

Teacher Digital Competence: A Bibliometric Analysis of Global Research Trends

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ABSTRACT

The quick progress of digital technologies has significantly changed education processes and increased the necessity for teachers to have enough digital skills. Teacher digital competence has become one of the important issues to be researched with an emphasis put on digital technologies integration into the process of teaching, assessment, professional development, and learning. This study is devoted to analyzing the global trends in researches, intellectual structure, major contributions, and new research directions concerning the issue of teacher digital competence through the bibliometric analysis method. The data were collected in the Scopus database with the use of appropriate keywords linked to teacher digital competence, digital literacy, digital skills, and educational technologies. The publications were analyzed by means of bibliometric methods like performance analysis, citation analysis, keyword co-occurrence analysis, density visualization, thematic evolution, and collaboration networks analysis with the use of VOSviewer. The results prove a significant trend of the increasing interest to the problem of teacher digital competence, especially since the beginning of the COVID-19 pandemic when more and more online and technology-enhanced learning became common. It is possible to state that the major research themes include digital competence, digital literacy, teacher training, e-learning, digital transformation, and technology integration. Citation analysis highlights influential studies focusing on digital competence frameworks, teacher readiness, and digital transformation in education, while collaboration analysis identifies Spain and several European countries as major contributors to global knowledge development. Recent trends indicate a growing research interest in artificial intelligence, digital tools, and innovative learning systems. This study contributes to the existing literature by mapping the evolution of teacher digital competence research and identifying future research directions related to sustainable digital education, AI-supported teaching, and equitable access to digital learning environments.

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1. INTRODUCTION

The notion of digital competence has gained a lot of attention in recent educational discourse due to ICTs' quick adoption in the educational process. During the past decade, the digital environment has impacted educational processes so much that educational institutions have had to reassess the place of technologies in the learning process [1], [2]. The COVID-19 pandemic served as an accelerator for this process and forced teachers to implement online and blended approaches in education literally overnight, emphasizing the significance of teachers' ability to work with new digital tools [3]. Therefore, today, teacher digital competence cannot be considered an additional feature but a key part of teachers' professional qualification.

From the perspective of educational policy, several countries have already created models which describe the definition and practice of digital competence among teachers. For instance, DigCompEdu: The Digital Competence Framework for Educators defines certain competencies of educators such as digital resources, pedagogy, assessment, and professional engagement [4], [5]. In addition, the ICT Competency Framework for Teachers (ICT-CFT) developed by UNESCO offers a wide range of global standards meant to facilitate teacher preparation and professional development [6]. Both projects reveal a general agreement between nations on the idea that the notion of digital competence among teachers is to be understood as a combination of technical skills, pedagogical knowledge, and ethics in the digital environment. Despite the existence of such frameworks, the application of digital competence varies dramatically depending on the country or academic field.

There is now an extensive body of academic literature dedicated to the concept of digital competence of teachers. In the initial phase of research on the issue, emphasis was often placed on the description of the level of ICT skills and access to technology infrastructure that teachers had [7], [8]. More

recent literature, on the other hand, pays more attention to multidimensional constructs that incorporate both pedagogical and affective components [9]. Research has been conducted regarding the connections of digital competence with teacher efficacy, pedagogical beliefs, professional development, and performance of students [10].

Bibliometric analysis offers a structured framework for mapping the research landscape quantitatively through assessing patterns of publications, citation networks, co-occurring keywords, and author collaboration networks [11]. Bibliometric analysis is a method which has been widely used in educational research to analyze issues like teachers' professional development, educational technology use, and digital literacy [11]. So far, there has been little bibliometric analysis of the literature related to teacher digital competence. With the fast evolution and diversification of research in the field, bibliometric mapping can reveal prevailing topics, influential scholars, top institutions, and new paradigms that literature review might not cover.

Global research trends concerning teacher digital competence are vital both for researchers and non-researchers like policy makers and teachers themselves. Through studying the intellectual structure and development of the field, it becomes possible to establish influential publications, see the shift in research directions and gaps in geographical or disciplinary distribution. Moreover, through the use of bibliometrics, it becomes possible to discover unexplored areas of teacher digital competence research which deserve further qualitative and quantitative studies. Some of those areas include teacher access to digital sources, quality of teaching through the prism of digital competence, and cultural aspects of the problem.

Even though the significance of teacher digital competence as an essential part of good teaching in the contemporary digital era is increasingly acknowledged, current research on this phenomenon demonstrates diversity in concept definition, methodology,

and geographical spread. At the moment, there is no complete analysis of the development stages, thematic areas, and theoretical framework of research on teacher digital competence globally. In the absence of such an analysis, researchers and policymakers find it hard to comprehend the dynamics of research trends, emerging issues and develop research-based theoretical frameworks reflecting the state of knowledge of this field of studies globally [12]–[14]. The purpose of this research paper is to analyze global research trends of teacher digital competence using bibliometric analysis.

2. METHODS

The research on global research trends in teacher digital competence used bibliometric research design. A bibliometric study allows a quantification of the research papers, enabling an analysis of authorships, collaborative relationships, citations, and topics. By applying the bibliometric research design, the research intended to reveal the intellectual structure of the discipline, influential documents, and topic clusters as research focuses of the field. The unit of analysis comprised journal articles, conferences proceedings and reviews from 2010 to 2026 related to disciplines such as education, educational technology, and teachers' professional development.

Data were collected from the Scopus database, which has been acknowledged for its broad scope of peer-reviewed publications and citation indexing [11]. The search approach entailed the use of keywords

relating to teacher digital competence such as “digital literacy”, “teacher ICT competence”, “digital pedagogy”, and “technology integration in education” through Boolean operations. Inclusion criteria consisted of publications in the English language, dealing with primary and secondary education and higher education, as well as being indexed in the Scopus journal. Duplicate entries and irrelevant publications were manually excluded to maintain consistency and integrity of the data set. The data set was made up of meta-data consisting of publication date, authors, affiliation, keywords, abstracts, citations, and references.

The processed data was then uploaded into the VOSviewer software [15] to create maps and visualize the data. VOSviewer software was used for analyzing co-authorships, keyword mappings, and citation networks. It helped identify research topics that were clustered together, influential scholars, and collaborations between different institutions and countries. Thresholds were used to analyze only those keywords that were most frequently used, citations of important works, and collaboration ties. This ensured that the visualization highlighted the key structure of the field under study. Bibliometric maps thus created helped reveal global trends, research hot spots, and emerging themes in teacher digital competence.

3. RESULTS AND DISCUSSION

3.1 Keyword Co-Occurrence Network

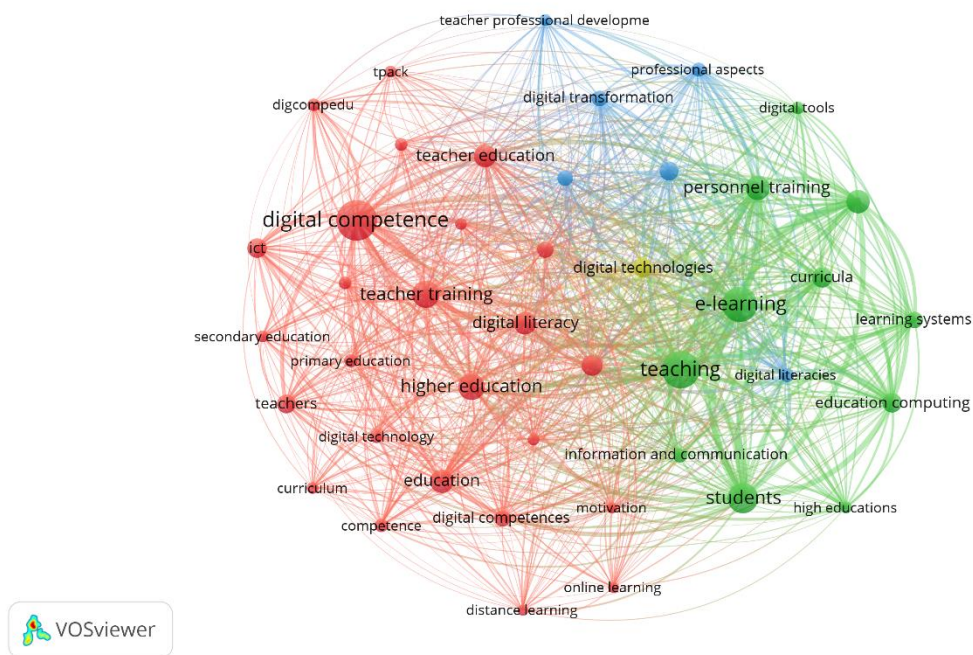


Figure 1. Network Visualization

Source: Data Analysis Result, 2026

Figure 1 depicts the cognitive architecture of teacher digital competence and the main research topics within this field. As can be seen from the network map below, there are three clusters of research that dominate this field, and they are shown in different colors, thus, signifying interconnected spheres of research contributing to the development of this particular field. The size of each node shows how often the corresponding keyword was used, whereas the connecting lines show how strongly connected these keywords are.

The red cluster is associated with the main concept of teacher digital competence, digital literacy, and teacher professional development. Such keywords as digital competence, ICT, teacher education, teacher training, digital literacy, teachers, and higher education are found in this cluster as the key concepts. It can be seen that there is a large amount of studies that pay attention to the study of teachers' ability to use digital technologies in their teaching process. The connection between digital competence and teacher training shows that researchers pay attention to the need for continuing professional development for educators who

should improve their skills in terms of technologies and pedagogy. The inclusion of DigCompEdu and TPACK proves that competency frameworks are significant in this case.

The green cluster captures the academic literature concerning digital learning environment, technology integration, and learner-centered learning processes. The keywords such as e-learning, teaching, students, digital tools, curricula, learning systems, and education computing reveal the direct relationship between teachers' digital competency and the use of technology to support learning processes. This cluster implies a change in emphasis from the digital capabilities of teachers alone to how these capabilities affect classroom practices and learning outcomes. Teaching, e-learning, and digital technologies are highly associated; this association implies that digitally competent teachers are becoming central players in developing flexible and technology-integrated learning environments.

Blue cluster represents new conversations on the issues of digital transformation, professional aspects, and the

support of digital education. Terms like digital transformation, teacher professional development, professional aspects, personnel training, and digital technologies show that the recent research has gone beyond individual competencies of teachers to a more organizational point of view. This cluster points to the fact that teacher digital competence cannot be developed without not

only improving their individual capabilities but also through educational policies, institutional approaches, digital infrastructure availability, and systematic training programs. The appearance of digital transformation in connection with digital competence shows that it is a part of a bigger process of transformation.

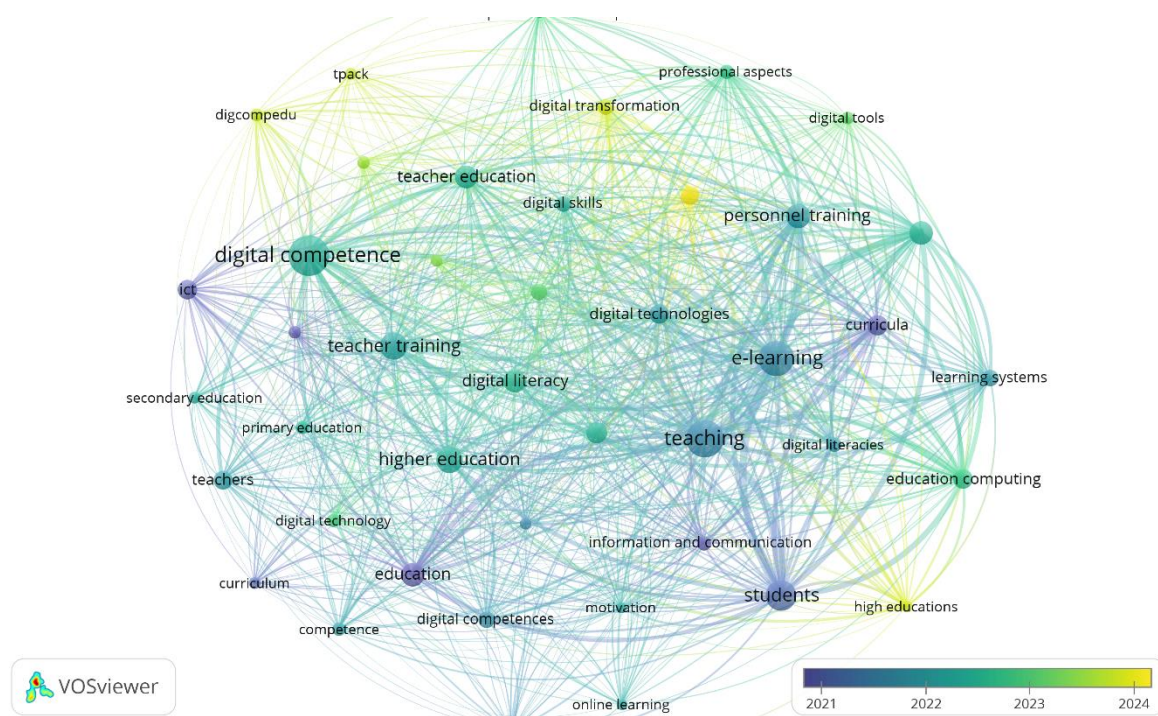


Figure 2. Overlay Visualization

Source: Data Analysis Result, 2026

Figure 2 is a visualization showing the timeline of research topics concerning teachers' digital competence in relation to their frequency of appearance and average year of publication. The color coding reflects the chronological development of research topics with darker shades of blue and purple denoting research topics which appeared some time ago (around 2021–2022) and the green and yellow shades depicting the more recent research topics (around 2023–2024). It shows that teacher digital competence has developed into an interrelated field of study covering such aspects as digital skills, educational technology, teacher training, and digital transformation.

Topics from the older research focus mainly on fundamental concepts like ICT,

digital competence, digital literacy, teacher education, and higher education. The topics reveal that previous studies largely considered the need for building basic competencies among the teachers along with their preparedness to incorporate digital technology within teaching practice. Nodes that are closely associated with the terms digital competence, teachers, teacher education, and digital literacy are considered as high connection nodes, implying that earlier studies focused on building competency and professional development models like DigCompEdu and TPACK.

The latest trends in research studies, presented through green to yellow-colored nodes, indicate that there has been a trend towards broader topics related to digital

transformation, e-learning, technologies, professionalism, and technology-enhanced teaching processes. New keywords like digital transformation, personnel training, learning systems, education computing, and digital technologies point to the idea that modern research has become less concerned with teachers' individual skills and more focused on the institutional level,

technological innovations, and sustainable digital learning environments. The growing number of papers devoted to the issue of students, e-learning, and teaching shows that future trends in research might deal with the influence of teacher digital competences on educational achievements, AI-based education, personalized learning environments, and technologies.

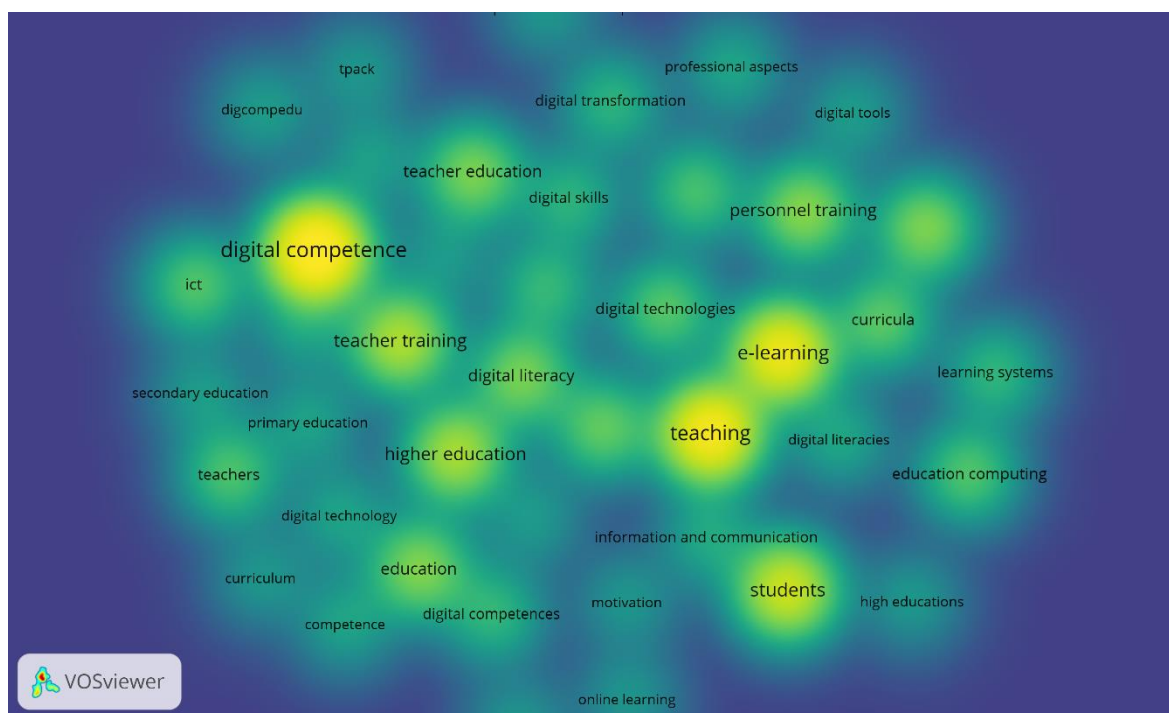


Figure 3. Density Visualization

Source: Data Analysis Result, 2026

Figure 3 brings out the strength and concentration of research within the area of teacher digital competence. Those regions which have brighter colors (yellow) depict those keywords which are characterized by high frequencies, meaning that they are the most widely researched themes, while darker regions show topics with low research frequency. The most concentrated research topics surround such keywords as digital competence, teaching, e-learning, students and higher education, thus proving that they are key elements of research on the topic of teacher digital competence across the globe.

The chart also demonstrates various research fields interrelated to each other, such as teacher training, digital literacy, digital technologies, digital transformation, and professional development. The existence of the above topics shows that existing research tends to progress from assessing the technological proficiency of teachers to exploring the role of digital proficiency in innovation in education and institutional digital transformation. As for emerging, but less represented topics, which include digital tools, learning systems, education computing, and professional aspects, these demonstrate some possible ways for further research.

3.2 Co-Authorship Analysis

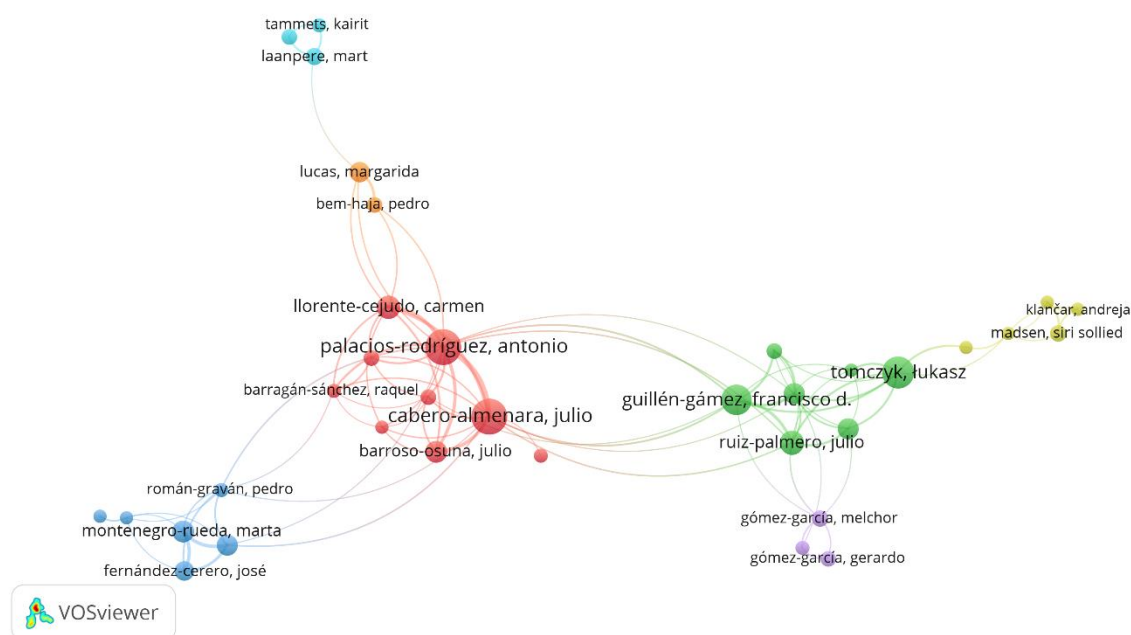


Figure 4. Author Visualization

Source: Data Analysis Result, 2026

Figure 4 depicts the intellectual relationships and research collaborations among prominent authors in the field of digital competence of teachers. The graph presents several clusters depicted in different colors showing various author clusters whose members are involved in collaborative research or conduct research on related topics. The largest and the most connected cluster (red) represents authors like Palacios-Rodríguez, Antonio; Cabero-Almenara, Julio;

and Barroso-Osuna, Julio since these authors have contributed significantly to the development of research related to digital competence, teachers' training, educational technologies, and digitalization in education. Some other clusters, including the cluster composed of authors like Guillén-Gámez, Francisco D.; Tomczyk, Łukasz; and Ruiz-Palmero, Julio, reflect other research networks dealing with teacher digital skills and technology-enhanced learning.

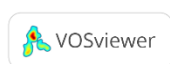


Figure 5. Institution Visualization

Source: Data Analysis Result, 2026

Figure 5 presents the relations and patterns of collaboration among universities involved in research into teacher digital competence. The map depicts the fact that there are clusters where research activities are centered around particular institutions, and one of such institutions, which is Universidad de Granada, Spain, can be highlighted as one of the most influential and connected institutions of the research network. Some other institutions, such as Universitat Rovira i Virgili, Universidad de Barcelona, and Universidad de Santiago de Compostela, have many collaboration relations, which is an indication of the fact that Spanish universities

play a significant role in developing research into digital competence, teacher education, and educational technology. The involvement of some other institutions, namely University of Limerick (Ireland) and Umeå University (Sweden), into collaboration indicates that there are some international links established, though not as active as those in the main Spanish research cluster. Thus, visualization demonstrates that global research into teacher digital competence is marked by the presence of regional collaboration clusters, where European universities are key producers of knowledge.

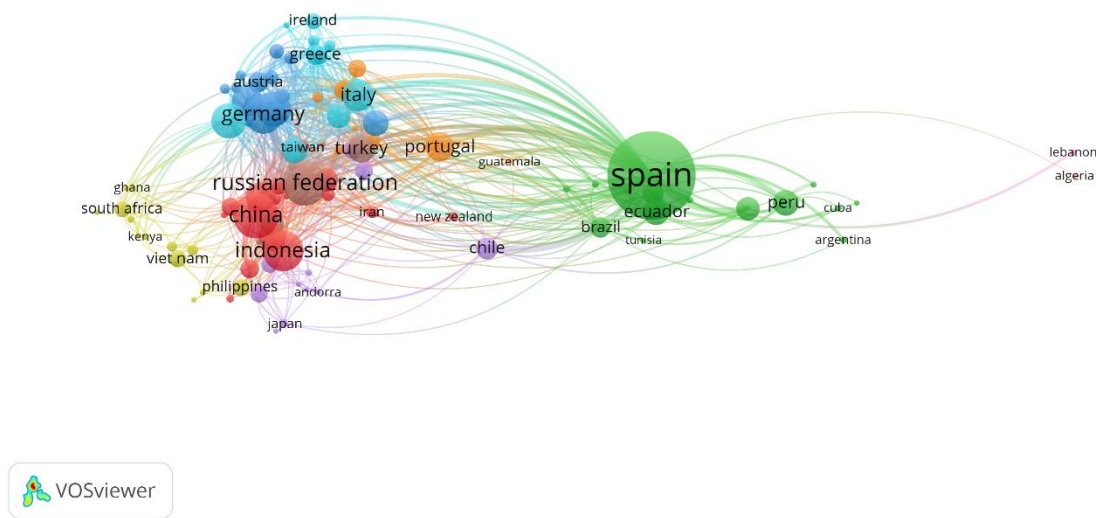


Figure 6. Country Visualization

Source: Data Analysis Result, 2026

Figure 6 shows the distribution and cooperation of nations in the research on the digital competence of teachers. The network clearly shows Spain to be the most prominent and influential nation because of its biggest node size and numerous connections with other nations. This implies that Spain has played a significant role in developing research on the digital competence of teachers, especially in the field of digital education, teacher training, and digitalization. Other nations, which are highly interconnected, such as Germany, China, Indonesia, Italy, Portugal, and Russia, can be viewed as important contributors to research,

forming interconnected collaboration networks in Europe and Asia.

In addition to this, there are some collaboration patterns for each region seen on the map. For instance, countries in Europe, especially those like Spain, Germany, Italy, Portugal, and Greece, are seen to be playing central roles as collaborators in this case due to the presence of European digital education policy and framework known as DigCompEdu. Countries in Asia, such as China, Indonesia, Japan, and Thailand, also show increased involvement in this research field. Latin America countries, for example, Brazil, Ecuador, Peru, and Chile, have formed an interconnected research community.

3.3 Citation Analysis

Table 1. Top Cited Research

Citations	Authors and year	Title
916	[16]	Adapting to online teaching during COVID-19 school closure: teacher education and teacher competence effects among early career teachers in Germany
891	[17]	From digital literacy to digital competence: the teacher digital competency (TDC) framework
573	[18]	Aligning teacher competence frameworks to 21st century challenges: The case for the European Digital Competence Framework for Educators (Digcompedu)

Citations	Authors and year	Title
518	[19]	Teacher support and student motivation to learn with Artificial Intelligence (AI) based chatbot
458	[20]	Digital competence in higher education research: A systematic literature review
446	[21]	Digital transformation in German higher education: student and teacher perceptions and usage of digital media
428	[22]	Newly qualified teachers' professional digital competence: implications for teacher education
397	[7]	Educating digitally competent teachers: A study of integration of professional digital competence in teacher education
378	[23]	Teachers' digital competencies in higher education: a systematic literature review
363	[24]	Preparing for life in a digital world: IEA international computer and information literacy study 2018 international report

Source: Scopus, 2026

Table 1 demonstrates the most cited scholarly works in the domain of teacher digital competence and reveals the most critical intellectual contributions that have affected the development of global research in this sphere. The most cited work belongs to [25] and has 916 citations. It concerns teachers' transition to online teaching amid the closure of schools due to the coronavirus and discusses the connection between teachers' competence, their education, and readiness for digital learning environment. The result indicates the considerable influence of the pandemic in accelerating research interest to the issue of teachers' digital preparedness. At the same time, [17], who cited 891 times, contributed a theoretical framework of the study with the development of the concept of Teacher Digital Competency (TDC) and the shift of discussion from digital literacy to more complex use of digital technology by teachers.

Other highly cited publications point out the significance of competency framework, digital transformation, and technology integration in education. In their article, [18] emphasized the significance of the European Digital Competence Framework for Educators (DigCompEdu) in ensuring congruence between teacher competencies and modern pedagogical challenges. This study can be considered one of the major theoretical references in subsequent scholarly investigation in this area. Further contributions to the field were made by [26]

and [23] in their systematic literature reviews on digital competence in higher education and teachers' competency development. Modern publications, for instance, those by [27], reveal a new direction of research in AI-based education technologies.

4. CONCLUSION

This bibliometric study offers a comprehensive review of current research trends, intellectual structures, and emerging topics in the field of teacher digital competence. The results have shown a remarkable growth of interest in this topic after the COVID-19 pandemic, which brought a rapid rise of digital technologies' use and highlighted the need for digital readiness among teachers. Based on the results of keyword analysis, it is possible to identify several important interconnected topics within the discussed field of research: digital competence, digital literacy, teacher education, e-learning, digital transformation, and technology integration. Thematic evolution shows how the focus of the researchers has shifted from developing fundamental technological skills among teachers to wider perspectives of digital pedagogy, professional development, organizational transformation, and integration of emerging technologies like artificial intelligence. Moreover, citation and collaboration analysis indicates the considerable contribution of prominent

scholars, organizations, and countries to the theoretical and empirical development of this research domain; in particular, Europe and Spain should be mentioned as central contributors. While a lot has been done, future research should be aimed at exploring

important topics of AI-assisted teaching, digital equity, sustainable digital education ecosystems, and the impact of different contexts on teachers' digital competence development.

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