



# Research Trends in Teacher Digital Competencies: A Bibliometric Review

Senita Butar Butar\*, Respita Haniva, Hari Mulyadi

Faculty of Economics and Business Education, Universitas Pendidikan Indonesia, Indonesia

\*Corresponding author's email: [butarbutarsenita@gmail.com](mailto:butarbutarsenita@gmail.com)

---

## Submission

### Track:

Received:

11 May 2024

Final Revision:

31 May 2024

Available online:

30 June 2024

## ABSTRACT

Teacher digital competence (TDC) is a pivotal skill in 21st-century education, essential for addressing the extensive educational demands of the digital age and technological advancements. This study aims to investigate and evaluate research trends in teacher digital competency from 2013 to 2023 using descriptive bibliometric analysis. Researchers utilized the Scopus database for data collection, following a four-stage process to obtain 235 publications. These publications were then analyzed using the VOS Viewer software. The findings of this study are as follows: 1) The research trend on TDC has shown a continuous increase from 2013 to 2020; 2) Citation trends peaked in 2018, with the work of Gudmundsdottir and Hatlevik (2018) being the most frequently cited; 3) Spain emerged as the leading country in this field, with 100 publications and five international collaborations; 4) Research on teacher digital competence primarily focuses on digital competence itself, higher education, ICT, digital technology, digital e-learning, personnel training, educational technology, digital devices, digital resources, teaching and learning, motivation, digital skills, digital literacy, TPACK, information and communication technologies, professional development, professional digital competence, self-assessment, education, and teacher professional development. Recent themes such as digital teaching competence, improvement, and digital tools are recommended for further research on teacher digital competence.

**Keywords:** Bibliometric, Digital Competence, Teacher Digital Competence, Teacher Competence

---

DOI: 10.23917/varidika.v36i1.4993

## INTRODUCTION

Technological advances and the availability of various forms of digital platforms today have greatly affected various fields of life including education, especially after the Covid-19 pandemic which requires educators to change the way of teaching by utilizing technology so that learning continues even from a distance (Antonietti et al., 2022; Masalimova et al., 2022; Myyry et al., 2022). Teachers are faced with a variety of digital facilities that can be used in learning and are required to be competent in utilizing these advances to support learning effectiveness (Çebi & Reisoğlu, 2022; Redecker, 2017). This makes teacher digital competence one of the important topics discussed today both by researchers and in education policy (Fernández-Morante et al., 2023; Tzafilkou et al., 2023). These days, one of the key educational qualities that instructors need to possess is digital competency, and even some countries

such as Norway have included digital competence as one of the basic competencies in the teacher education curriculum in higher education (Basilotta et al., [2022](#); Røkenes & Krumsvik, [2014](#)).

Teachers' digital competencies are the skills and abilities that enable educators to evaluate and use current technologies, data, and information in teaching, learning, and collaborating with others, as well as exploring new information technologies where appropriate, taking into account liability, privacy, and security issues (Muammar et al., [2023](#)). Several agencies such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), the British Educational Communications and Technology Agency (BECTA), the Organization for Economic Co-operation and Development (OECD), the International Society for Technology in Education (ISTE), and the European Commission (EU) have proposed standards and indicators to conduct a study on educators' digital competencies (Torres et al., [2022](#)).

Teachers' digital competence is crucial to integrating technology into the education process (Murat & Kukul, [2023](#); Windasari, Karwanto, Supriyanto, [2022](#)). Digitalization has changed the way information is delivered and processed in the classroom, requiring teachers to have appropriate skills in using information and communication technology (ICT). The study of TDC is essential for several reasons such as its importance in improving the quality of education, preparing learners for the future, adapting to technological change (Guillén-Gámez et al., [2021](#)), and ultimately reducing the digital divide. The COVID-19 pandemic and the rise of distance learning have accelerated the adoption of technology in education (Anderson, [2020](#)), making digital competency an urgent need (Siripan & Noirid, [2022](#)). Research on TDCs provides valuable insights into what challenges are faced and effective strategies for overcoming the challenges.

Even the European Parliament and the Council of the European Union identified digital competence as one of the eight key competencies to strengthen lifelong learning (van Laar et al., [2017](#)). Educators' digital competence can be seen in their ability to use digital technologies to improve their teaching, and their professional interactions with colleagues, learners, parents, and other interested parties, for their professional development and the collective good and continuous innovation (Redecker, [2017](#)). The Spanish Ministry of Education states that digital competence is something that involves the creative, critical, and safe use of information and communication technologies to fulfill objectives related to work, employability, learning, use of leisure time, inclusion, and social participation to enable all citizens to integrate well in society, develop as individuals, and respond to challenges and enlarge opportunities in digital transformation (Gordillo et al., [2021](#)). Teachers' digital competence is not only limited to the use of technology in teaching but also to their ability to understand the environment in

which learners learn and maximize technology to support learners' learning and competence development (García-Delgado et al., [2023](#); Tournon et al., [2018](#)).

The implications of studying TDC are wide-ranging. Understanding research trends in this field can assist policymakers in designing more effective and relevant training programs for teachers. In addition, it can provide insights for educational institutions on areas that need further improvement and support. From an academic perspective, this study can identify research gaps and opportunities, thus encouraging more in-depth and focused follow-up research.

Various studies have been conducted to explore the importance of teacher digital competence and how it can be implemented in various educational contexts (Blyznyuk, [2019](#); Cook et al., [2023](#); Pettersson, [2018a](#); Rani & Gandhi, [2022](#); Røkenes & Krumsvik, [2014](#); Torres et al., [2022](#); Tzafilkou et al., [2023](#); Windasari, Karwanto, Supriyanto, [2022](#)). However, while there is a wealth of research focusing on the development and implementation of digital competencies, there is still a lack of understanding of overall research trends in this area. There is no comprehensive bibliometric review that identifies patterns, directions, and developments in research related to teachers' digital competencies over time.

Identifying these gaps is important as it helps educational researchers and practitioners to understand the areas that have been well explored and those that still require further research. Without this understanding, efforts to develop teachers' digital competencies may not be fully effective or evidence based. Therefore, the purpose of this study was to conduct a bibliometric review of the existing literature on teacher digital competencies. By filling this gap, this study will not only provide a comprehensive overview of the teacher digital competence research landscape but also identify areas that require further research and provide guidance for future researchers and practitioners. This study aims to answer the following questions:

1. What are the publication trends related to Teacher Digital Competence?
2. What are the citation trends related to Teacher Digital Competence?
3. How are publications about teacher digital competency distributed geographically, and how do different nations collaborate on this research?
4. What is the distribution of journal rankings for Teacher Digital Competence based on quartile scores?
5. What is the focus of research related to Teacher Digital Competence?

## METHOD

This study uses a bibliometric analysis to explore the research landscape related to Teacher Digital Competence that was obtained from the Scopus database. The selection of the Scopus database is based on several considerations Scopus is one of the largest and most comprehensive databases covering a wide range of disciplines, including education. Scopus provides access to a large number of relevant journal articles, conference proceedings, and other documents that have been widely recognized in the academic community. However, the authors recognize that the use of a single database such as Scopus may pose a major limitation in that it may not include all relevant publications published in other databases.

In refining the data collected in this study, the authors ran several stages, i.e. identification, screening, eligibility, and inclusion adopted from the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) method. PRISMA is a set of guidelines created to help researchers properly and transparently disclose their systematic reviews and meta-analyses. To make sure that every crucial stage in the systematic review and meta-analysis process is properly explained and illustrated, PRISMA offers checklists and flow diagrams (Sarkis-Onofre et al., [2021](#)). The identification step is the first step taken to identify data sources that are relevant to the topic to be researched, while the screening step aims to reduce irrelevant or duplicate data. Next, the feasibility assessment step is used to evaluate the quality and relevance of each data source that has been screened. Finally, the inclusion step is performed to decide which data sources will be included in further analyses (Moher et al., [2009](#)). This data was collected on 24 July 2023 during the inclusion stage.

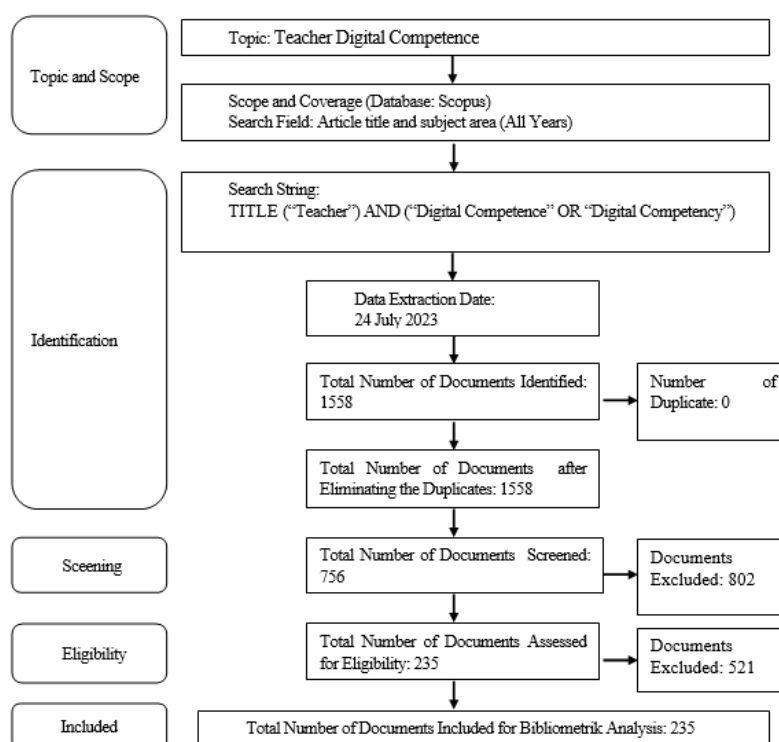
In addition, to ensure this review was focused and systematic, we used the PICO (Population, Intervention, Comparison, Outcome) framework. This framework helps in formulating specific and relevant research questions. By using the PICO framework, we were able to structure this review more clearly and systematically, making the results more relevant and useful (Eriksen & Frandsen, [2018](#)). The PICO of this study is shown in Table 1.

**Table 1.** PICO Framework for the Study on Teacher Digital Competencies

Component	Description
Population (P)	Teachers/Educators at various levels of education
Intervention (I)	Implementation, Assessment, and development of teacher digital competencies, use of technology in teaching
Comparison (C)	Teacher competency studies without a digital focus or traditional competencies
Outcome (O)	Research trends, improving teaching effectiveness, impact on education

In the first step, the identification step, researchers used 3 keywords on the Scopus database: ("Teacher") AND ("Digital Competence") OR ("Digital Competency"). These keywords were used to ensure that the data summarized specifically discussed specific digital competencies in teachers. The

identification step obtained publication data from as many as 1558 articles. In the second step, the screening process, the researcher filtered the documents according to some criteria: publications must be written in English, must be in the form of articles published in journals, and publications took only publications in the last ten years, 2013 to 2023. 756 publications that met the earlier requirements were found among the screening results. This indicates that 802 publications have been eliminated and will not be processed further.



**Figure 1.** Data Collection Process

Furthermore, in the third stage, researchers examined the titles and abstracts of 756 publications to evaluate those that included or contained teacher digital competency or teacher digital competence. We found articles on the topic of student digital competence, digital competence in the general public, and more general ICT topics. Publications like these are not included in the criteria for the required documents. This is because the authors specifically focused on teachers' digital competencies as our main objective was to identify research trends relevant to improving professionalism and teaching effectiveness through the use of digital technologies in educational settings. Articles addressing students' digital competencies, digital competencies in the general public, and more general ICT topics were excluded as they are not directly related to the development and assessment of teacher-specific digital competencies. Including these articles would have broadened the scope of our review beyond the defined

focus, which could have obscured results and recommendations specific to improving teachers' digital competencies. Upon completion of the third phase, 235 publications were acquired that met the requirements to proceed to the subsequent phase.

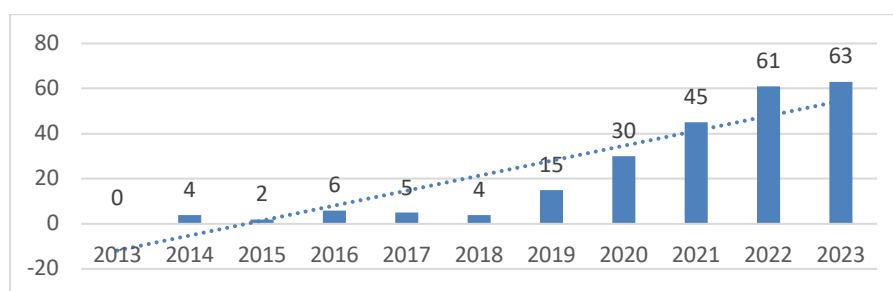
In the data analysis stage, the author uses one main application, VOSViewer. Network, overlay, and density visualization were the three primary panels that VOSViewer used to display research visualization (Van Eck & Waltman, 2021). In this study, researchers used VOSViewer to display relationships between countries and overlays. The overlay shows the various keywords in the various clusters used in the interpretation as well as the occurrence of countries, both those with collaborative relationships and those not. In addition, researchers used Ms.Excel to present several graphs and frequencies such as publication trend graphs and journal ranking distribution. The stages are summarized and shown in Figure 1.

## RESULTS & DISCUSSION

Descriptive bibliometric analysis is then performed on publications about Teacher Digital Competence that have undergone the data collection process to obtain 235 publications within the timeframe of 2013 to 2023 that satisfy the requirements. The author will talk more about publication trends, citation trends, country and journal distribution, and research focus.

### 1. *What are the publication trends related to Teacher Digital Competence?*

Figure 2 displays the evolution of publications about Teacher Digital Competence for 10 years (2013–2023). Figure 2 shows the 235 publications that have been categorized according to the year of publication.



**Figure 2.** Publications from 2013 to 2023 in Number

Figure 2 shows that the trend line related to Teacher Digital Competence publications tends to increase every year, whilst there hasn't been much of a difference in the number of publications between 2014 and 2018 when COVID-19 hit all countries. This significant increase shows that this topic has become one of the most important topics in education today. The number of publications increased by 275% between 2018 and 2019, indicating a strong growth in publishing volume.

**2. What are the citation trends related to Teacher Digital Competence?**

Table 2 presents how TDC-related citations trend over 10 years (2013-2023). From Table 2, the NCP percentage value in 2014, 2017, 2018, 2019, and 2020 is 100%, this means that all documents published in those years have been cited. Judging from the total citations, publications in 2020 have been cited the most, with a total of 1191 citations. Although the number of publications in the following year is more, publications in 2020 have a large research impact seen from the number of citations and the value of the h-index and g-index. Here are the 10 publications with the most citations in 2020.

**Table 2.** Citation Analysis of Publications

Year	TP (Total of Publication)	NCP (Number of Cited Publication)	%NCP	TC	C/P	C/CP	h-index	g-index
2013	-	-	-	-	-	-	-	-
2014	4	4	100%	248	62,0	62,0	3	4
2015	2	1	50%	14	7,0	14,0	1	2
2016	6	5	83%	432	72,0	86,4	5	6
2017	5	5	100%	418	83,6	83,6	5	5
2018	4	4	100%	449	112,3	112,3	4	4
2019	15	15	100%	677	45,1	45,1	10	15
2020	30	30	100%	1191	39,7	39,7	19	30
2021	45	43	96%	616	13,7	14,3	14	23
2022	61	49	80%	339	5,6	6,9	8	15
2023	63	23	37%	55	0,9	2,4	3	5

**Table 3.** Publications that received the most citations in 2020

Author (year)	Sources	Number of citation
(Falloon, 2020a)	Educational Technology Research and Development	179
(Nouri et al., 2020)	Education Inquiry	121
(Spiteri & Chang Rundgren, 2020)	Technology, Knowledge, and Learning	86
(Portillo et al., 2020)	Sustainability (Switzerland)	84
(Basantes-andrade et al., 2022)	European Journal of Teacher Education	71
(Cabero-Almenara, Romero-Tena, et al., 2020)	Journal of New Approaches in Educational Research	68
(Reisoğlu & Çebi, 2020)	Computers and Education	63
(Cabero-Almenara, Gutiérrez-Castillo, et al., 2020)	Sustainability (Switzerland)	49
(Miguel-Revilla et al., 2020)	Australasian Journal of Educational Technology	42
(Esteve-Mon et al., 2020)	International Journal of Emerging Technologies in Learning	42

Research conducted by (Falloon, [2020a](#)) entitled "From digital literacy to digital competence: the teacher digital competency (TDC) framework" became the most cited publication. This publication

discusses a conceptual framework that introduces the Teacher Digital Competence (TDC) view. The framework is more holistic and based on broader and more complex knowledge and skills. It also provides practical suggestions on how the framework can be utilized by teachers.

In addition to the documents published in 2020, several other documents have considerable citations in several other years. Here is the order of the 10 publications with the highest number of citations from all years.

**Table 4.** Articles with the highest number of citations from all years

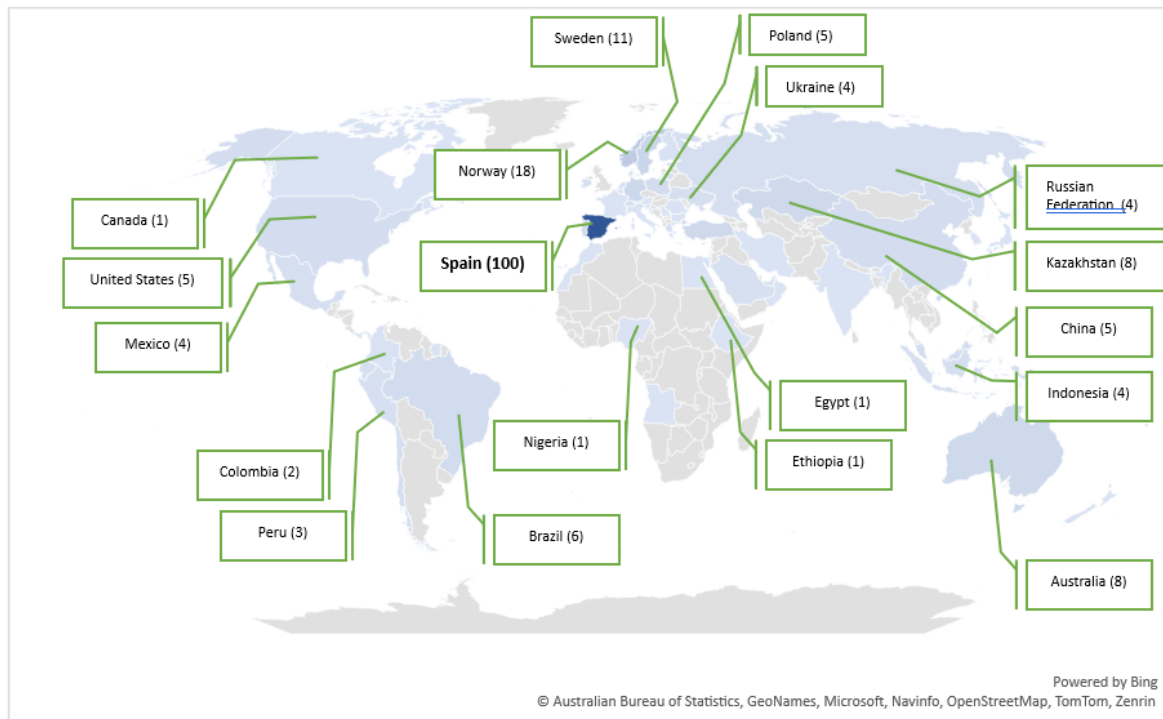
Author	Source	Number of citation
(Gudmundsdottir & Hatlevik, 2018)	European Journal of Teacher Education	206
(Instefjord & Munthe, 2017)	Teaching and Teacher Education	204
(Fernández-Cruz & Fernández-Díaz, 2016)	Comunicar	187
(Falloon, 2020b)	Educational Technology Research and Development	179
(Caena & Redecker, 2019)	European Journal of Education	176
(Krumsvik, 2014)	Scandinavian Journal of Educational Research	172
(Pettersson, 2018b)	Education and Information Technologies	152
(Amhag et al., 2019)	Journal of Digital Learning in Teacher Education	122
(Nouri et al., 2020)	Education Inquiry	121
(Area-Moreira et al., 2016)	Comunicar	105

These citation trends help identify the most cited articles that demonstrate significant contributions to knowledge and practice in the field of TDC. Frequently cited articles are typically considered to be foundational or groundbreaking research that provides a foundation for subsequent studies, as well as directing future research to fill gaps in their research. In addition, this analysis also reveals highly influential researchers, which can be a source of inspiration and collaboration for further research. The documents with the most citations allow us to identify key themes and major topics that dominate scientific discussions in the field of TDC. With changes in citation patterns, we can evaluate how the focus of research is shifting and identify specific periods where interest in the topic is increasing. It also helps in understanding how technological developments and changes in education policy affect research in this area. Table 4 shows relevant research topics in 10 years such as topics in identifying and integrating digital competence, how digital literacy changes into digital competence, developing digital competence of teachers, and various other topics. This can be an inspiration for other researchers in other regions so that it has an impact on surrounding institutions.

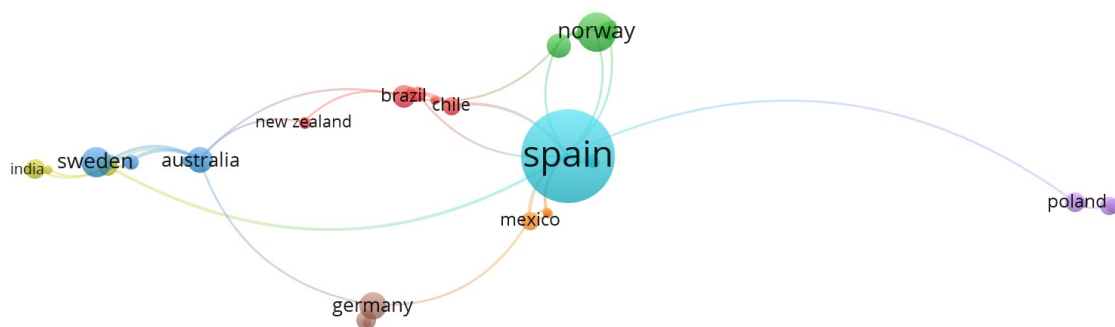


**3. How are publications about teacher digital competency distributed geographically, and how do different nations collaborate on this research?**

At this point, the authors did not establish a threshold. This means that even if a country doesn't have any cooperative relationships with other nations, it will still be displayed if it has just one document linked to this subject. The 235 publications that have been obtained have been published by 64 countries. The geographical distribution of the author's country of origin can be seen in the Figure 3.



**Figure 3.** Geographical Distribution of Publications



**Figure 4.** Country Collaboration Patterns

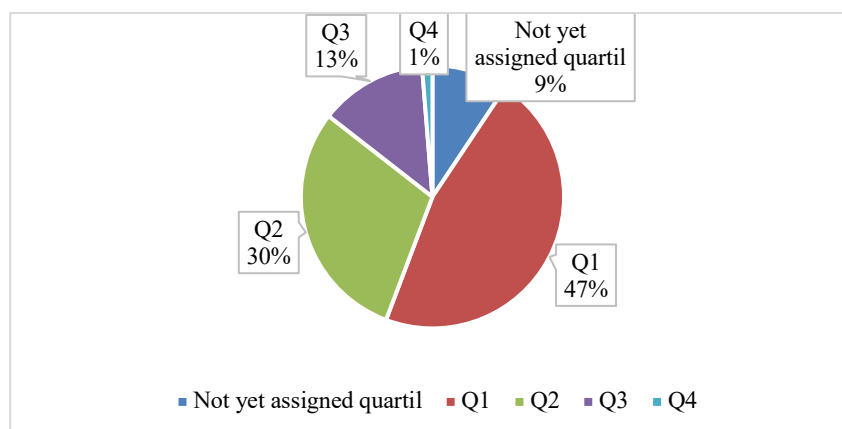
Figure 3 shows that Spain, with a total of 100 publications, is the most influential country regarding Teacher Digital Competence research. In second place is Norway with 18 publications and Sweden with 11 publications. Figure 3 shows that all continents have published documents related to

Teacher Digital Competence. With over 200 publications published, a significant amount in comparison to publications from other continents makes the European continent the most prominent in this discipline. Meanwhile, Figure 4 shows 34 countries that have collaborative relationships, including Spain, Australia, Brazil, the United States, Belgium, Germany, Mexico, Netherlands, Norway, and Chile. Spain with a total of 100 publications is the country that has the most level of cooperation with a total of 13 links.

Visualization of these countries can be used as a reference for further research and even create new collaborations related to teacher digital competence. From the data collection and selection process carried out by the author in this study, it was found that Spain is one of the countries that has developed a framework for measuring teacher digital competence, Digcompedu (Digital Competence for Educators). This is one of the reasons why Spain is the country with the largest circle. Digcompedu has also been used in several studies from other countries such as in the research of (Alarcón et al., [2020](#); Aningrum et al., [2022](#); Ari, [2023](#); Lucas et al., [2020](#); Masalimova, [2022](#)).

#### 4. What is the distribution of journal rankings for Teacher Digital Competence based on quartile scores?

The quartile value (Q) of journals with publications concerning Teacher Digital Competence shows the distribution of journal rankings. Anyone may examine journal rankings on the Scimagojr website. The distribution of journal rankings is displayed as follows in Figure 5.



**Figure 5.** Ranking based on Journal Quartile

In Figure 5, publications in journals related to Teacher Digital Competence research are mostly ranked Q1, which is 47% or 109 of the total documents. In second place is the journal with a Q2 ranking of 30% or 70 documents. However, when viewed from the number of articles in the journal can be seen in Table 3.

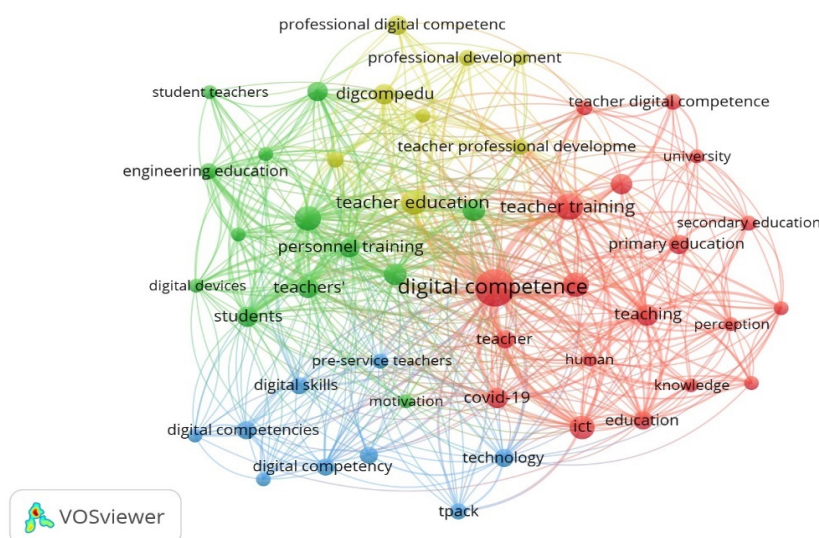
**Table 5.** Ten Journals with the most articles

Journals	Quartile	Number of Publication
Education and Information Technologies	Q1	17
Education Sciences	Q2	13
Sustainability (Switzerland)	Q1	10
Technology, Knowledge, and Learning	Q1	10
Nordic Journal of Digital Literacy	Q2	8
European Journal of Teacher Education	Q1	7
Computers and Education	Q1	6
Comunicar	Q1	6
Educational Technology Research and Development	Q1	6
Pixel-Bit, Revista de Medios y Educacion	Q2	6

Table 5 shows that the journal "Education and Information Technologies" which has a journal rank of Quartile 1 (Q1) has published 17 articles related to Teacher Digital Competence being the most published journal on the topic. The journal "Education Sciences" is a journal with a rank of Q2 which has published 13 articles being the second most published journal on similar topics. The previously mentioned list of journals might serve as a resource for publications of Teacher Digital Competence studies.

### 5. What is the focus of research related to Teacher Digital Competence?

At this point, authors set a threshold, which states that shared keywords must be presented with at least five publications. This means that using VOS viewer, keywords that have been used together in five or more publications will be displayed on the co-occurrence of keywords.



**Figure 6.** Co-occurrence of Keyword (Co-occurrence Threshold  $\geq 5$ )

In Figure 6, the research focus is grouped into four clusters with different colors. The first cluster, namely the cluster in red, consists of 19 items, namely digital competence, teacher training, teaching, higher education, ICT, covid-19, education, teacher, perception, primary education, Spain, human, digital competencies, digital technology, student, secondary education, knowledge, teacher digital competence, and university. The green color depicts the second cluster consisting of 13 items, namely digital e-learning, teachers', personnel training, students, educational technology, engineering education, digital technologies, teachers, digital devices, digital resources, teaching and learning, motivation, and student teachers. The third cluster in blue consists of 9 items with the keywords technology, digital skills, digital competency, digital literacy, digital competencies, pre-service teachers, TPACK, and information and communication technologies. The fourth cluster in yellow consists of 8 items consisting of curricula, digcompedu, professional development, professional digital competence, self-assessment, systematic review, teacher education, and teacher professional development.

The keyword "Digital Competence" is the keyword with the largest circle diameter with a total strength of 237 followed by the keywords "teacher training", "higher education", "ICT" and "Covid-19". In general, Cluster 1 provides an overview of issues related to teachers' digital competencies, technology integration, and evaluation at various levels of education, and highlights the importance of teacher training and preparation of prospective teachers to face future demands in an increasingly digitally connected world of education. This cluster also found discussions on how the COVID-19 pandemic affects the use of digital technology in the context of education. These discussions are shown through several works such as (McGarr & McDonagh, [2021](#); Nagel, [2021](#); Rodríguez-García et al., [2019](#); Sá & Serpa, [2020](#); Tarraga-Mínguez et al., [2021](#); Tømte, [2015](#)). It is not surprising that digital competence is very important for a teacher today and is a topic that is widely discussed even at the University level and by researchers (Basilotta et al., [2022](#); Fernández-morante et al., [2023](#)) teacher digital competence is one of the important skills in developing innovative learning, especially in the education of millennials today, even the European Parliament and the Council of the European Union identified digital competence as one of the eight key competencies to strengthen lifelong learning (Basantes-andrade et al., [2022](#)).

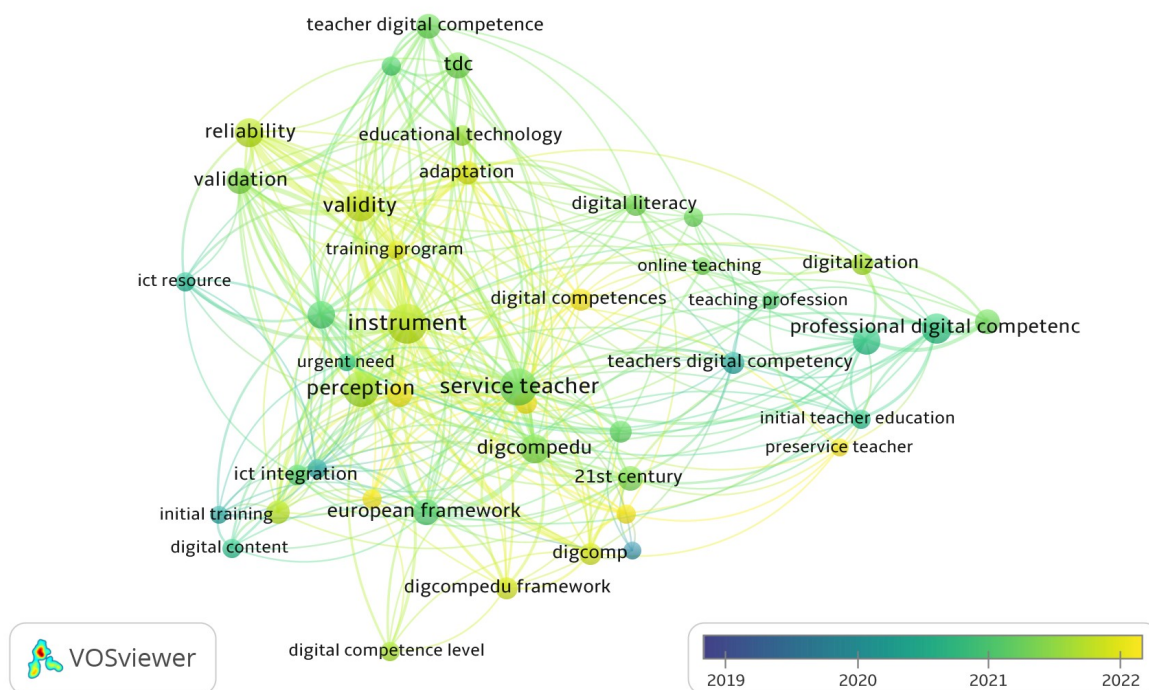
Cluster 2 offers rich insights into issues related to teachers' digital competencies with a particular focus on technology and its role in supporting teaching and learning. The integration of technology in all aspects of teaching and learning is important. Keywords in this cluster indicate teacher digital competence topics related to e-learning, educational technology, and digital resources. Furthermore, this cluster includes the issue of personnel training, which highlights the need to develop teachers' skills and knowledge in using technology in an educational context. This reflects the drive to increase teachers' capacity to adopt digital tools to enhance students' learning experience. These discussions can be seen in publications such as (Guillén-Gámez et al., [2022](#); Kildé, [2023](#); Melash et al., [2020](#)). In general, cluster 2 exhibits an all-encompassing emphasis on the different facets that facilitate the enhancement of

educators' digital proficiencies. Providing devices and resources is only one aspect of integrating digital technology into education; another is making sure that educators are driven and equipped with the skills needed to use them efficiently. The understanding of how these different components interact and affect the calibre of digital education is aided by research in this cluster.

Cluster 3 provides insights into how technology and digital skills are becoming an important element today. This cluster highlights the need for digital skills among pre-service teachers. In this context, it is important to prepare prospective teachers with the necessary skills to integrate technology into teaching practices. Special attention is also paid to the concept of TPACK (Technological Pedagogical Content Knowledge), which emphasizes the importance of incorporating technology, pedagogy, and content knowledge in teaching. There is also the keyword "digital literacy" which is closely related to digital competence. This includes an understanding of how teachers should be able to guide students in using technology wisely and responsibly and have the ability to manage information effectively in a digital environment. With references to Information and Communication Technologies (ICT), this cluster also highlights the role of technology in the transformation of education and the importance of teachers having a strong understanding of how ICT can be used to enhance students' learning experiences. Discussions of these issues can be found in publications such as the works of (Falloon, [2020b](#); Fernández-Cruz & Fernández-Díaz, [2016](#); Miguel-Revilla et al., [2020](#); Rani & Gandhi, [2022](#)). Overall, cluster 3 highlights the focus on developing comprehensive digital skills and competencies for both trainee and experienced teachers. Research in this cluster suggests that digital competencies include not only technical skills but also a deeper understanding of how technology can be used pedagogically to support effective learning.

Cluster 4 provides a rich overview of efforts in developing teachers' digital competencies specifically in the context of teacher education and professional development, with a focus on teacher education, professional development, and evaluation of competencies. By understanding these concepts, educational institutions and policymakers can develop effective strategies to support teachers in facing future demands in an increasingly digitized education. In this cluster, the keyword "digcompedu" appears. Digcompedu or Digital Competence for Educators is one of the frameworks used to measure digital competence, especially for teachers. This framework was developed by the European Commission. This framework has been widely adopted by various researchers to evaluate the digital competence of teachers. This shows that there is an effort to develop a clear and consistent framework for measuring and developing teachers' digital competencies. Discussions on topics in cluster 4 can be found in works such as (Çebi & Reisoğlu, [2022](#), [2023](#); Hanell, [2018](#); Kullaslahti et al., [2019](#); Lucas et al., [2021](#); Starkey & Yates, [2022](#)). Overall, cluster 4 highlights the importance of professional development, self-assessment, and teacher education in the context of digital competencies. Research in this cluster suggests that the development of teachers' digital competencies should be holistic, including

curriculum integration, the use of frameworks such as DigCompEdu, and ongoing support through professional development.



**Figure 7.** Evolution of Research Themes in Teacher Digital Competence

Figure 7 shows the development of research theme trends related to Teacher Digital Competence from 2019 to 2022. Various keywords that describe the research theme appear in the figure such as the keywords preservice teacher, digital competence, digcompedu, digcomp, digital teaching competence, ICT use, digital content creation, adaptation, training program, and digital competence.

From the results of the VOSviewer analysis, the four clusters provide insights into various important aspects of teacher digital competence. With the themes that emerged in these clusters, future research can conduct research on exploring the effectiveness of E-Learning technology, developing training programs and curricula, longitudinal studies on teacher motivation in using technology, attempts to develop competency frameworks, and evaluating teacher education programs.

The limitations of this study are as follows: 1) The data analyzed is exclusively from the Scopus database, thus excluding many relevant studies not indexed in this database. 2) The study employs a limited set of keywords, omitting others that address similar topics, such as "ICT Competence," "digital skill," and "ICT skill." 3) The data was collected on July 28, 2023, which means it does not reflect research conducted after this date, potentially leading to slight discrepancies. 4) The process of selecting articles based on title, abstract, and keywords introduces the possibility of selection bias, as relevant articles that do not use the appropriate terminology in the title or abstract may be overlooked.

Additionally, limited access to full articles may hinder the ability to thoroughly and accurately assess study relevance. The methodological limitations inherent to bibliometric evaluations include reliance on often inconsistent or inadequate article metadata. Variations in authors' keyword indexing and subject classification techniques can affect the findings. Moreover, techniques like co-word and citation analysis have limitations in capturing the richness and nuance of study content. To address these limitations, future research should utilize multiple databases to reduce selection bias and broaden the scope of analyzed literature, develop and adopt more comprehensive and inclusive keywords, improve methods for mapping author names and affiliations to enhance collaboration analysis accuracy, combine qualitative analysis methods with bibliometrics for deeper understanding of research content, and extend the analysis period to encompass classic studies and observe trend changes over a longer timeframe.

## CONCLUSION

Based on the analysis conducted, it can be concluded that the research trend related to Teacher Digital Competence (TDC) has shown a steady increase from 2013 to 2023, with 2020 being the peak year, evidenced by the highest h-index (19) and g-index (30). The collected documents indicate that various countries have made efforts to develop instruments for measuring and evaluating teachers' digital competence. Spain, notably, has developed the DigCompEdu Framework and leads in the number of publications in this field. Research on TDC primarily focuses on areas such as digital competence, teacher training, higher education, ICT, digital technology, digital e-learning, personnel training, educational technology, digital devices, digital resources, teaching and learning, motivation, digital skills, digital literacy, TPACK, information and communication technologies, professional development, professional digital competence, self-assessment, education, and teacher professional development. These areas serve as reference points for future research endeavors.

## REFERENCES

- Alarcón, R., del Pilar Jiménez, E., & de Vicente-Yagüe, M. I. (2020). Development and validation of the DIGIGLO, a tool for assessing the digital competence of educators. *British Journal of Educational Technology*, 51(6), 2407 – 2421. <https://doi.org/10.1111/bjet.12919>
- Amhag, L., Hellström, L., & Stigmar, M. (2019). Teacher Educators' Use of Digital Tools and Needs for Digital Competence in Higher Education. *Journal of Digital Learning in Teacher Education*, 35(4), 203 – 220. <https://doi.org/10.1080/21532974.2019.1646169>
- Anderson, V. (2020). A digital pedagogy pivot: re-thinking higher education practice from an HRD perspective. *Human Resource Development International*, 00(00), 452–467. <https://doi.org/10.1080/13678868.2020.1778999>
- Aningrum, T. A., Wardani, K., & Santosa, I. (2022). Digital Competence of Educators (DigCompEdu): Level of Digital Competence of English Pre-service Teacher in Indonesia. *Jisip*, 6(4), 2656–6753. <https://doi.org/10.36312/jisip.v6i4.3716/http>
- Antonietti, C., Cattaneo, A., & Amenduni, F. (2022). Can teachers' digital competence influence technology acceptance in vocational education? *Computers in Human Behavior*, 132.

- <https://doi.org/10.1016/j.chb.2022.107266>
- Area-Moreira, M., Hernández-Rivero, V., & Sosa-Alonso, J.-J. (2016). Models of educational integration of ICTs in the classroom. *Comunicar*, 24(47), 79 – 87. <https://doi.org/10.3916/C47-2016-08>
- Ari, M. Z. (2023). DIGITAL COMPETENCES LEVEL OF INDONESIAN TEACHERS IN PROFESSIONAL. *Jurnal Manajemen Pendidikan Islam Al Munadzomah*, 2(2), 117–131.
- Basantés-andrade, A., Casillas-mart, S., Cabezas-gonz, M., Naranjo-toro, M., & Guerra-reyes, F. (2022). *Standards of Teacher Digital Competence in Higher Education : A Systematic Literature Review*.
- Basilotta, V., Pablos, G., Matarranz, M., Alberto, L., Aranda, C., & Otto, A. (2022). Teachers ' digital competencies in higher education : a systematic literature review. *International Journal of Educational Technology in Higher Education*, February. <https://doi.org/10.1186/s41239-021-00312-8>
- Blyzniuk, T. (2019). Formation of Teachers' Digital Competence: Domestic Challenges and Foreign Experience. *Journal of Vasyl Stefanyk Precarpathian National University*, 5(1), 40–46. <https://doi.org/10.15330/jpnu.5.1.40-46>
- Cabero-Almenara, J., Gutiérrez-Castillo, J.-J., Palacios-Rodríguez, A., & Barroso-Osuna, J. (2020). Development of the teacher digital competence validation of DigCompEdu check-in questionnaire in the University context of Andalusia (Spain). *Sustainability (Switzerland)*, 12(15). <https://doi.org/10.3390/su12156094>
- Cabero-Almenara, J., Romero-Tena, R., & Palacios-Rodríguez, A. (2020). Evaluation of teacher digital competence frameworks through expert judgement: The use of the expert competence coefficient. *Journal of New Approaches in Educational Research*, 9(2), 275 – 283. <https://doi.org/10.7821/naer.2020.7.578>
- Caena, F., & Redecker, C. (2019). Aligning teacher competence frameworks to 21st century challenges: The case for the European Digital Competence Framework for Educators (Digcompedu). *European Journal of Education*, 54(3), 356 – 369. <https://doi.org/10.1111/ejed.12345>
- Çebi, A., & Reisoğlu, İ. (2022). Adaptation of Self-Assessment Instrument for Educators' Digital Competence into Turkish Culture: A Study on Reliability and Validity. *Technology, Knowledge and Learning*, 569–583. <https://doi.org/10.1007/s10758-021-09589-0>
- Çebi, A., & Reisoğlu, İ. (2023). Adaptation of Self-Assessment Instrument for Educators' Digital Competence into Turkish Culture: A Study on Reliability and Validity. *Technology, Knowledge and Learning*, 28(2), 569 – 583. <https://doi.org/10.1007/s10758-021-09589-0>
- Cook, H., Apps, T., Beckman, K., & Bennett, S. (2023). Digital competence for emergency remote teaching in higher education: understanding the present and anticipating the future. *Educational Technology Research and Development*, 71(1), 7–32. <https://doi.org/10.1007/s11423-023-10194-4>
- Eriksen, M. B., & Frandsen, T. F. (2018). The impact of patient, intervention, comparison, outcome (PICO) as a search strategy tool on literature search quality: A systematic review. *Journal of the Medical Library Association*, 106(4), 420–431. <https://doi.org/10.5195/jmla.2018.345>
- Esteve-Mon, F. M., Llopis, M. A., & Adell-Segura, J. (2020). Digital competence and computational thinking of student teachers. *International Journal of Emerging Technologies in Learning*, 15(2), 29 – 41. <https://doi.org/10.3991/ijet.v15i02.11588>
- Falloon, G. (2020a). From digital literacy to digital competence: the teacher digital competency (TDC) framework. *Educational Technology Research and Development*, 68(5), 2449–2472. <https://doi.org/10.1007/s11423-020-09767-4>
- Falloon, G. (2020b). From digital literacy to digital competence: the teacher digital competency (TDC) framework. *Educational Technology Research and Development*, 68(5), 2449 – 2472. <https://doi.org/10.1007/s11423-020-09767-4>
- Fernández-Cruz, F.-J., & Fernández-Díaz, M.-J. (2016). Generation z's teachers and their digital skills. *Comunicar*, 24(46), 97 – 105. <https://doi.org/10.3916/C46-2016-10>
- Fernández-morante, C., López, B. C., & Casal-otero, L. (2023). *Teachers ' Digital Competence . The Case of the University System of Galicia*. 12, 62–76. <https://doi.org/10.7821/naer.2023.1.1139>
- García-Delgado, M. Á., Rodríguez-Cano, S., Delgado-Benito, V., & Di Giusto-Valle, C. (2023). Digital



- Teaching Competence among Teachers of Different Educational Stages in Spain. *Education Sciences*, 13(6), 581. <https://doi.org/10.3390/educsci13060581>
- Gordillo, A., Barra, E., López-Pernas, S., & Quemada, J. (2021). Development of teacher digital competence in the area of e-safety through educational video games. *Sustainability (Switzerland)*, 13(15), 1–12. <https://doi.org/10.3390/su13158485>
- Gudmundsdottir, G. B., & Hatlevik, O. E. (2018). Newly qualified teachers' professional digital competence: implications for teacher education. *European Journal of Teacher Education*, 41(2), 214 – 231. <https://doi.org/10.1080/02619768.2017.1416085>
- Guillén-Gámez, F. D., Cabero-Almenara, J., Llorente-Cejudo, C., & Palacios-Rodríguez, A. (2022). Differential Analysis of the Years of Experience of Higher Education Teachers, their Digital Competence and use of Digital Resources: Comparative Research Methods. *Technology, Knowledge and Learning*, 27(4), 1193 – 1213. <https://doi.org/10.1007/s10758-021-09531-4>
- Guillén-Gámez, F. D., Mayorga-Fernández, M. <sup>a</sup>J, Bravo-Agapito, J., & Escribano-Ortiz, D. (2021). Analysis of Teachers' Pedagogical Digital Competence: Identification of Factors Predicting Their Acquisition. *Technology, Knowledge and Learning*, 26(3), 481–498. <https://doi.org/10.1007/s10758-019-09432-7>
- Hanell, F. (2018). What is the “problem” that digital competence in Swedish teacher education is meant to solve? *Nordic Journal of Digital Literacy*, 13(3). <https://doi.org/10.18261/issn.1891-943x-2018-03-02>
- Instefjord, E. J., & Munthe, E. (2017). Educating digitally competent teachers: A study of integration of professional digital competence in teacher education. *Teaching and Teacher Education*, 67, 37 – 45. <https://doi.org/10.1016/j.tate.2017.05.016>
- Kildè, L. (2023). ESL Teachers' Approaches towards the Acceptance of Educational Technology Integration in Non-Formal Education: A Case from Kenya. *Journal of Education Culture and Society*, 14(1), 634 – 649. <https://doi.org/10.15503/jecs2023.1.634.649>
- Krumsvik, R. J. (2014). Teacher educators' digital competence. *Scandinavian Journal of Educational Research*, 58(3), 269 – 280. <https://doi.org/10.1080/00313831.2012.726273>
- Kullaslahti, J., Ruhalahti, S., & Brauer, S. (2019). Professional development of digital competences: Standardised frameworks supporting evolving digital badging practices. *Journal of Siberian Federal University - Humanities and Social Sciences*, 12(2), 175 – 186. <https://doi.org/10.17516/1997-1370-0387>
- Lucas, M., Bem-haja, P., Siddiq, F., & Moreira, A. (2020). Jo ur na l P re of. *Computers & Education*, 104052. <https://doi.org/10.1016/j.compedu.2020.104052>
- Lucas, M., Dorotea, N., & Piedade, J. (2021). Developing Teachers' Digital Competence: Results from a Pilot in Portugal. *Revista Iberoamericana de Tecnologias Del Aprendizaje*, 16(1), 84 – 92. <https://doi.org/10.1109/RITA.2021.3052654>
- Masalimova, A. R. (2022). *Validation of The Scale on Pre-Service Teachers ' Digital Competence to Assist Students with Functional Diversity*. 14(4).
- Masalimova, A. R., Erdyneeva, K. G., Kislyakov, A. S., Sizova, Z. M., Kalashnikova, E., & Khairullina, E. R. (2022). Validation of The Scale on Pre-Service Teachers' Digital Competence to Assist Students with Functional Diversity. *Contemporary Educational Technology*, 14(4). <https://doi.org/10.30935/cedtech/12301>
- McGarr, O., & McDonagh, A. (2021). Exploring the digital competence of pre-service teachers on entry onto an initial teacher education programme in Ireland. *Irish Educational Studies*, 40(1), 115 – 128. <https://doi.org/10.1080/03323315.2020.1800501>
- Melash, V. D., Molodychenko, V. V, Huz, V. V, Varenychenko, A. B., & Kirsanova, S. S. (2020). Modernization of education programs and formation of digital competences of future primary school teachers. *International Journal of Higher Education*, 9(7), 377 – 386. <https://doi.org/10.5430/ijhe.v9n7p377>
- Miguel-Revilla, D., Martínez-Ferreira, J. M., & Sánchez-Agustí, M. (2020). Assessing the digital competence of educators in social studies: An analysis in initial teacher training using the TPACK-21 model. *Australasian Journal of Educational Technology*, 36(2), 1 – 12.

- <https://doi.org/10.14742/ajet.5281>
- Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *BMJ (Online)*, *339*(7716), 332–336. <https://doi.org/10.1136/bmj.b2535>
- Muammar, S., Hashim, K. F. Bin, & Panthakkan, A. (2023). Evaluation of digital competence level among educators in UAE Higher Education Institutions using Digital Competence of Educators (DigComEdu) framework. *Education and Information Technologies*, *28*(3), 2485–2508. <https://doi.org/10.1007/s10639-022-11296-x>
- Murat, M., & Kukul, V. (2023). *and reliability study*. 2747–2765.
- Myry, L., Kallunki, V., Katajavuori, N., Repo, S., Tuononen, T., Anttila, H., Kinnunen, P., Haarala-Muhonen, A., & Pyörälä, E. (2022). COVID-19 Accelerating Academic Teachers' Digital Competence in Distance Teaching. *Frontiers in Education*, *7*(January), 1–11. <https://doi.org/10.3389/educ.2022.770094>
- Nagel, I. (2021). Digital Competence in Teacher Education Curricula: What Should Teacher Educators Know, Be Aware of and Prepare Students for? *Nordic Journal of Comparative and International Education*, *5*(4), 104 – 122. <https://doi.org/10.7577/njcie.4228>
- Nouri, J., Zhang, L., Mannila, L., & Norén, E. (2020). Development of computational thinking, digital competence and 21st century skills when learning programming in K-9. *Education Inquiry*, *11*(1), 1 – 17. <https://doi.org/10.1080/20004508.2019.1627844>
- Pettersson, F. (2018a). *On the issues of digital competence in educational contexts – a review of literature*. 1005–1021. <https://doi.org/10.1007/s10639-017-9649-3>
- Pettersson, F. (2018b). On the issues of digital competence in educational contexts – a review of literature. *Education and Information Technologies*, *23*(3), 1005 – 1021. <https://doi.org/10.1007/s10639-017-9649-3>
- Portillo, J., Garay, U., Tejada, E., & Bilbao, N. (2020). Self-perception of the digital competence of educators during the covid-19 pandemic: A cross-analysis of different educational stages. *Sustainability (Switzerland)*, *12*(23), 1 – 13. <https://doi.org/10.3390/su122310128>
- Rani, G., & Gandhi, A. (2022). Digital Competence of Teachers: an Urgency for Future Classroom 1. *Peer Reviewed and Refereed Journal*, *816*(6), 11. <http://ijmer.in.doi./2022/11.06.90>
- Redecker, C. (2017). European framework for the digital competence of educators: DigCompEdu. In *Joint Research Centre (JRC) Science for Policy report*. <https://doi.org/10.2760/159770>
- Reisoğlu, İ., & Çebi, A. (2020). How can the digital competences of pre-service teachers be developed? Examining a case study through the lens of DigComp and DigCompEdu. *Computers and Education*, *156*. <https://doi.org/10.1016/j.compedu.2020.103940>
- Rodríguez-García, A. M., Aznar Díaz, I., Cáceres Reche, P., & Gómez García, G. (2019). Digital competence in higher education: Analysis of the impact of scientific production indexed in Scopus database. *Espacios*, *40*(21). <https://www.scopus.com/inward/record.uri?eid=2-s2.0-85074136249&partnerID=40&md5=5ea1b4eca3b0c29f6b412bdf7b940ed>
- Røkenes, F. M., & Krumsvik, R. J. (2014). Development of student teachers' digital competence in teacher education. *Nordic Journal of Digital Literacy*, *2014*(4), 250–280. <https://doi.org/10.18261/ISSN1891-943X-2014-04-03>
- Sá, M. J., & Serpa, S. (2020). COVID-19 and the promotion of digital competences in education. *Universal Journal of Educational Research*, *8*(10), 4520 – 4528. <https://doi.org/10.13189/ujer.2020.081020>
- Sarkis-Onofre, R., Catalá-López, F., Aromataris, E., & Lockwood, C. (2021). How to properly use the PRISMA Statement. *Systematic Reviews*, *10*(1), 13–15. <https://doi.org/10.1186/s13643-021-01671-z>
- Siripan, P., & Noirid, S. (2022). Components and Indicators of Digital Teacher Competency in Schools under the Provincial Administration Organization. *Journal of Educational Issues*, *8*(2), 855. <https://doi.org/10.5296/jei.v8i2.20320>
- Spiteri, M., & Chang Rundgren, S.-N. (2020). Literature Review on the Factors Affecting Primary Teachers' Use of Digital Technology. *Technology, Knowledge and Learning*, *25*(1), 115 – 128. <https://doi.org/10.1007/s10758-018-9376-x>

- Starkey, L., & Yates, A. (2022). Do digital competence frameworks align with preparing beginning teachers for digitally infused contexts? An evaluation from a New Zealand perspective. *European Journal of Teacher Education*, 45(4), 476 – 492. <https://doi.org/10.1080/02619768.2021.1975109>
- Tarraga-Minguez, R., Suarez-Guerrero, C., & Sanz-Cervera, P. (2021). Digital Teaching Competence Evaluation of Pre-Service Teachers in Spain: A Review Study. *Revista Iberoamericana de Tecnologías Del Aprendizaje*, 16(1), 70 – 76. <https://doi.org/10.1109/RITA.2021.3052848>
- Tømte, C. E. (2015). Educating teachers for the New Millennium? Teacher training, ICT and digital competence. *Nordic Journal of Digital Literacy*, 2015(4), 138 – 154. <https://www.scopus.com/inward/record.uri?eid=2-s2.0-84946546168&partnerID=40&md5=a691b3442fef7461a0045170add9e6d>
- Torres, N., María, H., & Gallego, J. (2022). *Indicators to assess preservice teachers' digital competence in security: A systematic review*. 8583–8602. <https://doi.org/10.1007/s10639-022-10978-w>
- Touron, J., Martin, D., Navarro Asencio, E., Pradas, S., & Inigo, V. (2018). Validation de constructo de un instrumento para medir la competencia digital docente de los profesores (CDD). *Revista Espanola de Pedagogia*, 75(269), 25–54. <https://doi.org/10.22550/REP76-1-2018-02>
- Tzafilkou, K., Perifanou, M., & Economides, A. A. (2023). Assessing teachers' digital competence in primary and secondary education: Applying a new instrument to integrate pedagogical and professional elements for digital education. *Education and Information Technologies*, 0123456789. <https://doi.org/10.1007/s10639-023-11848-9>
- Van Eck, N. J., & Waltman, L. (2021). Manual VOSviewer. *Univeriteit Leiden, January*, 54.
- Van Laar, E., van Deursen, A. J. A. M., van Dijk, J. A. G. M., & de Haan, J. (2017). The relation between 21st-century skills and digital skills: A systematic literature review. *Computers in Human Behavior*, 72, 577–588. <https://doi.org/10.1016/j.chb.2017.03.010>
- Windasari, Karwanto, Supriyanto, P. S. (2022). *Factors Affecting Teacher Digital Competence: An Exploratory Factor Analysis*. 8(4), 1029–1038. <https://doi.org/doi.org/10.33394/jk.v8i4.6095>