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A Bibliometric Analysis of Research on Teachers' Digital Competences

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Abstract

Global events have become a driving force for digital transformation in education. In the digital transformation process, education systems have started to evolve within a digital infrastructure and have gone beyond traditional education patterns. This process has reshaped education systems and increased the importance of digital competence. Therefore, in this digital transformation process, teachers' digital competence levels have emerged as a critical concept for the sustainability of education systems and the effectiveness and efficiency of education, and as a prerequisite for the effectiveness of learning processes. As a result, many academic studies have been conducted in recent years to investigate this need. The aim of this research is to analyze academic studies that focus on teachers' digital competence using bibliometric analysis methods. Among the results, it was found that the number of publications has been steadily increasing, with Spain being the country that produces the most publications in the field concerning teacher digital competence.

Keywords: Digital competences, bibliometric analysis, teachers, teacher's digital competences

Introduction

Digitalization has transformed modern schools into an increasingly complex school environment (Hatlevik & Christophersen, 2013). As societies become increasingly digitalized, the demand for digitally competent teachers has evolved and the need for new approaches when it comes to technology integration in education has increased (Instefjord & Munthe, 2017). Technology has great potential to enrich classroom environments, facilitate students' learning processes and increase equality of opportunity in education. However, the realization of this potential depends on teachers' ability to use digital tools effectively for pedagogical purposes (Tondeur et al., 2007). As digital technologies have become increasingly central to education, this

competency has emerged as a critical factor for student achievement. Digital competence refers to the skills, knowledge and attitudes needed to use digital technologies effectively in a variety of educational settings. It encompasses not only technical skills but also pedagogical knowledge that enables teachers to select, adapt and create digital content that enhances the learning process. While research shows that these competences are crucial for successful digitalization and effective technology integration in schools (Heine et al., 2023), this new competence is recognized as-critical in the teaching profession and leads to success in teaching quality (Garcia-Ruiz et al., 2023).

Following the digitalization of schools, it can be said that there is a growing interest among practitioners and researchers to understand what competences teachers need to carry out the teaching process using digital technologies (Skantz-Åberg et al., 2022). Both theoretical foundations and models need to be developed for a deeper understanding of digital competence in teacher education both nationally and internationally (Krumsvik, 2014). Academic studies have become widespread with the increasing role of digital transformation in education due to the rapid advancement of technology. The success of digital transformation in education is closely related to teachers' ability to use digital tools pedagogically effectively. Research examining this idea is of great importance in terms of shaping educational policies and teacher education programs. It is important to examine the studies in terms of purpose, content and context in order to reveal the picture of the current situation in the literature on digital competencies. In this context, this study aims to reveal the general situation of the studies on teachers' digital competence published in the WOS (Web of Science) database through bibliometric analysis. In line with this general purpose, the research was aimed to examine the distribution of the number of citation distribution, document types, countries, and keyword analysis. Also, analysis was made of co-authorship by countries, and citations in journals by authors in publications made in 2022, 2023 and 2024.

Conceptual Framework

Digital competence

In the 21st century, it is increasingly necessary to participate meaningfully in the new information society and economy (Napal Fraile et al., 2018). Technological changes, the adoption of Web2.0, its impact on citizens' privacy, and the need to know how to protect one's privacy and access information in a trusted environment bring renewed sets of competencies (Janssen et al., 2013). One of these competence areas is defined as digital competence. This is an important challenge for the education systems of the new century (Calvani et al., 2008). Digital competence generally refers to the skills and literacies required for the average citizen to learn and navigate the digitized information environment (Ilomäki et al., 2016). Digital competence, which consists of the knowledge and ability to manage different digital devices and software to use the Internet and digital technology in an educational and critical approach (Amhag et al., 2019), enables individuals to benefit from the wealth of new possibilities associated with digital technologies and the challenges they pose (Napal Fraile et al., 2018).

Digital competence, defined as “survival skills in the digital age” (Eshet-Alkalai, 2004), has in recent years become a key concept in discussions about what kind of skills and attitudes people should have in the information society (Ilomäki et al., 2011). It is also defined as the creative, critical and confident use of information and communication technologies to achieve goals related to work, employability, learning, leisure, inclusion in certain groups and participation in society (INTEF, 2017; Redecker, 2017), is identified as one of the eight key life skills in the recommendation on core competencies for lifelong learning proposed by the European Commission 2006. It also includes the confident and critical use of electronic media for work, leisure and communication, and is related to logical and critical thinking, high-level information management skills and well-developed communication skills (Delgado-Vázquez, 2021). At the same time, digital competence includes the ability to flexibly explore and confront new technological situations, to analyze, select and critically evaluate data and information, to use technological potentials to represent and solve problems, to create shared and collaborative knowledge, as well as to promote awareness of one's own personal responsibilities and respect for mutual rights/obligations (Calvani et al., 2008).

Due to the rapid development of digital technologies in the emerging information society, today's workforce requires individuals to be able to use a variety of cognitive skills to solve problems in digital environments (Aviram & Eshet-Alkalai, 2006). Since individuals do not have enough interest, confidence, social support or opportunities to start developing their digital competencies, people who do not have sufficient digital competence experience various problems. For example, they are at risk of being excluded from activities, not taking full advantage of available opportunities, and may even endanger themselves while using digital tools (Ala-Mutka, 2011). Accordingly, digital competence is the set of knowledge, skills, attitudes, abilities, strategies and awareness required when using digital tools; solving problems, communicating, managing information, collaborating, creating and sharing content, and constructing information effectively, efficiently, appropriately, critically, creatively, autonomously, flexibly, ethically and reflectively for work, leisure, participation, learning and socializing (Ferrari, 2012). Even the definition of digital competence reveals that digital competence is relevant to many areas of life (work, entertainment, communication) and that it goes beyond mere knowledge and technical skills as it also refers to self-confidence and a critical attitude (Janssen et al., 2013).

Teachers' Digital Competences

An assumption shared by researchers working on digital competence and different positions dealing with this concept is that teachers' digital competence is more complex than digital literacy in other professions and among average citizens (Krumsvik, 2014; Masoumi & Noroozi, 2023). Digital competence in education is much more than the skillful, creative and safe use of digital technologies. The continuous and very rapid development of modern ICT requires teachers to involve themselves in continuous pedagogical progress (Amhag et al., 2019).

Teachers' digital competence is becoming increasingly important in education as digital resources and digital media have become important parts of teachers' everyday practice (Gudmundsdottir & Hatlevik, 2018). Teachers need to update their competence profiles for 21st century challenges, their teaching strategies need to change and the competences they need to develop to empower 21st century learners

also need to change (Caena & Redecker, 2019). Teachers have a fundamental role in education as their task is not only to teach but also to be role models for information and communication-based instruction (ICT) (Ungar & Baruch, 2016). As digital technologies become a central part of everyday work, teachers are forced to rethink and transform previous educational traditions through technology (Pettersson, 2018). Being able to integrate and use technology for educational purposes requires having a set of general skills and specific teaching profession skills that are appropriate for all situations, both personal and professional (Instefjord & Munthe, 2017). Teachers' digital competence is one of the most important factors in the successful integration of technology into education. This requires digitally competent teachers to be confident and have a digital repertoire that can serve as a basis for making educated choices about when and how to integrate technology into educational practice (Johannesen et al., 2014).

The teaching profession is facing a rapidly changing world that requires broader and more complex competencies than ever before. The ubiquity and easy accessibility of digital devices and applications, especially in computer technologies, requires educators to develop their digital competencies (Gündüzalp, 2021a). Teachers need to know not only how to use new technologies, but also how to integrate them deeply into their curricula to meet the changing needs of their students (Gunter & Reeves, 2017; Gündüzalp, 2021b). How to apply the pedagogical use of ICT in education depends on their own high or low digital competences and requires both a practical and theoretical awareness of professional development (Krumsvik, 2014). By using technology, teachers have the opportunity to contribute to students' learning while creating more dynamic and flexible learning environments that address the educational needs of today's students. Many educational institutions are changing their teaching methods and striving to provide a convenient, safe and flexible learning environment for their students (Schleicher, 2020).

Krumsvik (2014) argues that the digital competence of teachers or educators is different from that of other technology users; it involves the intersection between cognition, metacognition, motor skills, learning strategies, self-efficacy and pedagogical-didactics. Teachers' digital competence requires not only technological knowledge and skills but also the ability to combine technology integration with their pedagogical approach (Koehler & Mishra, 2009). *Pedagogical Digital Competence* is the ability to develop/improve pedagogical work in a professional context, especially in online teaching, through digital technology (From, 2017). Teachers need to be aware of the effects of their competence in using ICT in a professional context with effective pedagogical-didactic judgment on learning strategies and students' digital development (Krumsvik, 2008).

Teachers' digital competence includes the ability to identify reliable information in digital environments, cite sources, protect intellectual property, apply ethical values and attitudes in communication and interaction, produce their own digital resources, and respect their own and their students' cultural differences, values and rights (Kelentrić et al., 2017). Research shows that digitally competent teachers are more likely to adopt student-centered approaches that promote collaboration, critical thinking, and problem solving (Voogt et al., 2018). For teachers, digital competence means that in addition to being able to use technology themselves, teachers need to meta-reflect on the use of technology in relation to pedagogy and what it can mean for student learning in specific contexts (Sanders & George, 2017). The ability to facilitate students' digital competence is an integral part of educators' digital competence (Redecker, 2017).

It is known that digital technologies can provide new opportunities for teaching and learning (Chauhan, 2017). Teachers need to develop their competencies to enable their students to engage productively, safely and ethically in digital environments (Falloon, 2020). Strategies should be created to support and create an environment for teachers to acquire the necessary digital competence (Krumsvik, 2008). Many schools have good access to computers and the necessary technology infrastructure, but despite access to such tools, the pedagogical use of instructional technology is changing (European Commission, 2013). While schools need to have access to technological infrastructure, teachers need to be digitally competent in order to use technological tools consciously and to be able to use them in instructional processes.

Digital tools can support differentiated instruction by allowing teachers to tailor content to the needs of individual learners, increasing both accessibility and engagement (Kozma, 2005). In addition to the benefits of incorporating digital technologies into learning processes of students', teachers need to have some skills in the digital World. It is no longer possible to think of students who are intertwined with technology as independent and approach them by ignoring their digital skills. (Gündüzalp, 2021a). Teachers need to be able to teach their students how to find information, including using various search engines and reading various articles, and then critically evaluating the results (Kinzer, 2010). When teachers apply this strategy for information management in the classroom, students learn to think critically about information found on the internet (Spiteri & Chang Rundgren, 2020). Therefore, being digitally competent includes not only having the skills to use digital technologies, but also having knowledge and awareness of ethical issues related to the practice and a broader understanding of technology and media in society (McGarr & McDonagh, 2021).

All educators have a responsibility to develop their digital competences, to improve them over time and to incorporate the adopted knowledge, skills and attitudes into their educational processes (Tretinjak & Anđelić, 2016). Teachers need to realize the potential of digital technology in their daily practice and use it well. However, teachers need training and guidelines to develop their expertise in using technology for teaching and learning (Spiteri & Chang Rundgren, 2020). Recognizing this need, many researchers and institutions have produced educational research on the integration of technology into classroom teaching, as well as models and frameworks for teachers' professional digital competence.

With the mission of lifelong learning, digital competencies need to be continuously updated and developed (Gündüzalp & Yaraş, 2022). Both in teacher education and teacher professional development, teachers' digital competence should be developed and teachers should be prepared for digitalization in schools (König et al., 2020). As an extended view of contemporary teacher digital efficacy, this has the possibility of teachers becoming 'change agents' in the digital transformation process (Falloon, 2020). Therefore, teachers need to continuously improve themselves. Due to factors such as the changing needs and expectations of students and the rapid development of knowledge, a good teacher is in pursuit of innovations and becoming a pioneer of change with a philosophy of continuous development.

Bibliometric Analysis

As noted by Donthu et al. (2021), bibliometric analysis is a rigorous method for exploring and analyzing large volumes of scientific data that helps researchers highlight

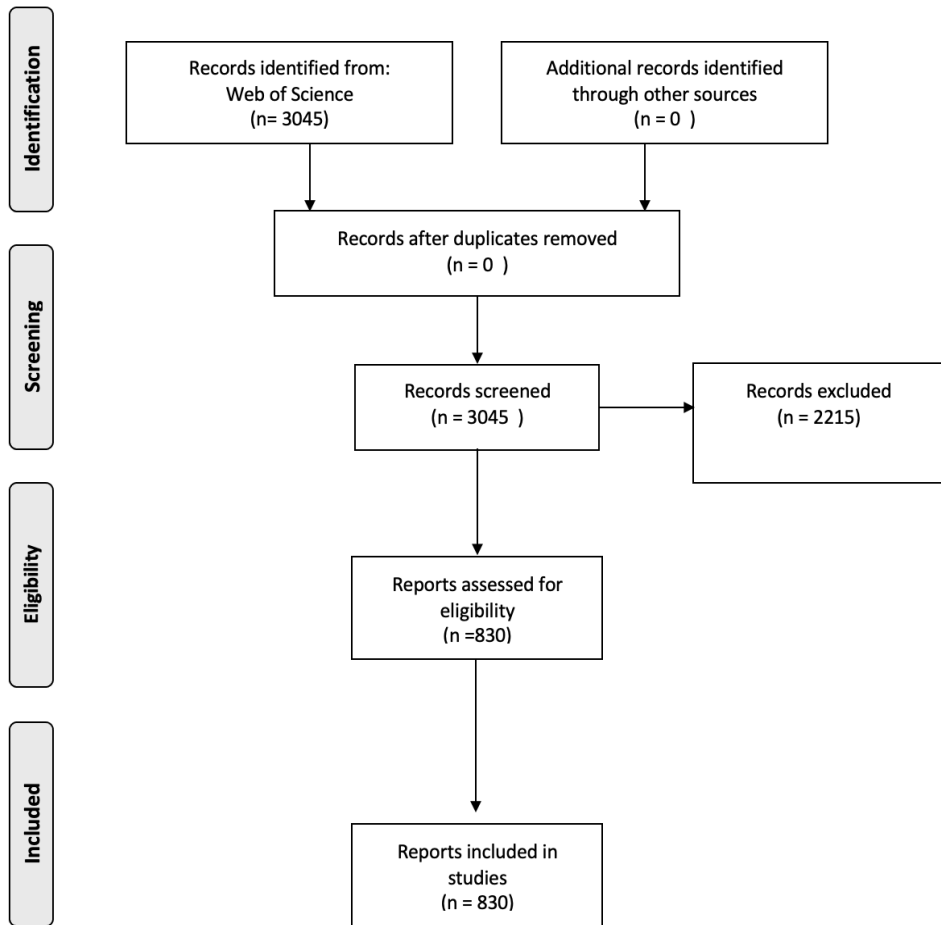
emerging patterns and trends while revealing research patterns in a limited field. Scientific measurement or bibliometrics, i.e. quantitative methods of analysis, can be used to understand emerging trends, hotspots and the overall knowledge structure in a research field (Chen et al., 2012). To extract and process data, bibliometric methods based on content or citation analysis are often used (Wallin, 2005). Bibliometrics is considered a statistical method used to process scientific data, reveal knowledge development, determine research impact, decipher disciplinary nuances, and uncover research topics (Li & Lei, 2021). According to Zupic and Cater (2015), it is possible to conduct in-depth analysis of hundreds or even thousands of studies with the bibliometric method. Bibliometric analysis has emerged as a powerful tool for researchers to uncover trends and patterns in scientific literature across a wide range of disciplines (Esh & Ghosh, 2024). It is recommended to use bibliometric analysis when examining a large data set that would be difficult to analyze manually (Donthu et al., 2021). Bibliometric analysis can provide an objective and quantitative analysis to measure the contribution of academic output to the advancement of knowledge on a particular topic (Yang et al., 2013). This method increases the objectivity of literature reviews (Gülmez et al., 2020).

Method

In this study, the articles on teachers' digital efficacy published in the Web of Science (WoS) database were analyzed by bibliometric analysis method.

Data Collection and Data Analysis

The studies in the WoS database were used for the literature review on teachers' digital competencies. It has the oldest and most comprehensive records of citation indexes and includes a useful analysis tool (Ellegaard & Wallin, 2015), was chosen as the search engine because it is the most widely accepted and frequently used database for the analysis of scientific publications (Yang et al., 2013). For this purpose, the WoS database was searched using boolean operators as ((teachers) and (digital competence) not (higher school)) as shown in Figure 1. Only the term "digital competence" was used in the search process. Other alternative terms to digital competence were not used. Because it was thought that the research results were obtained exactly in accordance with the research purpose. As a matter of fact, Mañas and González (2023) stated in their study that the terms "teachers" and "digital competence" are significantly more overlapping terms. On the search results, the year 2022, 2023, 2024, "Research Areas: Education Educational Research", "Web of Science Categories: Education Educational Research or Education Scientific Disciplines" were filtered again. Finally, 830 studies in eight different document types were obtained in Web of Science Core Collection. Analyses were carried out on these data. This process is shown in Figure 1. Bibliometric analyses on the obtained data were carried out in the categories of distribution of publications and number of citations, distribution of publications according to document types, country distribution of publications, keyword analysis, co-authorship analysis, co-author analysis by countries, citation analysis by journals, citation analysis by authors, citation analysis by countries.

Figure 1*Literature Review Process Using PRISMA Model in Web of Science (Moher et al., 2009)*

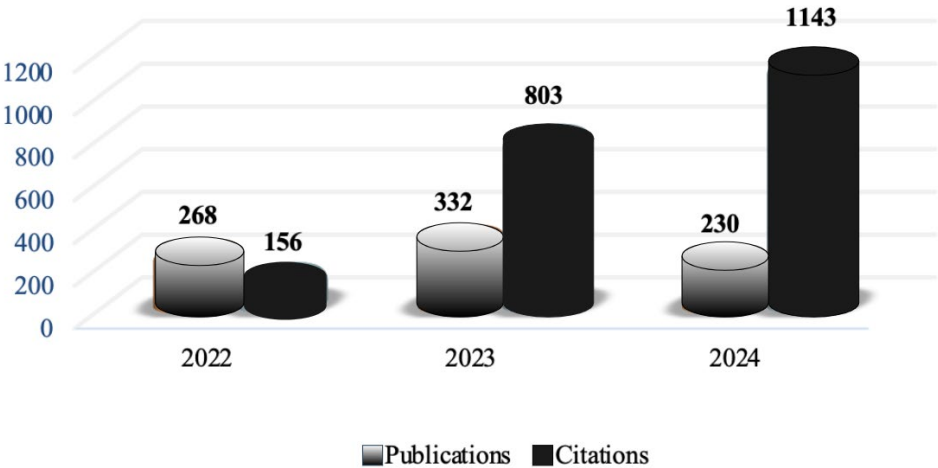
Bibliometric studies also include graphical descriptions of the research area (Börner et al., 2003). In this article, VOSviewer version 1.6.18, a bibliometrics software for visual analysis of research trends (Van Eck & Waltman, 2010), was used to see changes and development in science (Koza-Çiftçi et al., 2016) by revealing the quantitative analysis of scientific publications related to teachers' digital competencies. VOSviewer is a text mining software that creates co-occurrence networks and depicts topics or themes taken from the literature (Contreras & Abid, 2022). Bibliometric analyses on the data obtained were carried out in the categories of distribution of publications and number of citations, distribution of publications by document types, country distribution of publications, keyword analysis, co-authorship analysis, co-author analysis by country, citation analysis by journals, citation analysis by authors, and citation analysis by country.

Findings

Distribution of Publications and Citations by Year

The distribution of publications and citations by years as of 2022, 2023 and 2024 is given in Figure 2.

Figure 2
Distribution of Publications and Citations



When the figure is analyzed, it is seen that 268 publications were produced in 2022, 332 in 2023 and 230 in 2024. When the citations are analyzed, it is seen that 156 citations were made in 2022, 803 in 2023 and 1143 in 2024. It can be seen that citations have increased over the years.

Most Cited Publications

Table 1 provides information on the top five most cited publications.

When Table 1 is examined, it is seen that the most cited study in the literature is the article “Teachers’ Digital Competencies in Higher Education: A Systematic Literature Review” published by Basilotta-Gomez-Pablos, Matarranz, Casado-Aranda & Otto in 2022. It received a total of 112 citations as of 2022, 2023 and 2024.

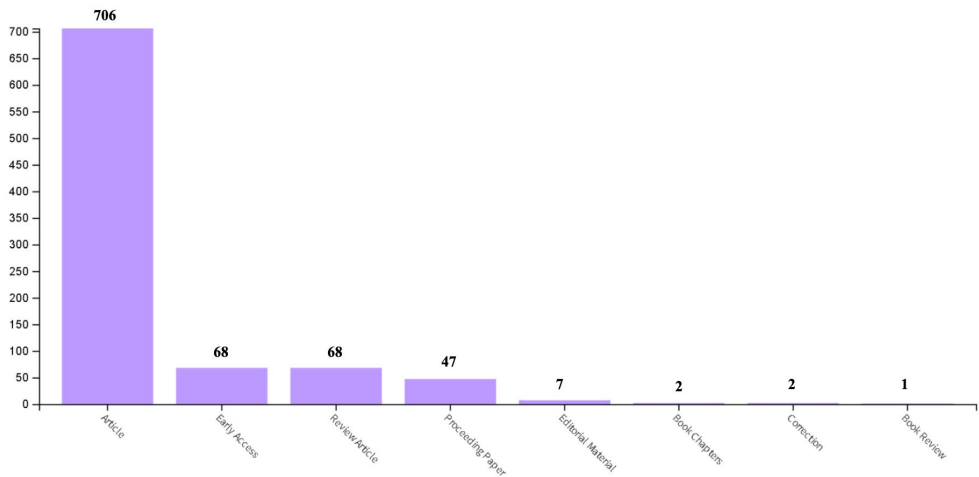
Table 1*Information on the Top Five Most Cited Publications*

	Publication Name	Author/ Authors	Publication Year	Citations
1	Teachers' Digital Competencies in Higher Education: A Systematic Literature Review	Basilotta-Gomez-Pablos, Veronica; Matarranz, Maria; Casado-Aranda, Luis-Alberto; Otto, Ana	2022	112
2	Teacher Support and Student Motivation To Learn With Artificial Intelligence (AI) Based Chatbot	Chiu, Thomas K. F.; Moorhouse, Benjamin Luke; Chai, Ching Sing; Ismailov, Murod	2023	69
3	Teachers' professional digital competence: an overview of conceptualisations in the literature	Skantz-Åberg, Ewa; Lantz-Andersson, Annika; Lundin, Mona; Williams, Pia	2022	50
4	Key factors in digital literacy in learning and education: a systematic literature review using text mining	Audrin, Catherine; Audrin, Bertrand	2022	40
5	Artificial Intelligence and Learning Analytics in Teacher Education: A Systematic Review	Salas-Pilco, Sdenka Zobeida; Xiao, Kejiang; Hu, Xinyun	2022	37

Distribution of Publications by Document Types

The distribution of publications made as of 2022, 2023 and 2024 according to document types is given in Figure 3.

Figure 3
Distribution of Publications by Document Types

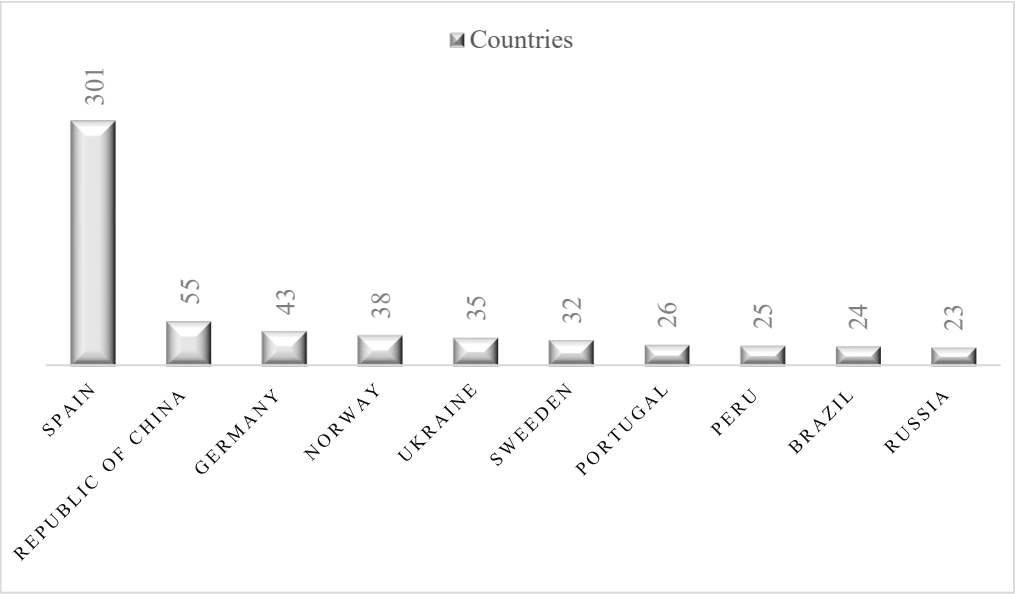


When the figure is analyzed, it is seen that the most common document type is article with 706 studies. The least document type is book review with 1 study.

Country Distribution of Publications

The distribution of the top ten countries with the most studies on teachers' digital competencies in the Web of Science database is given in Figure 4.

Figure 4
Distribution of Publications by Countries



the fifth cluster, 11 in the sixth cluster, 8 in the seventh cluster, 7 in the eighth cluster and finally 6 in the ninth cluster. The top five most used keywords are given in Table 2.

Table 2
Top Five Most Used Keywords

	Keywords	Occurances	Total Link Strength
1	digital competence	193	377
2	higher education	109	228
3	teacher training	86	195
4	teacher education	58	109
5	educational technology	52	106

Co-Authorship Analysis

Figure 6 shows the network map obtained as a result of the co-authorship analysis of the researchers with the highest number of co-authorships on teachers' digital competence. When the number of documents was at least 5 and the number of citations was at least 1, it was seen that only 15 authors out of 2137 authors met the conditions. In the last stage, it was revealed that 8 authors were connected among each other. At the same time, the number of documents, number of citations and link strength information of the authors are given in Table 3.

Figure 6
Co-Authorship (Authors) Analysis Network Map

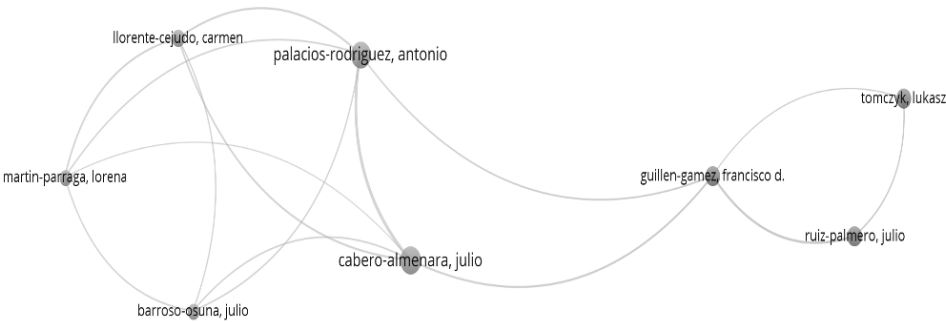


Table 3

According to the Findings of the Co-Authorship Analysis, the Author, the Number of Citations and Total Link Power

Author	Documents	Citation	Total Link Strenght
cabero-almenera,julio	15	80	18
palacios-rodriguez,Antonio	14	74	18
llorente-cejudo,carmen	6	21	11
guillen-gamez,francisco d.	8	35	10
barosso-osuna,julio	5	19	8
martin parraga,lorena	5	32	8
moorhouse, benjamin luke	8	95	6
ruiz-palmero,julio	8	14	6

As can be seen in Figure 6, cabero-almenera,julio and palacios-rodriguez, Antonio are the authors with the highest number of co-authors.

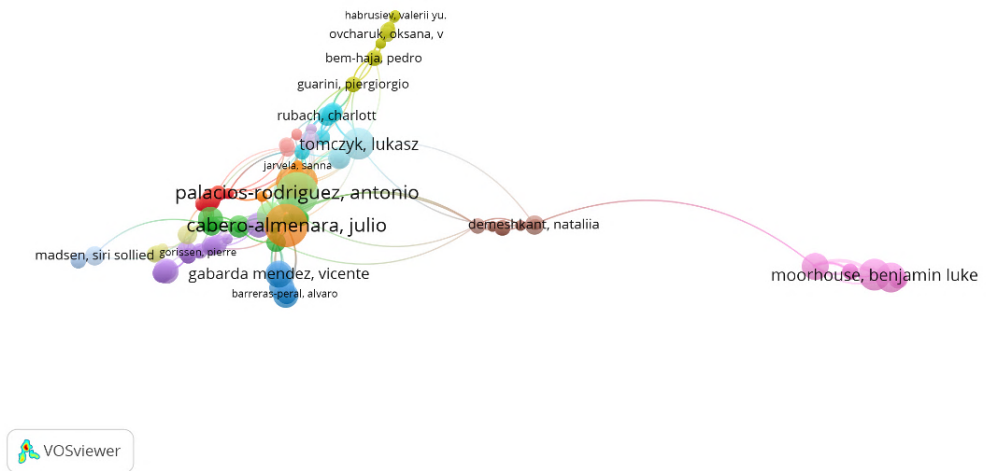
Co-Author Analysis by Countries

The results of the co-author analysis according to the countries in order to reveal the country-specific connections of the authors who conducted a joint study on teachers' digital competence are shown in Figure 7. In the analysis phase, the minimum number of studies was determined as 1 and the minimum citation value as 1. It was determined that there were 90 countries that met these conditions. It was concluded that 69 out of 90 countries were linked to each other. In the last stage, it was concluded that 61 out of 69 countries were interconnected. When Figure 7 is analyzed, it can be seen that Spain stands out with the most studies in the literature.

Citation Analysis by Sources

In Figure 8, the number of studies on teachers' digital competencies was determined as at least 1 and the number of citations was determined as at least 1. It was determined that 155 of the 279 sources that met these conditions were linked. In the last stage, it was concluded that 63 of the 155 studies were linked to each other. citation analysis network map of the journals and citation analysis density map of the journals in Figure 8. In the figure, the size of the circles and the number of citations are in direct proportion. In this context, when the top three journals with the highest number of citations are evaluated, it is revealed that the journal "Education and Information Technologies" ranks first with 321 citations. In the second place was the journal "Education Sciences" with 217 citations and in the third place was the International Journal of Educational Technology in Higher Education with 121 citations.

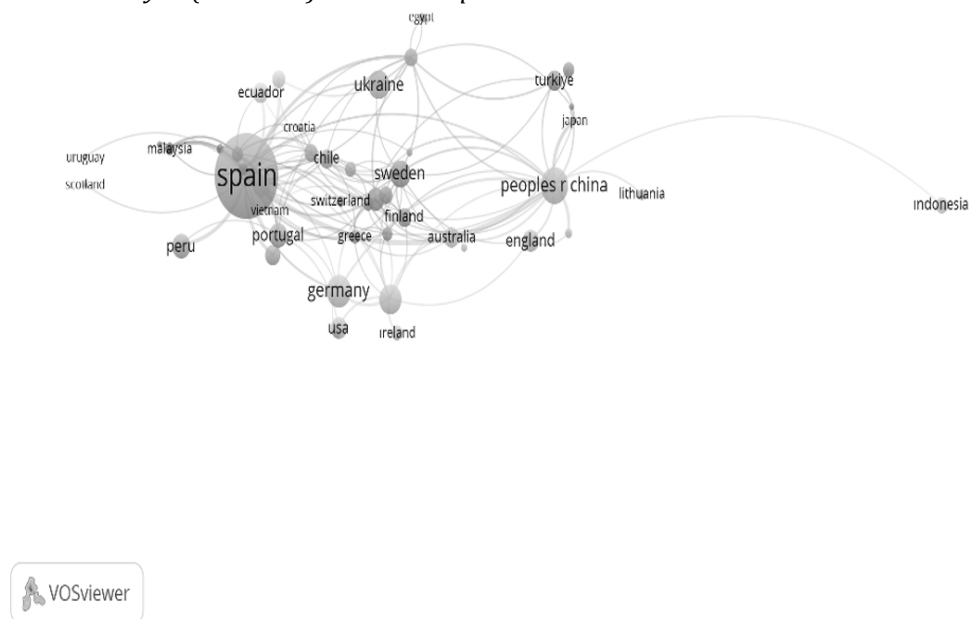
Figure 9
Citation Analysis (Authors) Network Map



Citation Analysis by Countries

Figure 10 shows the citation analysis map by countries. In the analysis process, the number of citations of countries was determined as at least 1 and the number of documents as at least 1, and it was determined that 69 out of 90 countries met the criteria. In the last stage, 50 countries that were found to be interconnected were included in the analysis. The most cited country was Spain with 912 citations.

Figure 10
Citation Analysis (Countries) Network Map



Discussion and Conclusion

In the 21st century context, defining and measuring the digital skills and competencies needed to succeed has been a widely researched topic in recent years. The digital revolution and the increasing digitization of school life in recent decades have created a need for digitally competent teachers who can apply ICT adequately (Mishra & Koehler, 2006). Beyond these basic digital skills, educators need adequate digital competences to cope with the challenges of the technological world, a competence that enables them to enrich their teaching and their own professional development (Esteve-Mon et al., 2020). In parallel with this need, there are many studies in the literature on teachers' digital competencies. Academics and other researchers consider it to be of increasing importance due to the digital transformation process that institutions and organizations and society are immersed in, forcing them to achieve an information society (Orero-Blat et al., 2022). Especially in recent years, the COVID-19 health crisis has given impetus to the digitalization of education (Basilotta-Gómez-Pablos et al., 2022; Leksansern et al., 2023). Wu et al. (2024) found that education research is among the top 3 categories of research on digital competencies/literacy. In this study, the studies on digital competence of teachers published in the journals in Web of Science were examined by bibliometric analysis.

Wu et al. (2024) examined all studies on digital literacy in WoS 1990-2024 and found that 5469 publications in the last 5 years accounted for a significant 60% of the total number of publications. Delgado-Vázquez et al. (2019) similarly showed that productivity in studies on digital competence has increased significantly since 2006-2019. Basilotta-Gómez-Pablos et al. (2022) found a significant increase in the number of articles published on teachers' digital efficacy between 2000 and 2021 in the last decade. According to Audrin & Audrin (2022), in 2001 very few studies were published on the topic of digital literacy and learning, whereas in 2020 nearly 300 articles were published on this topic. These results may seem logical and obvious since digitalization itself is a fairly new concept that has really exploded in the last decade. Rodríguez-García et al. (2019) reported that of the 112 publications on digital competence published in the scopus up to 2016, this area concentrated the most research production, representing 63.4% of all research on this topic, especially in the period 2014-2016. Palacios-Núñez et al. (2022) conducted a bibliometric analysis of 172 studies published in Web of Science linking innovation and digital competence and found that 54% of the articles were published during the pandemic period (2020-2021). Our study shows that the number of publications that increased after the pandemic continued in 2022-2023 and 2024.

Esh and Ghosh (2024) used bibliometric analysis to investigate the contributions in the field of digital literacy and digital competence between 2002 and 2022. In the current study, it was determined that this increase continued between 2022-2024 and especially in 2024, studies on teachers' digital competencies received 1143 citations. Three of the top five most cited articles are systematic reviews and one is a literature review. The fact that literature reviews are more preferred in citation may indicate that these studies have more visibility. Skantz-Åberg et al. (2022) found that only one of the studies they examined published between 2010-2019 was a literature review. This may indicate that as research on digital competencies increases, systematic reviews increase in the following years.

Another result of our study is that Spain, China, Germany, Norway are the countries that publish the most on teachers' digital competencies. Similar to Juliandarini et al.

(2024), Spain and Germany are the leading countries in the field. Spanish authors and institutions also stand out in the study on teaching digital competence in universities, expanding networks to Latin America, Europe, Anglo-Saxon countries and Asia (Cisneros-Barahona et al., 2022). According to Palacios-Núñez et al. (2022), Spain has the highest production in the related field. Among the countries with the highest production related to digital competence are: United States, Spain and Great Britain (Delgado-Vázquez, 2019). Rodríguez-García et al. (2019) found that out of 112 publications on digital competence published in the scopus until 2016, Spain was the country with the highest number of digital competence research in the field of higher education with 65 publications and 58.04%. In second and third place are the United Kingdom (7.14%) and Norway (6.25%). This is also supported by the study of Esteve et al. (2020). Spain is the country with the most research on this topic. It is noted that the subject of study focusing on digital competence in the Spanish field has been established from 2018 to the present, with lines of research focusing on pedagogical teaching methods, technological resources and intermediaries involved in educational processes (Moreno-Guerrero et al., 2022). Despite this, Mañas and González (2023) argue that the scopus is still in its infancy in Spain, considering the scientific research focused on digital competence training in teachers and the results obtained.

One of the countries with the most publications on teachers' digital competences is China. Professionals and researchers in various fields in China have been interested in teachers' digital competence since the beginning of the twenty-first century, which has led to an increase in the number of publications in the field (Li & Tinmaz, 2024). Shi & Wan, (2024) in China's education digitization research, noted that many studies have examined improving teachers' and students' digital literacy/competence.

The most commonly used keywords are digital competence, higher education, teacher training, teacher education, educational technology. According to Skantz-Åberg et al. (2022), digital competence is the most commonly used concept in the reviewed studies. According to Juliandarini et al. (2024), one of the main themes of the widely cited articles is the digital competence of teachers in relation to the COVID-19 pandemic that has been ongoing since the end of 2019. In the study of Palacios-Núñez et al. (2022), two important relationships between the concepts of innovation and digital competence stand out in the use of keywords together. Skantz-Åberg et al. (2022) found that in publications retrieved from a search of educational databases, the concept of teachers' professional digital competence or related concepts was frequently mentioned in abstracts, keywords and full texts, but largely rarely explained in detail.

Looking at the top three most cited journals, it was revealed that "Education and Information Technologies" ranked first with 321 citations. According to (Juliandarini et al., 2024), this result was not surprising with the finding that most of the articles were published in educational technology journals between 2018-2022.

Although our research concludes that there is an increasing trend in the literature regarding teachers' digital competence, as Basilotta-Gómez-Pablos (2022) points out, there is still a long way to go. There continues to be a need to improve teachers' digital competence to ensure that ICT is integrated more strategically in the classroom; instead of simply transferring Power Point or other virtual materials to students, the teacher needs to become an analyst and problem solver as well as a creator of digital content (Rahimi & Tafazoli, 2022).

In line with the results obtained from the research, it can be said that efforts to improve teachers' digital competencies remain important in terms of ensuring the sustainability of digital transformation in education. With our research, it can be

concluded that there is an increasing trend in the literature regarding teachers' digital competence, but as Basilotta-Gómez-Pablos (2022) states, it can be seen that there is still a long way to go. In order to integrate ICT more strategically in the classroom, there is a need to improve teachers' digital competence. Teachers should not only transfer Powerpoint or other virtual materials to students, but also be analyzers, problem solvers and creators of digital content (Rahimi & Tafazoli, 2022). Therefore, training for teachers' digital competencies needs to be continuously promoted to ensure the digital transformation and sustainable development of education (Shi & Wan, 2024). In this context, although the increasing trend in the literature shows that awareness of this field is rising, it is clear that teachers' digital competencies need to be continuously supported and updated. For this reason, trainings on digital competence should be encouraged continuously to guarantee the digital transformation and sustainable development of education (Shi & Wan, 2024). Thus, increasing digital competencies will enable teachers to develop more effective and creative teaching methods by strategically using information and communication technologies (ICTs) in the classroom. As a result, for digital education to be implemented efficiently, teachers need to be able to not only use digital tools, but also to act as creators of digital content and designers of digital learning environments. Therefore, educational policies and teacher training programs should focus on the development of digital competencies and create long-term strategies for digital transformation in education.

Limitations

The application of the inclusion and exclusion criteria set to examine research on teachers' digital competencies limited the scope of the study. Therefore, the results of the review were limited to only those studies that met the identified criteria. The key terms used to search the databases may have missed potentially important studies and the database searches may not have revealed all relevant studies for the review. At the same time, the exclusion of articles that did not explicitly state teachers' digital competencies in their titles may have led to the exclusion of studies that indirectly addressed competence. Although the fact that it does not include studies conducted before 2022 is also considered as a limitation of the study, the fact that most of the systematic studies from the relevant field cover the years until 2021-2022 may eliminate this limitation as this study is a continuation. Another limitation of the study is that the search was conducted in WoS and other bibliographic databases such as Scopus or ERIC were excluded. Despite these limitations, it is possible to say that the current study will provide a general view of the journals in WoS as the indexes in which they are indexed have high international validity and are one of the most prominent bibliographic databases.

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