VOSviewer with the bibliometric data of the 833 authors that produced the 406 studies. The authors meeting the threshold score of 4 studies were included in the analysis. The findings extracted from bibliometric analysis were provided in Figure 7 and Table 3.

As illustrated in Figure 7, there were eight clusters. The first cluster (shown in yellow) included three authors, namely Palacios-Rodrigues A. (TLS=13), Guillen-Gamez, F. D. (TLS=6), and Cabero-Almenara, J. (TLS=13). Second cluster consists of two authors; Lopez Belmonte, J. (TLS=7) and Pozo Sanchez, S. (TLS= 7). The other authors formed a cluster.

### Table 3

| Author                | Documents | Citations | Total link strength | Total Citations | h-index |
|-----------------------|-----------|-----------|---------------------|-----------------|---------|
| Cabero-Almenara, Julio| 11        | 96        | 44                  | 39001           | 96      |
| Palacios-Rodriguez, Antonio | 10       | 96        | 44                  | 416             | 11      |
| Guillen-Gamez, Francisco D. | 12       | 116       | 34                  | 571             | 13      |
| Hatlevik, Ove Edvard  | 5         | 331       | 16                  | 3310            | 27      |
| Esteve-Mon, Francesc M.| 7         | 43        | 3                   | 3712            | 27      |
| Lopez Belmonte, Jesus | 7         | 75        | 34                  | 1321            | 22      |
Table 3 illustrates the most influential authors regarding the TDC literature. 10 authors out of 833 have met the threshold score. Cabero-Almenara, Julio is the author with the most papers, yet regarding the citation scores Hatlevik, Ove Edvard outperformed the other authors. In addition, as to the total link strength Palacios-Rodriguez, Antonio and Cabero-Almenara, Julio were the leading authors in the TDCs literature.

3.2.2. The most influential documents

Of the 406 documents included in the bibliometric analysis, top 10 most cited articles were presented in Table 4.

**Table 4**

| Rank | Article Title                                                                 | Authors                                                                 | Source Title                                      | TC  | DOI                              |
|------|------------------------------------------------------------------------------|------------------------------------------------------------------------|---------------------------------------------------|-----|----------------------------------|
| 1    | Adapting to online teaching during COVID-19 school closure: teacher education and teacher competence effects among early career teachers in Germany (2020) | J. König, D. J. Jäger-Biela, & N. Glutsch                              | European Journal of Teacher Education             | 201 | 10.1080/02619768.2020.1809650   |
| 2    | Teachers Generation Z and their Digital Skills (2016)                         | F.-J. Fernández-Cruz & M.-J. Fernández-Díaz                           | Comunicar                                         | 167 | 10.3916/C46-2016-10             |
| 3    | Educating digitally competent teachers: A study of integration of professional digital competence in teacher education (2017) | E. J. Instefjord & E. Munthe                                        | Teaching and Teacher Education                    | 131 | 10.1016/j.tate.2017.05.016     |
| 4    | Digital competence at the beginning of upper secondary school: Identifying factors explaining digital inclusion (2013) | O. E. Hatlevik & K.-A. Christophersen                                  | Computers & Education                              | 130 | 10.1016/j.compedu.2012.11.015   |
| 5    | Newly qualified teachers’ professional digital competence: implications for teacher education (2018) | G. B. Gudmundsdottir & O. E. Hatlevik                                | European Journal of Teacher Education             | 129 | 10.1080/02619768.2017.1416085   |
| 6    | Models of educational integration of ICTs in the classroom (2016)             | M. Area-Moreira, V. Hernández-Rivero, & J.-J. Sosa-Alonso            | Comunicar                                         | 111 | 10.3916/C47-2016-08            |
| 7    | Digital transformation in German higher education: student and teacher perceptions and usage of digital media (2018) | M. Bond, V. I. Marín, C. Dolch, S. Bedenlier, & O. Zawacki-Richter | International Journal of Educational Technology in Higher Education | 97  | 10.1186/s41239-018-0130-1       |
| 8    | Construct validation of a questionnaire to measure teachers’ digital competence (TDC) (2018) | J. Tourón, D. Martín, E. Navarro Asencio, S. Pradas, & V. Íñigo,     | Revista Espanola de Pedagogia                     | 88  | 10.22550/REP76-1-2018-02        |
Document citation analysis purported the most influential documents in TDC literature. The literature acknowledges that the most influential documents are called as canonical documents and they have the most contribution in the intellectual foundation of a specific research area [17], [28]. Given this, the canonical documents of the TDC literature that theoretically contribute in thrive of the TDC literature were presented in Table 4. The most influential documents list is partly overlapping the most influential authors lists given in Table 2 and 3. These documents are also representation of different research streams in TDC literature. For example, digital competence of pre-service teachers and TDC in teacher training programs are the topics that are the most addressed topics by the TDC researchers [22], [27]. Another research stream is the studies mostly scrutinizing pre-school, primary and secondary school teachers’ digital competences and their adoption of ICT in their instruction [21], [23] – [25]. There is only one conceptual paper addressing TDC in the canonical documents list [26]. Consequently, new researchers interested in TDC research and post graduate students can benefit from these documents.

### 3.3. Publications by Co-Occurrence of Keywords

![Figure 8: The co-occurrence of keywords in 406 TDC research studies from 2002-2021 (keywords that occur at least three times)](image)

Of the 998 keywords entered by the authors in 406 studies, the co-occurring keywords analysis identified that there were 105 co-occurring keywords with a threshold of co-occurrence at least three times. The results illustrated that the most co-occurring keywords are (1) digital
competence, (2) ICT, (3) teacher training, (4) higher education and (5) teacher education. The map based on the analysis of co-occurrence results are illustrated in Figure 8 and Figure 9.

With a closer look at Figure 8, the co-occurring keywords are clustered under three colors. These are red, green, and blue. Four concepts are clustered under red. These are (1) teachers’ digital competence, (2) higher education, (3) teacher, and (4) DigiCompEdu. The blue cluster included the keywords of (1) digital competence, (2) teacher education, and (3) technology. Finally, the green cluster showed that (1) teacher training, (2) ICT, and (3) teachers were the concepts. These clusters are consistent with the previous findings given in Table 4.

![Diagram](image)

**Figure 9: The co-occurrence of keywords by years from 2002-2021 (keywords that occur at least three times)**

Regarding the research trends based on the co-occurrence of keywords given in Figure 9, researchers are paying more heed to TDC in a context of distance education, Covid-19, teacher training and DigiCompEdu. These concepts can be signaling the research trends in TDC literature.

4. CONCLUSIONS AND PROSPECTS FOR FURTHER RESEARCH

In the present study, the search terms “digital competence” AND “teachers” were inserted to review the studies addressing TDCs published in the journals included in the Web of Science (WoS) database from 2002 through 2021. The bibliometric data of 406 academic studies in the educational research category in WoS formed the data set of the study and the data were analyzed in VOSwiever 1.6 employing bibliometric performance and science mapping techniques.

Based on the findings, we extracted three main results. First, there has been an exponential increase in the number of studies examining TDCs after 2019. Given this context, more than 50% of the total research has been published in the last two years (2021: f=120, 2020: f=88). This can be an indicator of that digital competence has become one of the most important teacher core competences that teachers and educational systems must face in the digital age. Another reason
for the proliferation of TDC studies can be related with the OERT practices put into practice with the Covid-19 pandemic period and in the aftermath. Thus, this can be an indicator of the research studies focusing on TDC will continue to increase due to the acceleration gained by the digitalization of education in the Covid-19 period. This conclusion is also evident in the previous studies asserting that Covid-19 lockdowns has led to a revision of educational practices including teachers’ competences to adapt teaching in the digital settings [29].

Second, there is a dominance of European and Latin American countries in the TDC literature. Given the increasing importance of TDC, it would be appropriate to make more comprehensive analyzes from global studies. While there is a large literature on this topic in Spain and some other countries, more research studies are needed from other countries to present a broader picture of worldwide state of TDCs. Our results also supported that TDC literature is mainly based on European and pro-European countries. Thus, there is a need for further studies from different regions. Additionally, previous studies argued that there is a dominance of quantitative studies focusing on examining TDCs, especially through self-assessment and reflection via questionnaires [30]. However, the selected articles show that teachers have a positive attitude towards competence development; The increase in the number of articles and training projects trying to explain standards, competence frameworks and models to increase competence development proves this. The “DigicompEdu” can be ultimately useful for determining which key features and competencies teachers need to adopt technologies in their educational practices and strengthen their developmental training.

Finally, the intellectual structure of TDC knowledge base indicated that there are three research streams in TDC literature. These are (1) TDC in teacher training programs, (2) TDC at higher education studies, and (3) TDC at pre-school, primary and secondary level. Co-occurrence of keywords analysis illustrated that recent studies are focusing on TDC in teacher training programs. This is partly because the number of countries that have incorporated TDCs in the teacher-training programs are increasing in number as it is documented in [5].

As a conclusion, based on research results, our recommendations and prospects for future research can be listed as:

1. There is a proliferation in TDC research in the last two years and most studies are carried out in European context, such as Spain, Norway and Ukraine. Thus, there is a need for further studies from different countries or regions to present a global perspective.

2. Thanks to the OERT practices implemented with the Covid-19 pandemic, education at primary, secondary and tertiary levels has become digitalized, thus it is imperative for teacher training institutions to address TDCs along with the generic teacher competences in their curricula.

3. Future research should focus on TDC in a context of distance education, Covid-19, teacher training and DigiCompEdu.

REFERENCES (TRANSLATED AND TRANSLITERATED)

[1] Rodriguez-Garcia, M. Reche, ve S. Garcia, “The digital competence of the future teacher: bibliometric analysis of scientific productivity indexed in Scopus”, Ijerı-International Journal Of Educational Research And Innovation, vol.10, pp. 317-333, 2018. (in English)
[2] E. Council, “Recommendation of the European Parliament and the Council of 18 December 2006 on key competencies for lifelong learning”, Brussels: Official Journal of the European Union, 30(12), 2006. (in English)
[3] O. Erstad, S. Kjällander, S. Järvelä, “Facing the challenges of ‘Digital Competence’ A Nordic agenda for curriculum development for the 21st century”, Nordic Journal of Digital Literacy, vol.16, no.2, pp77-87. 2021. (in English)
[4] C. Redecker, “European Framework for the Digital Competence of Educators: DigCompEdu”, Joint Research Centre (Seville site), JRCI07466, 2017. Access: 03 Agust 2022. [Online]. Access Address: https://ideas.repec.org/p/ipt/iptwpa/jrcI07466.html. (in English)
F. M. Røkenes and R. J. Krumsvik, “Prepared to teach ESL with ICT? A study of digital competence in Norwegian teacher education”, Computers & Education, vol. 97, pp. 1-20, 2016, doi: 10.1016/j.compedu.2016.02.014. (in English)

H.D. White, K.W. McCain “Visualizing a discipline: An author co-citation analysis of information science, 1972-1995”, Journal of the American Society for Information Science & Technology, vol.49, no.4, pp. 327-355, 1998, http://garfield.library.upenn.edu/bwhite/whitejasist1998.pdf. (in English)

D. Sales, A. Cuevas-Cerveró, and J.A. Gómez-Hernández, “Perspectives on the information and digital competence of social sciences students and faculty before and during lockdown due to covid-19”, Profesional De La Información, vol.29 no.4, pp.1-20, 2020. https://doi.org/10.3145/epi.2020.jul.23. (in English)

F.D. Guillén, and M. Mayorga, “Prediction of factors that affect the knowledge and use higher education professors from Spain make of ICT resources to teach, evaluate and research: A study with research methods in educational technology”, Education Sciences, vol.10, no.276, pp.1–12, 2020. https://doi.org/10.3390/educsci10100276. (in English)

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