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MAPPING THE LANDSCAPE OF DIGCOMPEDU: A BIBLIOMETRIC APPROACH

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Abstract: This study is an analysis of all the academic work that was done on DigCompEdu (the European Framework for the Digital Competence of Educators) between the year 2017 and 2024. It does this because schooling around the world is quickly becoming more digital. VOS Viewer 1.6.20 edition software and complex bibliometric methods such as co-authorship mapping, keyword co-occurrence, and co-citation networks are used in this study to analysed for research trends, patterns of collaboration, and intellectual frameworks in this new field through the finally selected 303 papers from the Scopus database. Based on the data, there have been significantly more publications since 2020. The investigation has been revealed that Spain as the most productive and beneficial country globally. “Digital competence,” “teachers training,” and “e-learning” are found to be important study clusters by thematic mapping, and visualization technologies are used on top of them. The most mentions came from high-impact journals like Computers and Education and Sustainability (Switzerland), and well-known people like Redecker and Cabero-Almenara became thought leaders in the field. More and more people from all over the world and different fields are using DigCompEdu. However, the data also shown that there are gaps in geography and themes, especially from the global South. This paper does a thorough, evidence-based study of the philosophical and structural framework of educator digital competency research. It gives researchers, policymakers, and practitioners significant information.

Keywords: DigCompEdu, Teacher Education, Digital Competence, Bibliometric Analysis.

Introduction

Over the past decade, schooling has become more computerized. The demand for strong, validated frameworks to evaluate and improve the digital skills of teachers has increased (UNICEF, 2022). The European Commission developed the European Framework for the Digital Competence of Educators (DigCompEdu) in the year of 2017; This has been become a model for training teachers, making policies, and comparing institutions in various educational settings (Redecker, 2017). DigCompEdu has continues to attract academic attention as more countries integrate professional development criteria with digital innovation. After the year of 2020, scholarly outputs have been expanded substantially, especially when reforming schools after the global pandemic (Caena & Redecker, 2019; Zhao et al., 2021).

Bibliometric analysis presents a systematic and scalable method for delineating the intellectual terrain of this developing domain. We do identify influential works and collaborative dynamics through the analysis of publishing trends, citation patterns, co-authorship networks, and keyword co-occurrences, that shape the discourse on educator digital competency (Van Eck & Waltman, 2010; Mina, 2025). Although, the growing significance of DigCompEdu in academic literature, a thorough and quantitative analysis of worldwide research trends, institutional contributions, and knowledge clusters remains not extensively examined.

This study aims to give an authoritative picture of the structure and growth of DigCompEdu-related knowledge by showing how keywords appear together, mapping reference networks, and investing how authors and countries work together. The results are expected to future research, encourage the creation of knowledge that includes everyone, and make it easier for policymakers and practitioners to use the framework successfully. This study fills in that gap by doing a full bibliometric analysis of 303 peer-reviewed articles from the Scopus database (2017–2024). The articles were found using structured search methods and PRISMA-guided screening. The research investigates key questions:

1. How has scholarly interest in DigCompEdu evolved over the years, across countries and Disciplines?
2. What is the relation between the citation rankings of related journals and their Q-value and h-index?
3. What trends occur if examining authorship collaboration among authors, institutions, and nations?
4. What is the global distribution of significant keywords and their pattern shifted over the years?
5. What kind of pattern occur after co-citation examination within cited authors and references?

Review of Related Literature

Growing emphasis on Teachers digital competence, specially DigCompEdu framework, has resulted in a substantial volume of literature. This section analyses key contributions related to the conceptual evolution, empirical validation and application of DigCompEdu in various educational settings.

Key Concepts' Overview

The concept of digital competence has evolved from a generic understanding of ICT literacy to a more nuanced, multidimensional construct that encompasses professional, pedagogical and ethical use of technology in educational contexts (Tondeur et al., 2025). During this period of transition, the European framework for the digital competence of educators was developed as a landmark model by the European Commission's Joint Research Centre (JRC) on behalf of the Directorate-General for Education, Youth, Sport and culture (Redecker, 2017); which is popularly known as DigCompEdu. It is a pedagogically grounded and practice-oriented model and also widely adopted and serves as a reference point for national teacher training strategies (Castaneda et al., 2021; Gutierrez-Castillo et al., 2022). Recent studies emphasize that digital competence is no longer a peripheral skill but a core requirement for 21st-century educators ((Lan et al., 2024; Foster, 2023). This framework aims to help educators recognize their strengths and weaknesses by outlining various stages of development for each competence of proposed classification (Bayrak et al., 2023). Comprehensive review reveals that DigCompEdu is a new framework designed just for educators which is Unlike than earlier framework such as DigComp (for general citizens) or UNESCO's ICT competency framework for teachers (ICT-CFT), DigCompEdu is specially tailored for educational professionals, addressing both teaching-specific and transversal digital competencies (Redecker, 2017).

According to JRC DigCompEdu describe how digital technologies can be utilized to augment and innovate educational processes and training practices instead of emphasizing merely on technical skills. This framework comprising 22 competencies categorized into 6 domains: professional engagement, digital resources, teaching and learning, assessment, empowering learners, and facilitating learners' digital competence (European Commission, 2025). Furthermore, Each Competence within DigCompEdu framework is delineated through a six-tier evaluative structure in the form of grade like A1, A2, B1, B2, C1, C2 where, A1 denoting the basic level or "Beginner" stage and C2 indicating the pinnacle of proficiency or "pioneer" stages (Bayrak et al., 2023). This sequence of stages enables educators in comprehending their development, ranging from fundamental awareness (A2 Explorer) to the integration of digital technologies across diverse contexts (B1 Integrator), and ultimately to the secure and innovative application of these technologies to enhance professional activities (B2 Expert) (Caena & Redecker, 2019; Bayrak et al., 2023).

Digital Competence in Education, and Educator

The notion of digital competence in education has broadened from technical skills to cognitive, socio-emotional, pedagogical, and ethical skills (Ilomaki et al., 2016; Ferrari, 2013). It was initially conceptualized as the successful ability to use digital tools effectively but now digital competence reflects an educator's capacity to critically evaluate, communicate, collaborate, create and safeguard digital content in pedagogically significant approaches (Redecker, 2017; Hatlevik & Christophersen, 2013). A systematic review from 2015 to 2021 conducted and found that digital competence is broadly recognized as essential for both students and educators in higher education with most possessing only a basic level of these skills (Zhao et al., 2021). This comprehensive and in-depth review offering suggestion about the urgent need for institutions to develop targeted strategies and tools to enhance

digital competence among teachers, thereby improving educational quality and outcomes among the learners. The definitions as well as features of digital competence generally coincide with DigCompEdu frameworks, highlighting its significance to policy (Zhao et al., 2021).

Furthermore, Before and during the COVID-19 pandemic the classification of digital competence of teachers emphasizing the growing scope of digital skills to encompass not only technical proficiency but also pedagogical integration, assessment of different discipline, and the empowerment of learners in the digital environments (Smestad et al., 2023). Indeed, this transitional phase signifies the growing complexity of digital competence as a multi-faceted paradigm and dynamic for effective teaching practices in the modern learning environment. Moreover, De Soriano (2024) also conducted a systematic review on digital competence and educational inclusion in higher education and found various digital competence associated issues for instance, the digital divide issues, interculturality, and virtual learning environments difficulty. It is emphasizing the potential of digital competence to support strongly personalized and inclusive learning aligned with the 2030 agenda for sustainable development (De Soriano, 2024).

Lopez-Nunez et al. (2024) examined worldwide digital competence assessment tools and emphasized the need for standardized assessments to monitor and promote digital competence among instructors. Educational research has shown that digital competence improves student engagement, individualized learning, and assessment innovation (Castaneda et al., 2021; Instefjord & Munthe, 2017). Advanced digital abilities help teachers adapt, innovate, and feel confident using technology in the classroom (Cabero-Almenara & Palacios-Rodriguez, 2020). However, various studies show regional differences, generational gaps, and institutional barriers in digital competence acquisition, particularly in under-resourced or rural education systems (Gudmundsdottir & Hatlevik, 2020; Siddiq et al., 2016).

The COVID-19 pandemic served as a significant impetus for re-evaluating digital competence for prompting educational institutions globally to transition so that emergency remote teaching goes on smoothly and effectively. Unexpectedly transitioning to digital showed the significance it is to have structured, fair methods for improving digital skills (Zhao et al., 2021; Konig et al., 2020). there is an emphasis on resilience, teacher autonomy, and student-centered digital pedagogy in post-pandemic. This finding suggests a necessity to transition from methods that focus solely on tools to more reflective and ethically-oriented digital education practices. The current literature indicates a division concerning effective assessment tools and indicators for measuring digital competence across various contexts, despite the increasing interest in this area. Validated scales and self-assessment tools based on DigCompEdu have been developed (Gonzalez-Fernandez et al., 2023; Claro et al., 2018), but cross-cultural usability and scalability remain concerns.

Methodological Gap and rationale for bibliometric Analysis

Most of the existing research conducted till now is anchored in qualitative case studies, surveys and descriptive analyses of limited or specific populations (Castaneda et al., 2021; Cabero-Almenara & Palacios-Rodriguez, 2020). Although these methods have given useful information about how to teach digitally or approach digital teaching practices; but they often lack a macroscopic, data-driven perspective of the field's structural dynamics, like intellectual foundations, authorial influence or global collaboration networks. For instance, prior systematic reviews by Zhao et al. (2021) have synthesized the thematic breadth of digital competence studies but have not applied quantitative network-based methods like bibliometric analysis. It provides quantitative evidence on publication trends, author productivity, source impact and collaboration intensity (Aria & Cuccurullo, 2017; Van Eck & Waltman, 2010). This study addresses this gap through a full-scale bibliometric analysis of 303 Scopus-indexed articles published between 2017-2024, offering an empirically grounded overview of the field.

Methodology

This research analysed Digital Competence framework for Educator (DigCompEdu) through the utilisation of bibliometric analysis methodology. Bibliometric analysis functions as a research GPS,

enabling researchers to maintain focus and remain competitive by quantifying research productivity, identifying emerging trends, and evaluating the impact of their work (Mina, 2025; Ogondiek, 2025).

Data Source and Search Strategy

The article search was executed on 27th July 2023, yielding a total of 1,312 records; utilised Scopus database. It is one of the world's major abstracts and the citation databases, playing a central role for researchers in searching for high quality and reliable scientific information (Meilinaeka, 2024). This methodology consisted of three consecutive phases: (i) Establishing the topic, coverage and eligibility requirements for inclusion; (ii) Reviewing the articles; (iii) Incorporating the articles that have passed the screening, as illustrated in Figure 1. The main search string focused on research articles about the digital competence framework for educators (DigCompEdu), utilising pertinent keywords depicted in Figure 1. Stringent inclusion and the exclusion eligibility norms were implemented. The search strategy employed a detailed Boolean keyword string incorporating synonyms and related terms as depicted in the below figure 1 box; namely 'keywords and search string'. These records were initially screened based on title, abstract, document type (articles), language (English), source type (journals), and publication stage (final) between 2017 to 2024. The reason behind duration was releasing year of DigCompEdu framework document by European Commission in 2017, publicly.

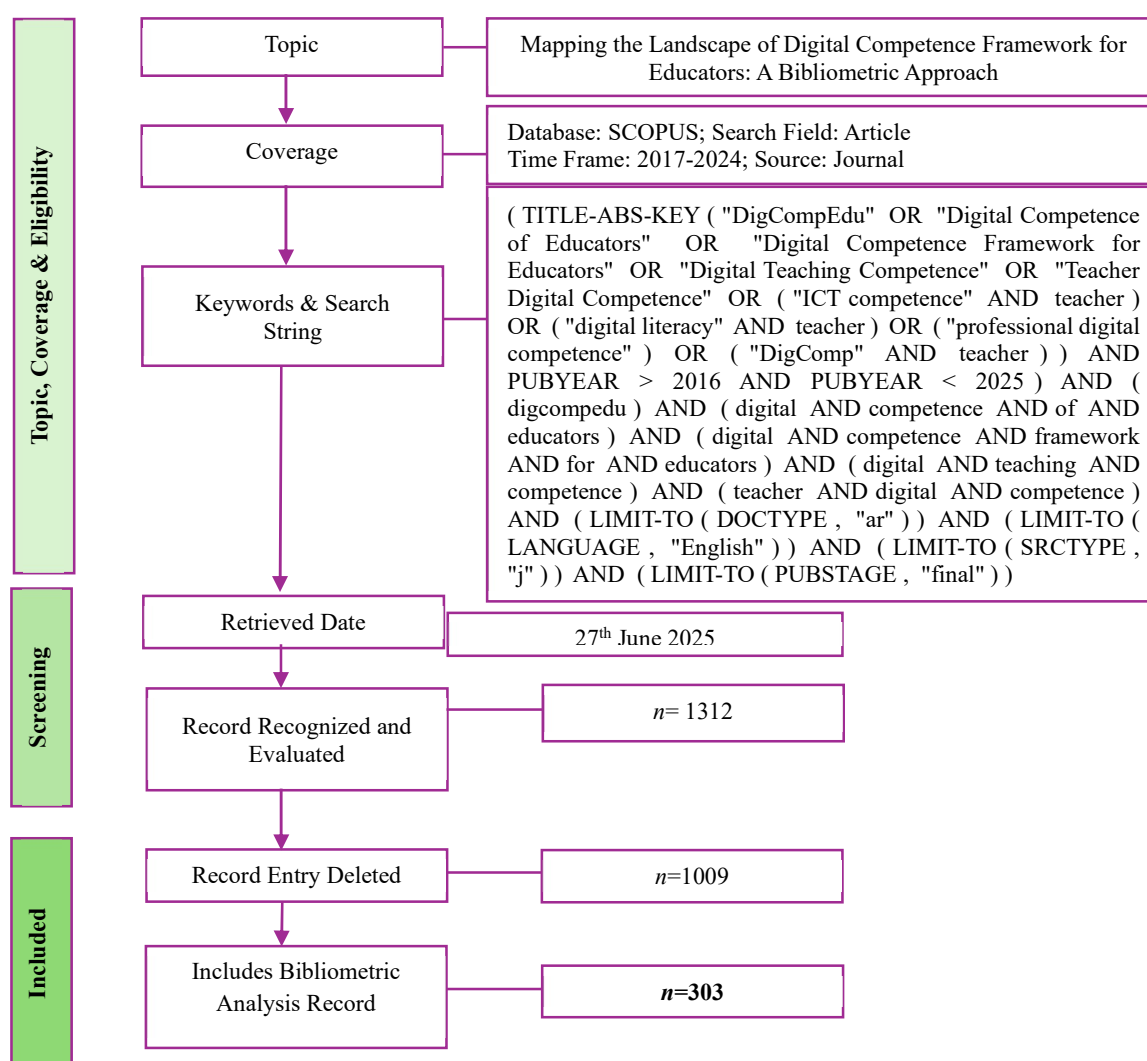


Figure 1. The search approach flow diagram modified from Zakaria et al. (2021) as cited in Joshith et al. (2024).

Articles Selection and Management

The study selection process followed a structured protocol inspired by the PRISMA 2020 approach. The topic focused on mapping the landscape of the DigCompEdu framework and its related constructs in the domain of DigCompEdu. After applying Scopus database features 'refine search within result' through 5 appropriate keywords; "DigCompEdu", "digital competence of educators" "digital competence framework for educators", "digital teaching competence" and "teacher digital competence" in the first stage for exclusion process. After that, the researcher reviewed the abstract and the title of the remaining identified document, 1,009 records were removed due to irrelevance or duplication, on the ground of covering the study about DigCompEdu in the perspective of teacher, leaving 303 documents deemed eligible for bibliometric analysis. Data were extracted and managed using spreadsheet software and exported in CSV format for further processing in VOSviewer 1.6.20, a free software application with a user-friendly graphical interface for text analysis and network visualization (Van Eck & Waltman, 2023; Bukar et al., 2023). This ensured consistency, transparency and replicability in the document selection and preparation process.

Result & Discussion

The subsequent findings have been derived from the research objectives. The study's findings are presented in the tables and figures.

Yearly Distribution of the Article Publications

The study analysed through the refined data, the distribution of publications from the year of 2017 to 2024 within the Scopus database; and the outcomes of this study are depicted in the figure 2 as below.

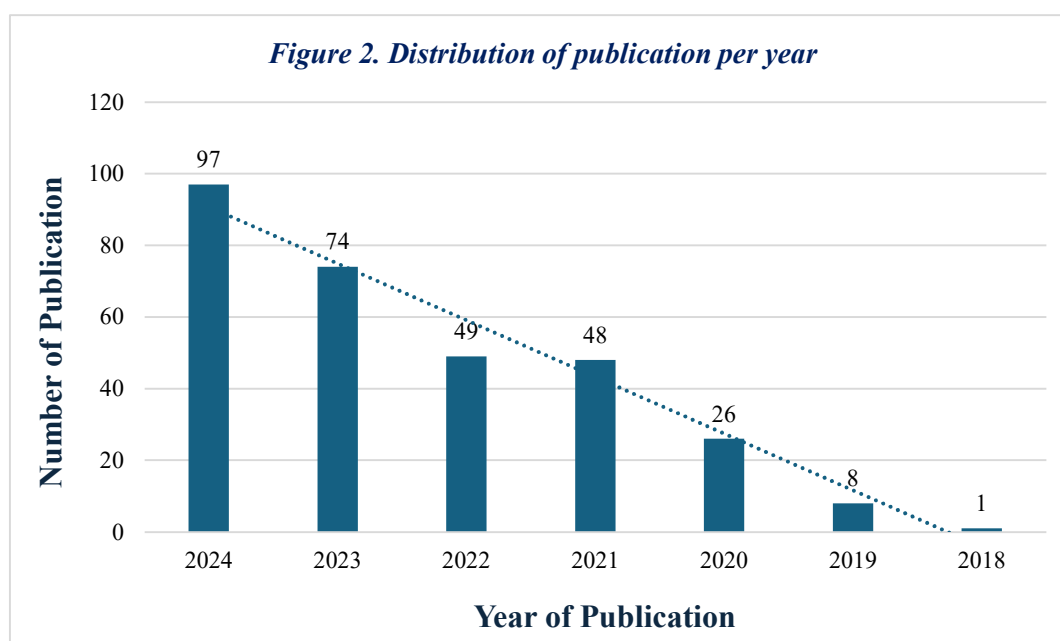
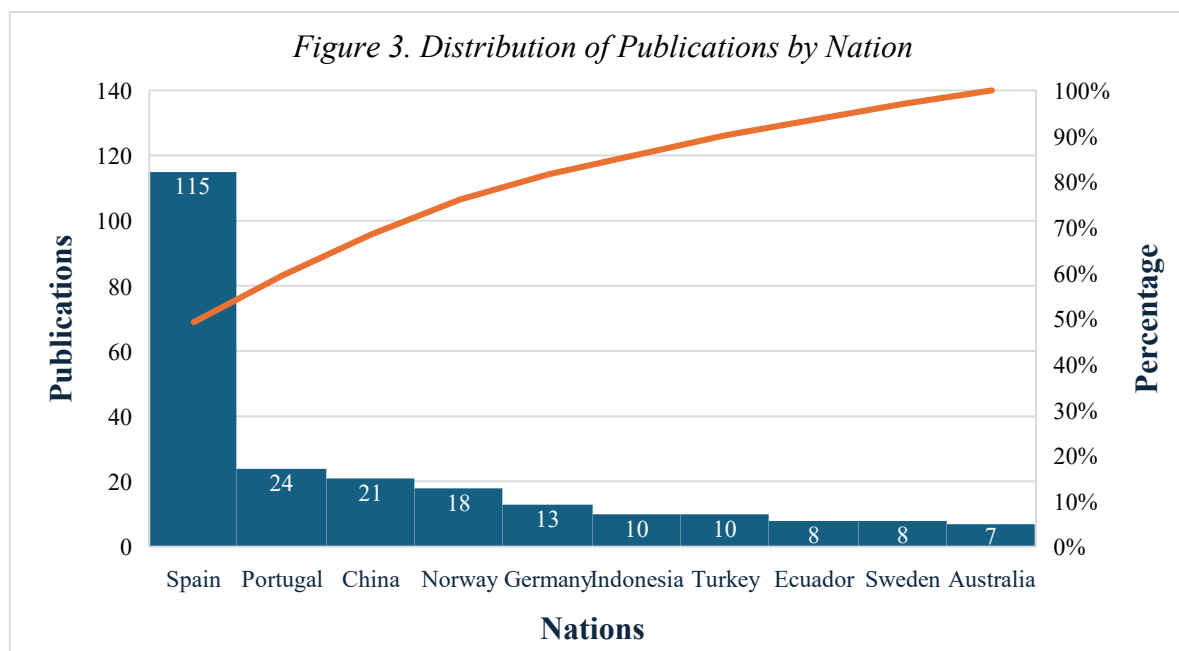


Figure 2 display the distribution of publications related to the DigCompEdu framework yearly basis from the year 2018 to 2024. Analyzed data revealed a consistent upward trend in academic interest along with a significant increase in the year 2024; when recorded the highest number of publications (n=97). Finding suggests an increasing trends on digital competence within educational contexts, likely shaped by post-pandemic digital reforms and enhanced policy alignment with DigCompEdu frameworks. The number of publications increased from one article in 2018 to eight in 2019 with a consistent rise and the year 2021 to 2024 demonstrates a noticeable increase, evidenced by 74 publications in 2023 and 49 in 2022 which indicating heightened research activity. The decrease in earlier years probably indicates the recent establishment of DigCompEdu framework formally. Among

the global research community indeed underscores yearly publication distribution with the increasing and dynamic interest in educator digital competence.

Nation-wise Distribution of Publication

Figure 3 display the detail of the topmost ten nations with the maximum number of already published articles distribution on the various discipline which was examined in the current study.



The distribution of publications pertinent to the DigCompEdu framework across different countries indicating noticeable geographical concentration in the above figure 3; where Spain dominates with 115 publications and representing almost 50% of the total research output on the selected field of research study currently. Indeed, this shown dominance is anticipated due to early and formal implementation of the DigCompEdu framework and its incorporation into national teacher education policies by Spain.

Moreover, Portugal in the western Europe, China in the Asia region, and Norway among the Scandinavian country exhibit a notable gap along with 24, 21, and 18 publications respectively which is actually reflecting an increasing yet still nascent involvement with the DigCompEdu framework. Outcome of the analysis also revealed that countries such as Germany, Indonesia, Turkey, Ecuador, Sweden, and Australia exhibit a more modest contribution because each producing fewer than 15 publications.

The skewed distribution observation by investigator indeed indicates that research on teacher digital competence, especially within the DigCompEdu model is predominantly Eurocentric with insufficient representation from the Global South including significant areas like Africa, South Asia, and Latin America. This revealing outcome after analysis highlights issues regarding the global applicability and inclusiveness of the framework which indicating a significant research gap that necessitates expanded international collaboration and context-specific adaptations in future investigations.

Distribution of Publications by subject or Discipline

Figure 4 display in detail the most and least number of publications in the different field of discipline in the terms of percentage. The results has depicted and observed in the pie chart presented below.

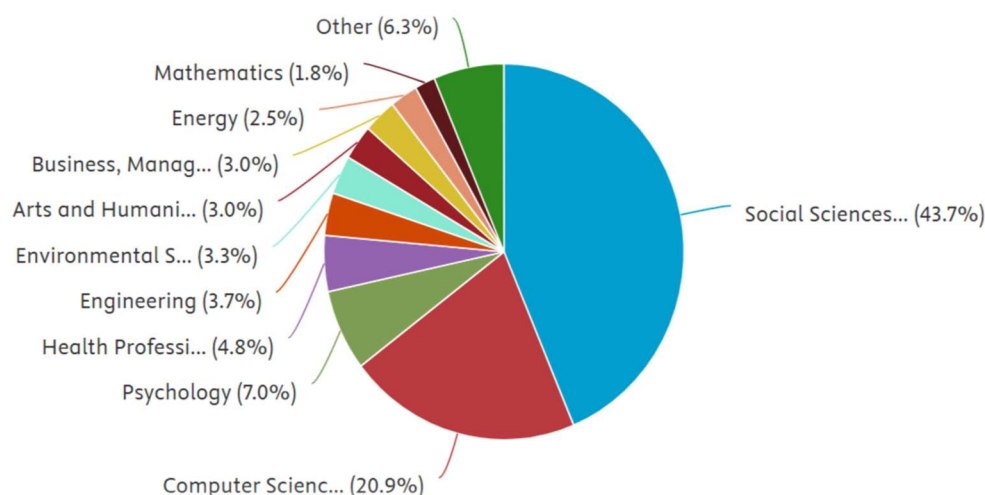


Figure (source: Scopus analysis) 4. Distribution of Publications by subject or Discipline.

The subject-wise distribution in this pie-chart reveals that research on digital competence, especially within the DigCompEdu framework is dominated by Social Sciences discipline (43.7%) which is emphasizing pedagogical and educational relevance. Computer Science discipline (20.9%) reflects the technological foundation of the field. Emerging contributions from psychology and Health Professions highlight cognitive and professional dimensions. However, limited representation from Engineering, Humanities and Mathematics suggests untapped potential. Overall, this field is interdisciplinary but still education-centric with the scope for broader cross-domain integration and research.

Bibliometric Findings

Journal Citation Analysis

Table 1. Distribution of Journals by Publications and Number of Citations

No.	Journals	Number of Articles	Number of Citations	h Index	Q Value
1	<i>Education Sciences</i>	20	188	68	Q1
2	<i>Education And Information Technologies</i>	18	411	97	Q1
3	<i>Sustainability (Switzerland)</i>	15	654	207	Q1
4	<i>Pixel-Bit, Revista De Medios Y Educacion</i>	11	161	20	Q2
5	<i>Computers And Education</i>	7	843	253	Q1
6	<i>Technology, Knowledge and Learning</i>	7	149	45	Q1
7	<i>Nordic Journal of Comparative and International Education</i>	6	81	10	Q3
8	<i>Nordic Journal of Digital Literacy</i>	6	57	25	Q2
9	<i>Revista Iberoamericana De Tecnologias Del Aprendizaje</i>	5	175	25	Q2
10	<i>Frontiers In Education</i>	5	48	55	Q2

The top ten DigCompEdu-related journals' articles and citations are shown in Table 1. Education Sciences published the most articles (n=20) but ranking lower in total citations (188) and h-index (68) than other Q1 journals. Although they publish less, Education and Information Technologies and Sustainability (Switzerland) have 411 and 654 citations, respectively. Computers and Education, with only seven papers, had the greatest citation count (843) and h-index (253), demonstrating its prestige and high-impact audience in educational technology. Q2 and Q3 publications like Pixel-Bit and Nordic Journal of Comparative and International Education have modest publication counts but low citation

influence, indicating regionally focused or growing scholarly platforms. Multiple Q1-ranked publications demonstrate DigCompEdu discourse's academic rigor and worldwide relevance. The uneven distribution also suggests that high-impact research is concentrated in a few elite publications, highlighting the need for more diversity and visibility across linguistic and regional publishing ecosystems.

Publication Citation Analysis

Table 2. *Articles with highest citations*

No.	Article's Title & Authors (Year)	Title Source	Cited by
1	Aligning teacher competence frameworks to 21st century challenges: The case for the European Digital Competence Framework for Educators (DigCompEdu) (Caena F. and Redecker C., 2019)	<i>European Journal of Education</i>	416
2	Digital competence in higher education research: A systematic literature review (Zhao Y. et al., 2021)	<i>Computers and Education</i>	300
3	Teachers' AI digital competencies and twenty-first century skills in the post-pandemic world (Ng D.T.K. et al., 2023)	<i>Educational Technology Research and Development</i>	237
4	The relation between in-service teachers' digital competence and personal and contextual factors: What matters most? (Lucas M. et al., 2021)	<i>Computers and Education</i>	176
5	New challenges in higher education: A study of the digital competence of educators in Covid times (Nunez-Canal M. et al., 2022)	<i>Technological Forecasting and Social Change</i>	174
6	Teacher digital literacy: The indisputable challenge after covid-19 (Sanchez-Cruzado C. et al., 2021)	<i>Sustainability (Switzerland)</i>	166
7	Digital literacy and higher education during COVID-19 lockdown: Spain, Italy, and Ecuador (Tejedor S. et al., 2020)	<i>Publications</i>	165
8	How can the digital competences of pre-service teachers be developed? Examining a case study through the lens of DigComp and DigCompEdu (Reisoglu I. and Cebi A., 2020)	<i>Computers and Education</i>	156
9	Can teachers' digital competence influence technology acceptance in vocational education? (Antonietti C. et al., 2022)	<i>Computers in Human Behaviour</i>	153
10	Self-perception of the digital competence of educators during the covid-19 pandemic: A cross-analysis of different educational stages (Portillo J. et al., 2020)	<i>Sustainability (Switzerland)</i>	150

Table 2 highlights the most influential articles in the field of educator digital competence research, as measured by citation count. The highly referenced paper by Caena and Redecker (2019) with 416 citations reveal the significant influence of the European DigCompEdu framework in informing policy and academic discussions. The studies conducted by Zhao et al. (2021), Ng et al. (2023), and Lucas et al. (2021), reveal a pronounced increase in research following the pandemic, emphasizing AI competencies and the preparedness of teachers in various contexts notably and, Journals like *Computers and Education* and *Sustainability (Switzerland)* consistently emerge with highlighting their prominence as preferred forums for significant research contributions.

Indeed, the prevalence of studies during COVID-19 shows the pandemic served as a significant driver for the exploration of digital competence and the analysis of these highly cited contribution shows a transition from establishing theoretical foundations to developing practical frameworks that integrate technology for effectively responding to the educational challenges of the 21st century.

Co-Authorship Analysis – Countries

Figure 4 displays the co-authorship networks analysis among countries within the discipline where adopted threshold criterion was at least 5 documents along with 10 citations. Subsequently, nations possessing a single document relevant to this area was incorporated, while those without collaborative links were omitted from the display. The country collaboration network map revealed that Spain functions as the prime center for worldwide study partnerships in the area of digital competence and/or DigCompEdu-related research domain. The robust connections with Portugal, Norway, Mexico, Chile, and Brazil indicate a thoroughly developed academic network, especially in the region of Europe and Latin America as shown in the figure just below.

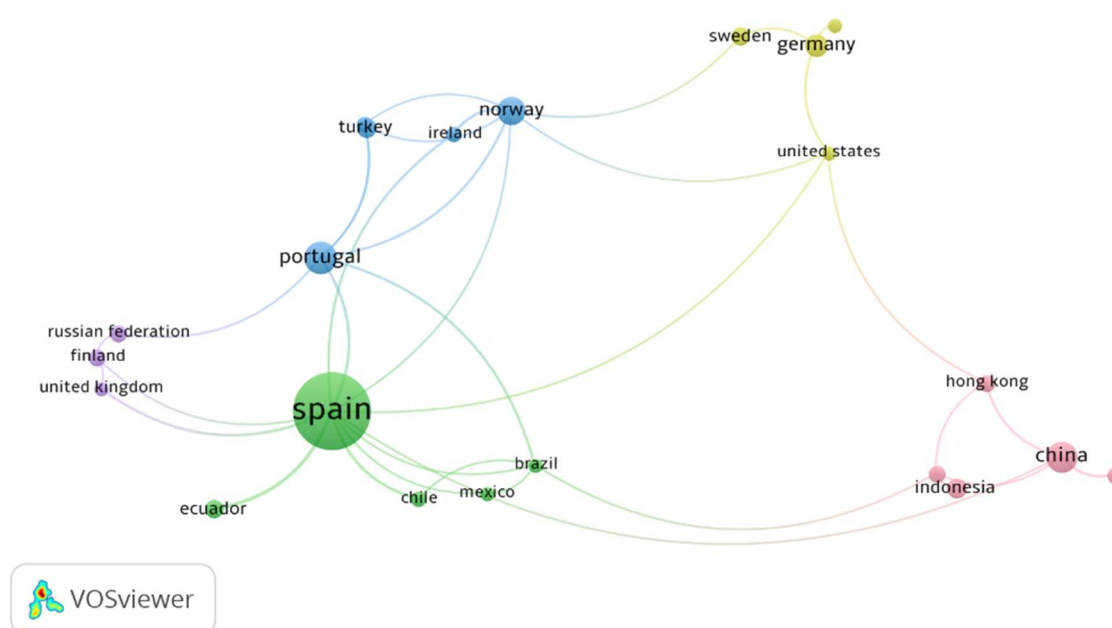


Figure 4. Network of Collaboration Among countries

The collective effort of countries like China, Indonesia, and Hong Kong suggests a significant and noticeable pattern of regional cooperation, while also highlighting a degree of separation from Western region networks in the network map. The United States, Germany, and Sweden seem to have a more independent relationship and each making notable contributions with their own effort. Moreover, the network map reveals significant regional clustering and collaboration asymmetry with Spain accounting for an unusually large proportion of global partnerships. In contrast, countries from Africa and South Asia are conspicuously missing within the established threshold on the network map which is highlighting a continuing geographic imbalance in the DigCompEdu framework research landscape.

Co-Authorship Analysis – Authors

Figure 5 display the analysis of co-authorship networks among authors within the research domain after the established threshold of one publication and five citations which identified 560 active contributors from a total of 882 authors. The network map identifies Antonio Palacios-Rodríguez as a significant contributor who was demonstrating robust co-authorship connections with scholars such as Julio Cabero-Almenara and Juan Jesús Gutiérrez-Castillo on the map. This suggests a cohesive academic cluster in Spain centred on digital competence in education.

Moreover, different collaboration communities have emerged with Romero-Tena, Barragán-Sánchez, and Guillén-Gámez leading separate thematic sub-groups and network exhibits regional density and cohesive partnerships. However, the restricted cross-cluster connections indicate a fragmentation of research efforts across various domains which shows a necessity for expanded inter-disciplinary and international collaboration to develop the diversity and scalability of research related to DigCompEdu frameworks.

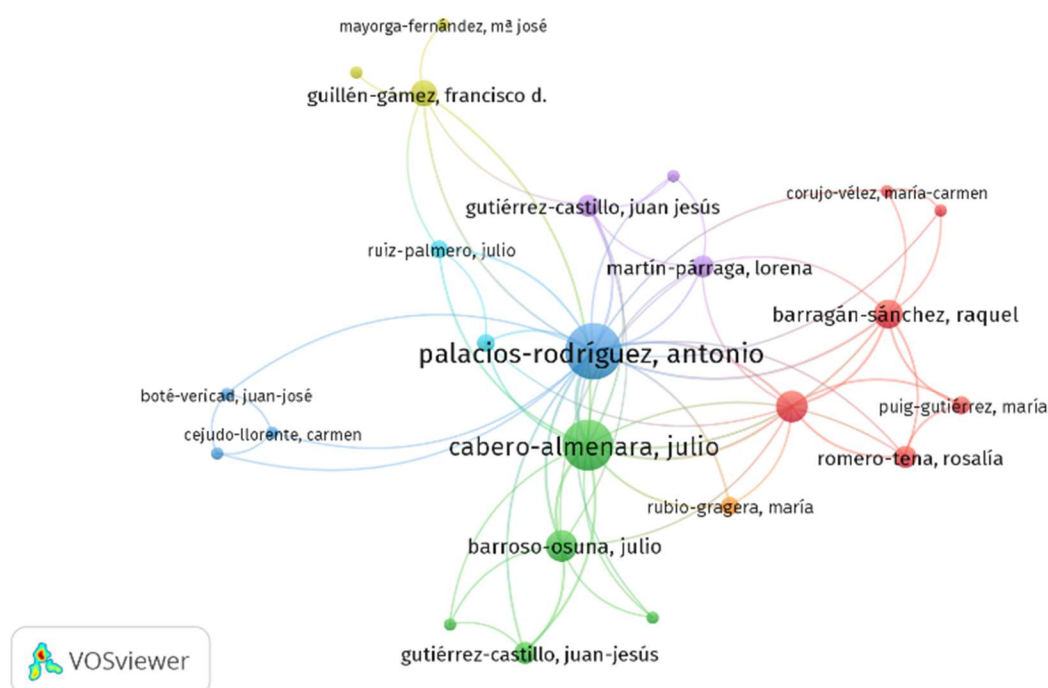


Figure 5. Network of collaboration Among Authors

Co-occurrence Keyword Network Analysis

Figure 6 display a visual representation of the relationships among the keywords. Utilizing the default threshold of a minimum five occurrences of keyword co-occurrence obtained refined data analysed which resulted in the identification of 75 frequently used terms from a total of 1,086 keywords. The network map shows that “digital competence” stands out as the most central and densely interconnected node and highlighting its conceptual significance within the research corpus.

Moreover, the terms “teacher training,” “e-learning,” “higher education,” and “digital technologies” are strongly interconnected which developed specific thematic clusters that highlight significant areas of research. The depicted network reveals distinct sub-fields; for instance, pedagogical integration shown by the blue cluster, technological implementation indicated by the green cluster, and the human factors in learning shown by the red cluster.

Indeed, the variety of clusters and their interconnections indicate a complex understanding of digital competence which are highlighting the interplay between professional development, teaching practices, and learner readiness. The presence of broad terms such as “education,” “teacher,” and “learning” specifies semantic saturation which is offering the necessity for more specific and domain-focused keyword selection in the future research to improve or strong thematic clarity.

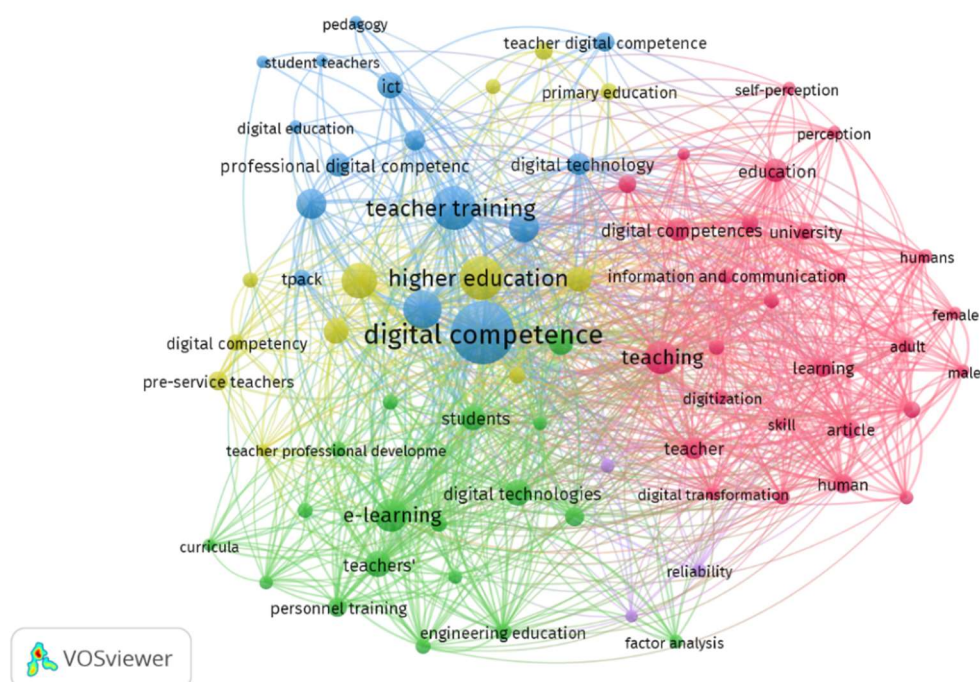


Figure 6. Network of Co-occurrence Among Keywords.

Overlay Visualization

VOS viewer facilitates overlay visualizations, which are employed to present information concerning time, impact, or trends across a network, such as keywords, utilizing colour coding (Van Eck & Waltman, 2010). This overlay visualization shows how research themes in the area of digital competence shift over time. The yellow-coloured keywords “engineering education,” “teachers,” and “e-learning” cover areas of study that have been studied more recently (around 2023). The blue- and purple-coloured keywords “ICT,” “teaching,” and “digital technology” refer to ideas that have been around for a longer time. The map indicates a visible shift in scholarly attention from foundational digital education terms toward more practice-oriented and context-specific topics, particularly those related to teacher training and the integration of emerging technologies in education.

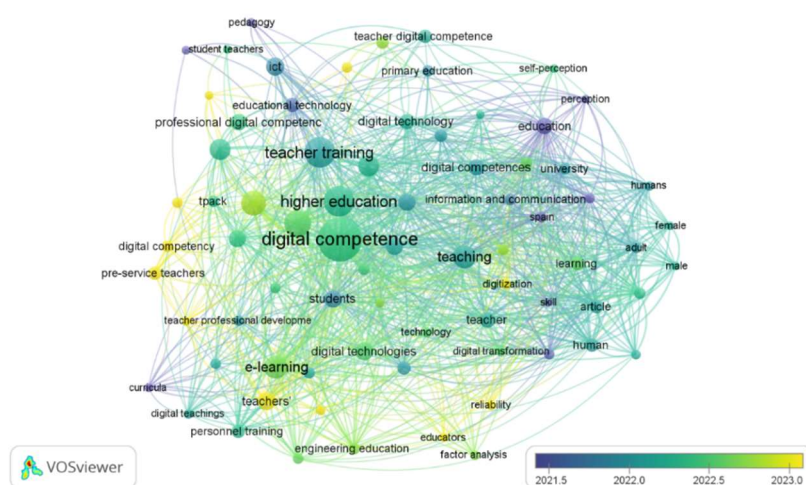


Figure 7. Keywords Co-occurrence- Overlay Visualization

Co-Citation Analysis – Cited Authors

Co-citation analysis serves to reveal significant intellectual foundations by emphasizing the frequency with which influential authors and their works are cited in conjunction (Park & Shea, 2020). This approach facilitates the mapping of the intellectual framework within a study domain by identifying the interconnections among documents, authors, or journals based on the frequency of their co-citation (Oberg, 2023).

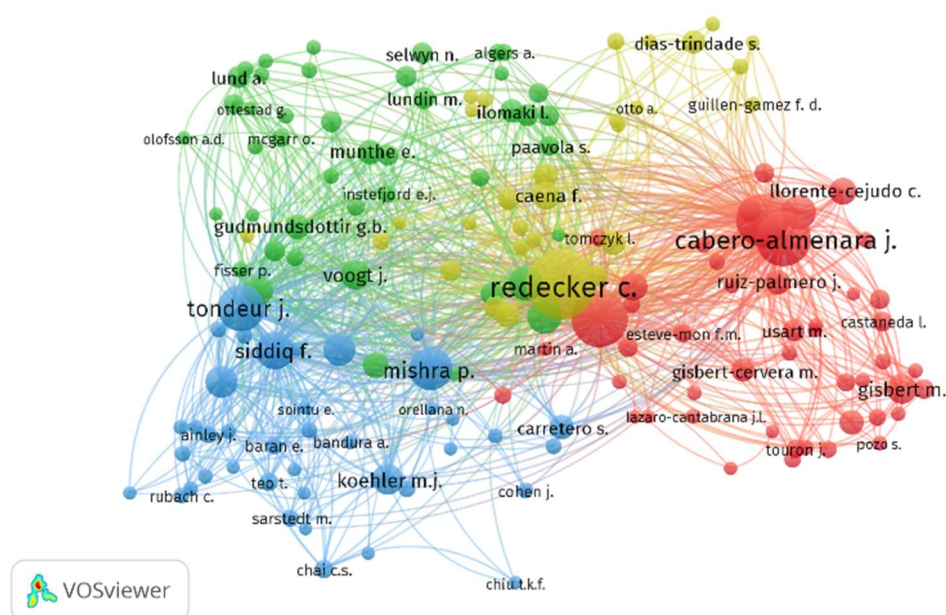


Figure 8. Co-citation Network Among Cited Authors

Figure 8 display the examination of the co-citation network among authors with a minimum threshold of 20 citations revealed 162 influential scholars from a total of 19,011 authors. Redecker, C. clearly stands out as the most significant and influential author who exhibiting the highest co-citation strength (11,677) and total citations (417) recognizing their essential contribution to the development of the DigCompEdu framework and its theoretical foundations. Additionally, Cabero-Almenara, J. exhibits notable network integration, especially within the Spanish-speaking academic community as evidenced by 8,143 link strengths and 266 citations.

The network shows clear clusters which acclaim a convergence of disciplines that spans from educational technology to teacher professional development and the density and overlap of connections on the map indicate a developing interdisciplinary discourse albeit with evident regional clustering. This underlines the necessity for global collaboration to broaden perspectives and enhance the 's relevance of the European DigCompEdu framework across the cultures.

Co-citation Analysis – Referenced Citations.

Figure 9 display below the logical framework for DigCompEdu research which organized into thematic groups; where co-citation analysis identified 27 prominent authors from the large pool of 14,232 authors and each meeting the minimum requirement of not less than 10 citations per cited work. For instance, Redecker, Punie, Vuorikari, and Ferrari are leading authors as they established European digital competence frameworks. Moreover, the connections established by the authors indicate a strong foundational theory that is deeply entrenched in EU policy as well as the criteria of digital competence. Additionally, Caena, Starkey, and Mishra's clusters underscore the significance of teacher training along with the inclusion of educational technology and the principles of digital pedagogy.

However, the visualization reveals relatively weaker connections among specific clusters which is suggesting a level of specialization and fragmentation within subdomains and, also network presents a complexly interconnected yet thematically varied knowledge base as well as featuring several key authors who lead the discourse alongside others who provide context indeed.

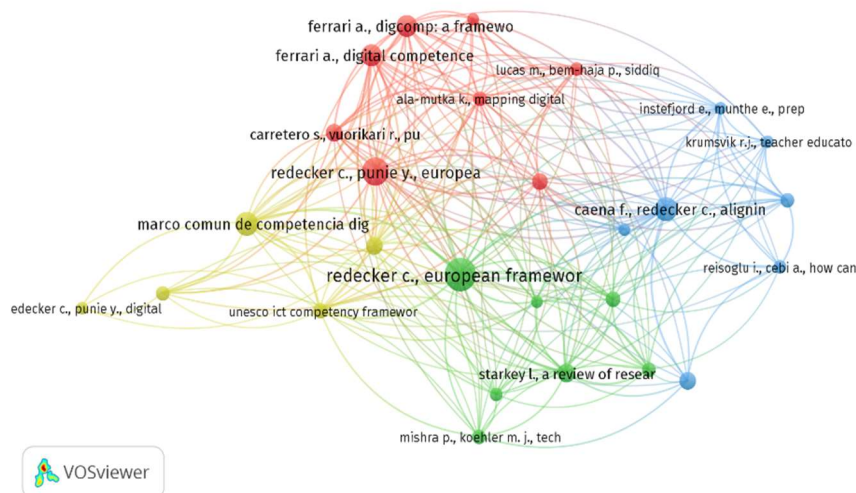


Figure 9. Co-Citation Network for Cited References.

Conclusion

As Donthu et al. (2021) describe bibliometric analysis as a “popular and rigorous method for exploring and analyzing large volumes of scientific data,” which authenticates that it offers an in-depth view of research trends and patterns. Therefore, 303 published significantly relevant articles from Scopus database were examined from the justified time frame 2017 to 2024 in this study; concerning the DigCompEdu framework. Finding reveals that Spain, Portugal and China as key contributors’ country and prominent authors like Redecker and Cabero-Almenara shaping the academic structure within the field along with the prominent journal like Computers and Education and Sustainability (Switzerland) serve as key publication platform. The theme cluster was highlighting a predominant emphasis on digital competence, educator training, and AI-augmented pedagogy. Major findings inform and comprehend researchers, policymakers, and teacher education institutions about DigCompEdu’s global diffusion, conceptual development, and collaborative dynamics strongly and highlights the growing multidisciplinary integration and relevance to post-pandemic digital education reforms. Moreover, AI integration, digital self-efficacy, and remote learning specify shifting objectives of the 21st-century educator training or professional development.

However, the study has drawbacks like the analysis is limited to the Scopus database, potentially omitting relevant literature indexed elsewhere and the study relies on metadata and citation-based indicators, which may not fully capture qualitative dimensions of academic impact or contextual nuances across countries and education systems indeed. Therefore, future research should explore different globally authentic and established database for bibliometric comparisons such as Web of Science or Dimensions and incorporate content-based text mining to enrich thematic insights. Moreover, examine regional implementation of DigCompEdu, particularly in the underrepresented regions like South Asia, Africa and Latin America region. And the last but not the least, the integration of DigCompEdu framework into national digital education strategies is also needed to validate its practical applicability and global relevance for each country.

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