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Science Mapping the Knowledge Base on Digital Competency in High Education, 2000–2025

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Abstract: "Science Mapping" is used as a means of understanding the evolution of research in digital competency in high education in this systematic review. The review analyzed 3892 Web of Science-indexed documents on digital competency in high education published between 2000 and 2025. The review aims to document the size, growth trajectory, and geographic distribution of digital competency in high education research, identify high-impact scholars and documents, and illuminate the "intellectual structure" of the field. Metadata associated with these documents was analyzed using the VOS viewer, Excel, Citespace and Tableau software for descriptive statistics, citation, and co-citation analyses of publication patterns, authors, documents, and journals. The study reveals that the intellectual structure of this domain is composed of three distinct schools of thought: computer education, psychology, and sustainability. The review further delineated the field's current research front iers, which are centered on high education, digital competency, and digital technology.

Keywords: Digital Competency, High Education, DigitalTechnology, Bibliometric Analysis, Bibliometric Review, Science Mapping.

1. Introduction

The rapid development of digital industrialization is transforming the global workforce, necessitating new knowledge, skills, and competencies. The increasing application of digital technology in education plays a significant role in our daily lives and work. Digital competencies are crucial for modern education systems. UNESCO (2018) highlights that digital literacy enhances learning outcomes by enabling access to online resources, collaborative learning, and personalized education.

Consequently, a growing number of schools and educational institutions around the world are beginning to adopt digital teaching methods. In addition to having solid professional knowledge, teachers also need to upgrade technical skills such as digital competence, and professional development should focus on the integration of emerging technologies [12].

Digital competencies refer to the ability of high education students to use technology and digital media interactively to enhance their learning experiences. They encompass skills in communication, content creation, content management, digital security, and digital empathy, which are essential for effective engagement in digital environments [13].

While there have been impressive advances in the study of digital capabilities in the past, particularly in the context of education and workforce development, challenges remain. Recent studies highlight the importance of digital skills across various demographics, emphasizing the need for tailored training programs [2]. Scholars rarely conceptualize the impact of digital competency on education from the perspective of its impact on higher education [7].

This systematic review examines and synthesizes trends in knowledge production regarding digital competencies in high education. The study explores the following research questions:

(1) What is the overall volume, growth trajectory, and distribution of published documents across countries, types of papers, and research methods on digital competency in the high education knowledge base?

(2) What journals, authors, and research papers have had the most significant influence on digital competency in high education?

(3) What is the intellectual structure of the knowledge base underlying theory and digital competency in high education?

(4) What is the 'research front' or most frequently studied topics in recent years in the digital competency in high education literature?

By applying quantitative methods and established bibliometric standards, our analysis will identify research patterns, temporal trends, conceptual relationships, and knowledge architectures to resolve questions 1 through 4."

2. Methodology

2.1. Study Design

In the past decade, bibliometric analysis has attracted increasing research attention. Due to the introduction of new software programs, multidisciplinary approaches, and the ability to handle large databases, this analysis has become more scientific and practical [10]. To conduct a more scientific and quantitative analysis of the current research status and development trends, this project adopts the bibliometric method to systematically and scientifically analyze and confirm the research status, hot spots, and development trends. Bibliometric reviews provide distinct advantages compared to traditional qualitative literature reviews, such as greater coverage and unbiased analytical rigor. To strengthen the paper's practical contribution and yield deeper content-based insights, qualitative analysis was integrated with bibliometric methods. This dual approach facilitates a more holistic examination of digital competency in the field of high education.

2.2. Data Sources and Criteria

The Web of Science Core Collection database (WoS) and the Chinese National Knowledge Infrastructure (Cnki) Chinese journal database are used as data sources. Thematic searches are conducted using the terms " digital competency in high education research "and their synonyms as search terms to capture relevant research papers in the field over the past two decades (2000-2025). The development trends of the field are systematically analyzed from multiple dimensions, including the number of published papers, research institutions, authors, journal collaboration networks, and research topics. The aim is to comprehensively grasp the current development status of the research field, identify research hot-spots and frontiers, and provide a theoretical basis and decision-making references for the project. Our selection criteria encompassed studies that investigated digital competency in high education from theoretical, conceptual, or empirical perspectives, where conflict was analyzed as an antecedent, mediating, or moderating variable.

This review analyzed a data set of WoS publications, including journal articles. The bibliographic metadata were processed using analytical tools, which include Excel, Tableau, and VOS- viewer and Citespace to conduct multiple analyses: descriptive statistics (e.g., publication trends, authorship patterns); citation analysis (direct citations and co-citations); social network analysis (collaboration networks); and keyword co-occurrence mapping (thematic trends).

The bibliographic dataset was extracted from WoS and subsequently analyzed through VOS-Viewer's network visualization and mapping functionalities [16]. This scientometric investigation employed bibliometric analysis to systematically examine the scholarly landscape of digital competency in high education research. Unlike conventional literature reviews that focus on synthesizing research findings, this methodology provides unique value by delineating macro-level patterns and structural characteristics within the knowledge domain. Through science mapping techniques, the study reveals latent intellectual architectures and developmental trajectories of the field—insights that remain largely inaccessible through traditional review methodologies [17, 18].

2.3. Identification of Sources

The researchers adhered to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework [14]. When performing their systematic literature review. This methodology outlines specific documentation requirements for study selection in systematic reviews Figure 1.The investigation sought to compile all publications indexed under the number 3892 in the Web of Science. The database was queried with the following search configurations:

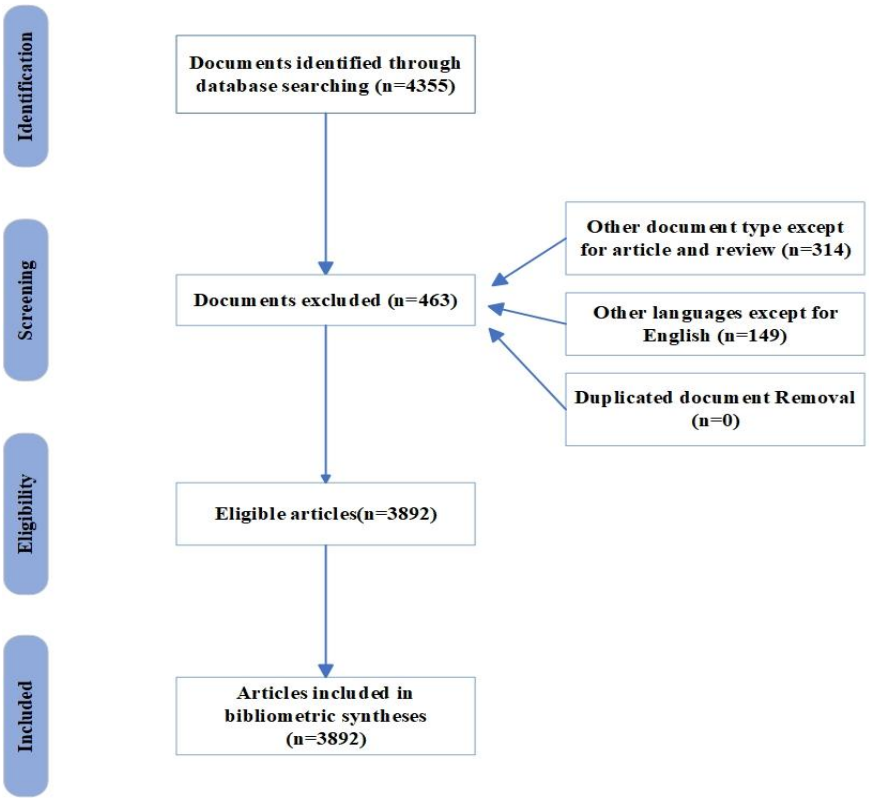

Figure 1. PRISMA flow diagram detailing steps in the identification and screening of sources [14].

2.4. Data Analysis

Bibliographic data (including author, title, institutional affiliation, and citation data) for 3892 documents were completed in preparation for subsequent data analysis. It conducted bibliometric analyses on the selected 3892 articles using several tools, including Excel, Tableau, and VOS viewer 1.6.18 [16]. To visualize publication trends, growth trajectory lines were generated using Excel. Tableau was utilized to create a geographic map depicting the global distribution of research. Furthermore, advanced bibliometric analyses, such as author, document, and journal citation and co-citation, were conducted using the widely recognized software tools VOS viewer and CiteSpace.

3. Results

The findings of the bibliometric analysis on digital competency in higher education are presented in this section, along with a discussion of the research questions related to

this analysis.

3.1. Descriptive Trends

The annual distribution of publication volume serves as a key indicator for assessing research activity within a given discipline. To some extent, it reflects the dynamic trajectory of the field's development and offers a scientific basis for predicting future trends. Based on the measurement and visual analysis of the sample data, the overall publication trend on digital competency in high education is presented in Figure 2.

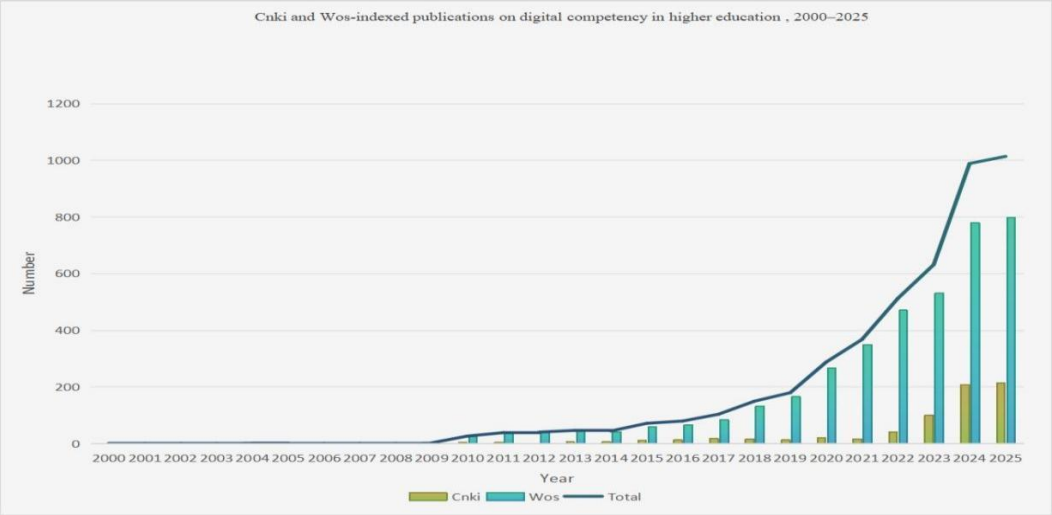

Figure 2. Growth trajectory of Cnki and WoS-indexed publications on digital competency in higher education, 2000–2025

As illustrated in Figure 2, the overall publication trend shows a consistent upward trajectory in the annual number of articles indexed in both Cnki and WoS from 2000 to 2025. Specifically, WoS has exhibited steady growth since 2010. In contrast, Cnki experienced a relatively slow development phase between 2010 and 2021, followed by a rapid increase starting in 2022. Based on the current data, the total number of publications recorded in Cnki and WoS combined is projected to reach 4576 by 2025.

Although Cnki's output remains lower than that of WoS and its growth started later, the number of publications in Cnki demonstrates a clear upward trend. The data indicate a growing research focus on digital competency in higher education in the Cnki database. At the same time, the volume of English-language articles on this topic in WoS continues to expand, reflecting a sustained increase in research productivity in the related field.

3.2. Landscape of Digital Competency in High Education

By analyzing the author's position, we can gain a deeper understanding of the academic interests in digital competency in higher education research. These documents come from 131 different countries around the world, thus affirming the global interest in this topic. Figure 3 presents a heat map illustrating the publication density of different countries. The US-based authors constituted the most significant proportion of contributors, accounting for 17% (677 papers) of all articles, Other significant contributors included China (528 papers), Spain (418 papers), England (340 papers), Australia(320papers), Germany (237 papers), Canada (161 papers), China Taiwai (133papers), Italy (131papers), the Netherlands (116papers), and Norway (98 papers).

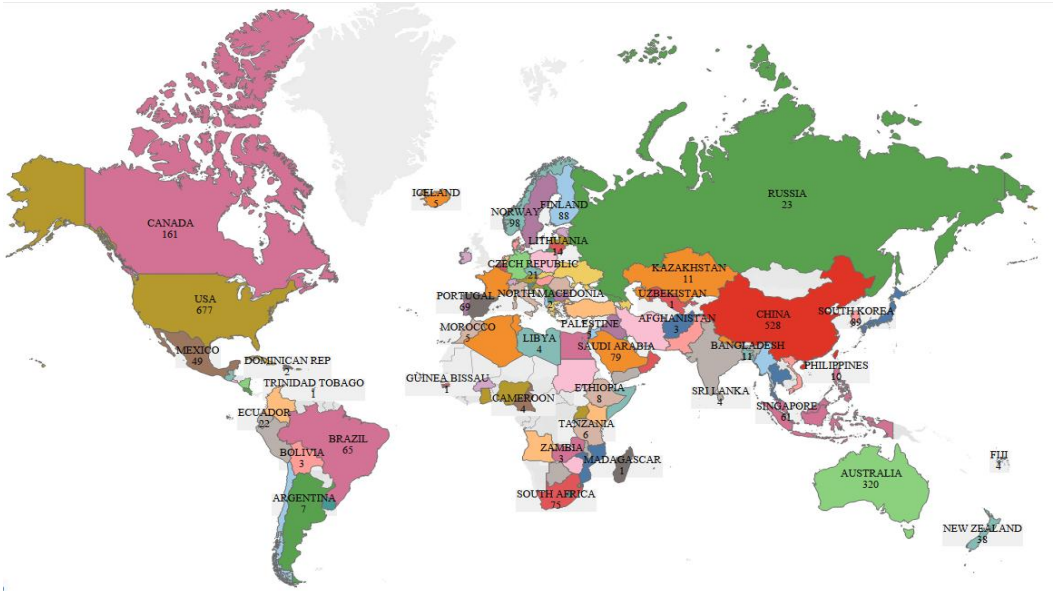

Figure 3. Worldwide distribution of digital competency in higher education literature, 2000–2025 (n = 3892 documents)

A comparative analysis reveals a growing global emphasis on digital competency in high education, with attention

intensifying annually. Developed nations currently demonstrate significantly greater focus and investment in this area, whereas developing countries are progressing at a comparatively slower pace. Within this international landscape, China stands out as a notable exception among emerging economies, exhibiting a level of commitment that aligns closely with advanced national standards.

3.3. Analysis of Influential Authors and Documents

WoS' citation analysis of authors is shown in Table 1. The review identified 276 listed authors and co-authors through Citespace. It indicates that the field has attracted significant attention from a wide academic community. Concurrently, even the core contributors have published a modest number of papers in absolute terms.

Table 1. Rank order of the most influential and productive authors by WoS citations and documents published

Author	Nation	Documents	WoS Citations	Citations Per Document	Wos h-Index
Tom Crick	South Wales	6	1693	282.5	4
van Dijk, Jan	the Netherlands	6	1069	179	5
Car, Lorainne Tudor	Singapore	13	822	66.77	11
Car, Josip	Singapore	10	693	71.2	9
Hwang, Gwo-Jen	China Taiwan	7	444	63.71	7
Kyaw, Bhone Myint	Singapore	9	363	43.11	8
van Deursen, Alexander J.A.M.	the Netherlands	5	275	55.2	4
Muñoz-Repiso, Ana García-Valcárcel	Spain	6	202	33.67	2
Mikkonen, Kristina	UK	8	158	20.13	6
Ramírez-Montoya, María-Soledad	Mexico	6	124	20.83	5
Kääriäinen, Maria	Finland	5	122	24.4	4
Herrmann-Werner, Anne	Germany	5	95	19.2	3
Sousa, Maria José	Portugal	5	78	16	3
Alt, Dorit	Israel	6	74	12.83	4
van der Gijp, Anouk	the Netherlands	5	70	15	5
Cate, Olle Th.J. ten	the Netherlands	5	54	11.4	5
Buggenhagen, Holger	Germany	6	23	4.67	3
Weimer, Andreas	Germany	6	23	4.67	3
Weimer, Johannes Matthias	Germany	6	23	4.76	3
Bonnaud, Olivier	France	7	9	1.71	3

The data presented in Table 1 indicates that the most influential scholars on digital competency in higher education are Tom Crick (1693), van Dijk, Jan (1069), Car, Lorainne Tudor (822), Car, Josip (693), Hwang, Gwo-Jen (444), Kyaw, Bhone Myint (363), The authors listed in Table 1 exhibit a relatively low citation impact based on our bibliometric analysis. Nevertheless, it is crucial to acknowledge that the quantitative methods employed here serve as statistical proxies for "most influential." A discernible gap may exist between these metrics and the substantive scholarly influence of the work, a limitation that warrants attention.

Table 2 presents the most influential publications on digital competency in the higher education field as measured by total citation counts in the Web of Science (WoS) database. Five of these documents have each been cited more than 100 times [1, 3, 6, 8, 15]. Given the relatively recent emergence of much of the digital competency in higher education literature, this citation frequencies can be considered moderate. For readers more familiar with citation metrics from Google Scholar or Scopus, it should be noted that WoS has a narrower coverage; therefore, citation counts for the same literature or authors may appear comparatively lower in WoS. Nevertheless, the data presented here remain meaningful for our analysis. Additionally, the results in Table 2 suggest that highly cited digital competency articles in higher education in Wos primarily consist of original research articles that have significantly advanced the field. Review articles are less prominent but still have the potential to contribute further.

Table 2. Presents the most influential documents on digital competency in higher education, measured by total WoS citations

Ranking	Author	Document	Wos Cites	Type of paper
1	(Sailer et al., 2021)	Contextual facilitators for learning activities involving technology in higher education: The C(sic)-model	127	Article
2	(Hazrat et al., 2023)	Developing a Skilled Workforce for Future Industry Demand: The Potential of Digital Twin-Based Teaching and Learning Practices in Engineering Education	125	Article
3	(Car et al., 2022)	Digital Education for Health Professionals: An Evidence Map, Conceptual Framework, and Research Agenda	118	Review
4	(Barra et al., 2024)	Digital divide, gender gap, and entrepreneurial orientation: How to foster technology adoption among Pakistani higher education students?	115	Article
5	(de Obesso et al., 2023)	How do students perceive educators' digital competence in higher education?	110	Article
6	(Yang et al., 2022)	Research Status, Hotspots, and Evolutionary Trends of Global Digital Education via Knowledge Graph Analysis	98	Article
7	(Cheng et al., 2021)	Validity Evidence Based on Relations to Other Variables of the eHealth Literacy Questionnaire (eHLQ): Bayesian Approach to Test for Known-Groups Validity	96	Article
8	(Cetindamar et al., 2022)	Explicating AI Literacy of Employees at Digital Workplaces	94	Article
9	(Kuhn et al., 2024)	Who gets lost? How digital academic reading impacts equal opportunity in higher education	74	Article
10	(Ho & Chen, 2023)	Developing the e-commerce competency for entrepreneurship education from a gamified competition	73	Article

3.4. Intellectual Structure of The Digital Competency in High Education

The "intellectual structure" of diverse research fields has also been examined using scientific mapping reviews. This concept denotes the key theoretical and empirical lines of inquiry, or the distinctive "schools of thought," that characterize a field of study.

Co-citation analysis examines the relationships between journals within the reference lists of the 3892 documents in our database. The resulting map identified four primary clusters, as indicated by their distinct colors. Each cluster signifies a collection of journals that share convergent research interests and intellectual traditions. By setting the co-citation threshold in VOSviewer to a minimum of 60 per journal, we obtained a final set of 433 journals with the highest co-citation counts.

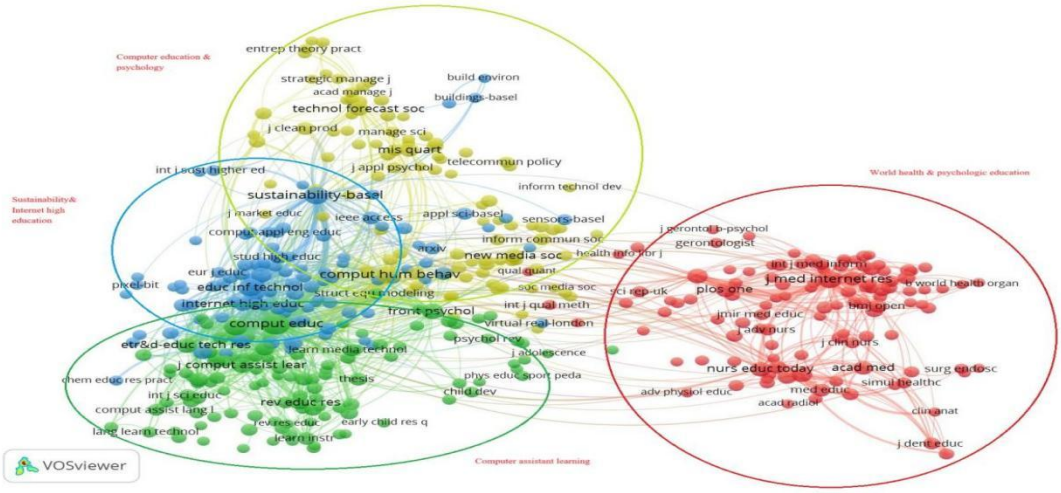

Figure 4. Co-citation network analysis of journals on digital competency in higher education

The four clusters are centered around computer education, psychology, sustainability, internet high education, computer assistant learning, world health, and psychological education (as shown in Figure 4).

3.5. Topical Foci of The Digital Competency in High Education

A co-occurrence analysis was performed to investigate the primary research topics in the literature on digital competency in higher education. As the initial step, the most frequent keywords were identified using the VOS viewer software. The density map (Figure 5) reveals high-frequency keywords such as "education" (809), "technology" (414), and "students" (408), among others. This pattern of results directly corroborates the author's co-citation analysis, confirming that the literature is predominantly concerned with the technological dimensions of education.

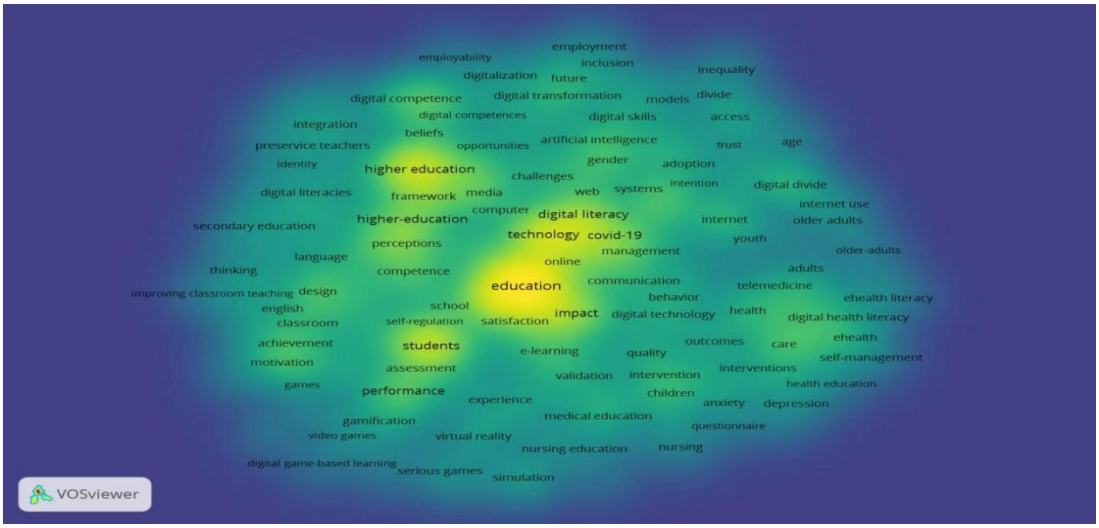

Figure 5. Keyword density heat map for the digital competency in higher education literature, 2000–2025 (threshold 20 occurrences, display 259 keywords)

To visualize the evolution of research themes, a temporal co-keyword map (Figure 6) was created in VOS viewer, with a minimum co-occurrence threshold set to 20. Temporal co-keyword analysis investigates the distribution of keywords over time, based on the publication dates of the source documents. In the resulting map, yellow/light-colored bubbles represent the most recent topics of scholarly interest, whereas darker bubbles signify themes that were prominent in earlier periods. Interpreting this map involves analyzing three key attributes: bubble size (indicating frequency), color (denoting recency), and spatial position (reflecting relational proximity to other topics).

"Education, Technology, Digital literacy" occupies a central position on the map, exhibits the highest number of connections to other topics, and represents an area of ongoing scholarly interest. This finding echoes earlier discussions on the intellectual structure of the knowledge base, in which all three major schools of thought placed strong emphasis on digital competency in education.

The analysis also identified the emergence of a 'Higher Education' cluster (green), which was linked to the central 'Education and digital literacy' topic. This cluster encompassed the key concepts of digital competency.

A second cluster of recent keywords, also linked to 'Education', centers on various aspects of ' digital literacy' (purple cluster). This theme encompasses 'digital device,' 'Internet,' Communication,' 'Quality,' 'E-learning,' and 'Performance.' It resonates with research priorities from the first and second schools of thought, underscoring their continued relevance.

The temporal co-word analysis thus affirms and extends earlier work, indicating that current scholarly interest in digital competency in higher education is primarily focused on digital literacy, technology, and higher education, specifically reflected in terms like 'digital transformation' and 'artificial intelligence'. In addition, the co-word analysis indicates significant attention to digital competency or technology dimensions of education within the field.

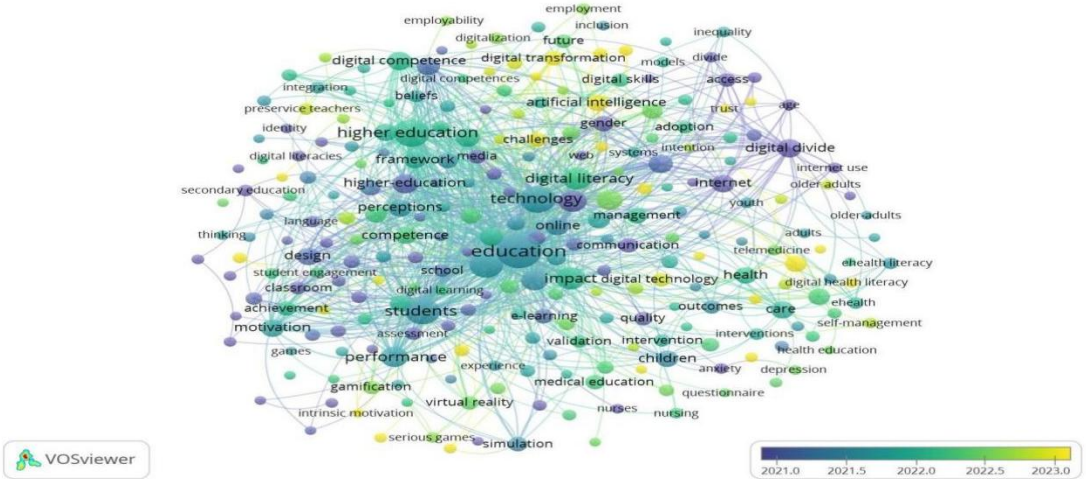

Figure 6. Temporal co-word map of the digital competency in higher education literature, 2000–2025 (threshold 20 occurrences, display 259 keywords)

4. Discussion

This review reveals that the literature on digital competency in higher education remains limited in volume. Although the first relevant study appeared in 2000, the majority of publications have emerged within the past decade. This pattern of growth can be attributed to the growing emphasis on digitalization across professional disciplines and the impetus provided by the digital century.

The analysis of the global geographic distribution of digital competency in higher education literature confirms the worldwide scope of interest in this domain. However, we also observed that the production of knowledge on the digital competency in higher education remains heavily concentrated

in a few countries—namely USA (677 papers), China (528papers), Spain (418papers), England (340 papers), Australia (320papers), Germany (237papers), Canada (161papers), China Taiwan (133papers), Italy (131papers), the Netherlands (116papers), and Norway (98 papers) with a notable paucity of contributions from some developing societies. This imbalance represents a critical gap in the literature, especially given the vital role of digital competency in higher education in the social and economic progress of these regions. To address this gap, we urge scholars to prioritize research in developing country contexts.

Citation analysis enabled the identification of pivotal authors contributing to this field.

The analysis identifies the following as the most influential scholars in this domain, based on their citation numbers: Tom Crick (1,693), Jan van Dijk (1,069), Lorainne Tudor Car (822), Josip Car (693), Gwo-Jen Hwang (444), and Bhone Myint Kyaw (363). The high citation count for five key publications (Barra et al., 2024; Car et al., 2022; de Obesso et al., 2023; Hazrat et al., 2023; Sailer et al., 2021) demonstrates their substantial impact, despite the relatively nascent state of digital competency research in higher education.

A central contribution of this review is its empirical mapping of the field's intellectual structure, thereby identifying the distinct schools of thought that constitute this interdisciplinary body of literature and extending the findings of prior reviews. The analysis identified four major thematic clusters: Computer Education, Psychology and Sustainability, Internet-based Higher Education, and Computer-Assisted Learning, along with two smaller clusters focusing on World Health and Psychological Education.

The predominant themes emerging from the density map within the digital competency in higher education field reflect current research priorities in education. A key conclusion from this review is that future research should urgently incorporate digital competency and educational outputs into its core models and empirical investigations. This entails a dual focus: firstly, on developing comprehensive assessment systems to gauge their impact, and secondly, on elucidating their mechanistic role in optimizing educational management. Simultaneously, the building of these very capabilities and infrastructures within higher education has rightfully become a prominent and active research stream in its own right.

5. Limitations

This study's first limitation arises from its methodological choice to conduct a quantitative, bibliometric review. Firstly, the analysis is based on the characteristics and relationships of publications (e.g., citations, keywords) rather than a direct engagement with their scholarly arguments and conclusions. This methodological focus means that while the review effectively identifies major research fronts and collaborative networks, it cannot offer insight into the substantive knowledge claims within the field of digital competency in higher education. The impact is therefore confined to revealing 'big picture' trends rather than synthesizing specific research results.

The second limitation concerns the definition of digital competency in the field of higher education itself. As an emerging domain, digital competency lacks a well-established conceptual perimeter. Consequently, the use of the search term "digital competency" often retrieved publications focused on the technology and innovations, rather than on environmental or social dimensions. While this represents a constraint, our bibliometric analysis has nonetheless established a baseline for the current discourse on "digital competency" in the digital competency in higher education, providing a benchmark for tracking the field's evolution.

Another limitation pertains to the completeness and accuracy of the database. The absence of standardized keyword protocols means our search string may not have captured all relevant studies. Additionally, the exclusion of conference proceedings, books, book chapters, and theses may have led to the omission of significant research. The sole focus on English-language publications further limits insights into research progress in non-English-speaking countries. Future reviews should consider expanding the search to a wider range of databases and including publications in other languages.

Furthermore, an overreliance on citation metrics alone offers an incomplete and potentially misleading assessment of a publication's scholarly impact. It is critical to recognize that citations are not monolithic endorsements; they may also signal methodological critique or substantive disagreement. Consequently, to avoid an oversimplified narrative, a more nuanced understanding of impact requires methodological triangulation. This involves synthesizing quantitative indicators (e.g., citation counts, journal impact factors) with qualitative evidence of a work's influence on both academic discourse and professional practice.

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Conflicts of Interest

The authors declare no conflicts of interest.

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