



## Review article

# Research hotspots and trends in digitalization in higher education: A bibliometric analysis

Bin Zhao<sup>a</sup>, Jie Zhou<sup>b,\*</sup><sup>a</sup> School of Public Administration, Heilongjiang University of Science and Technology, Harbin, 150020, China<sup>b</sup> Ningxia Polytechnic, Yinchuan, 750000, China

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## ABSTRACT

This bibliometric analysis reviews 8521 articles related to the digitalization of higher education, spanning from 1968 and 2023, sourced from the Web of Science Core Collection (WoSCC), PubMed, and Scopus databases. Employing this analytical framework, we identify key authors, leading institutions, and influential countries while highlighting high-impact literature and intricate collaborative networks within this field. Through an examination of high-frequency keywords and topics, this study maps the knowledge structure of the field, suggesting emerging hotspots and setting the trajectories for future research directions. Notably, the study by Crawford et al., in 2020 has received the highest number of citations, marking a significant impact. Furthermore, Spain has been particularly active, emerging as a leader in the volume of contributions to digital research in higher education. Keywords such as “co-creation”, “competency”, “hybrid teaching”, and “digital writing” are identified to drive future research trends, reflecting a growing interest in these areas. Meanwhile, themes like “e-learning” and “blended learning” are expected to remain central in upcoming research work.

## 1. Introduction

The integration and application of digital technology in higher education have transformed the traditional teaching paradigm, facilitating a shift toward more personalized [1], diverse [2], and open [3] learning experiences. This transformation has enabled the transcendence of time and space limitations, allowing students to access professional knowledge and skills through online learning platforms beyond conventional classroom settings. As a result, the digitalization of higher education has enriched educational resources, including instructional videos [4], virtual labs [5], and online libraries [6], which enhances self-directed and profound learning opportunities.

Despite these advancements, traditional constraints of time and space still often restrict higher education. However, the advent of digitalization has not only mitigated these constraints but has also expanded the scope of educational research. Scholars are increasingly using digital data and technologies to support their research [7], which improves the breadth and depth of academic inquiry. That overcome the constraints of time and space [8]. These digital tools facilitate cross-geographical interactions and the global sharing of educational resources [9], thereby accelerating the globalization of education. From instructional design to assessment, and from online learning communities to big data analytics, digitalization offers more opportunities for education researchers to explore and refine their understanding of learning processes and teaching effects [10].

\* Corresponding author.

E-mail addresses: [zhbin202206@163.com](mailto:zhbin202206@163.com) (B. Zhao), [2024016@nxtc.edu.cn](mailto:2024016@nxtc.edu.cn) (J. Zhou).

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Nevertheless, the rapid adoption of digital technologies in higher education also presents challenges, particularly concerning the quality and effectiveness of digital educational resources. There is a pressing need for educational administrators and researchers to collaboratively address issues such as the assurance of online courses quality [11], information overload [12], knowledge fragmentation [13], and digital division [14].

Digitalization of higher education has been considered a focal point in academic research, with increasing attention directed towards aspects such as open education [15], e-learning [16], and hybrid teaching [17]. Significant contributions to the field include Khaldi, A's exploration of gamification elements and theories used in empirical research. This work creates different applications of game elements and reviews contemporary gamification strategies in higher education e-learning systems [18]. Similarly, Jill Jameson has provided an extensive review of literature on digital leadership in higher education from 1999 to 2022 [19], offering insights into the evolution of leadership in the digital era. Additionally, Zhao, Yu provides a systematic overview of digital competencies in higher education from 2015 to 2021. This study includes an examination of the definitions, assessment dimensions, and research methodologies related to digital competencies, along with their outcomes and limitations [20]. In another study, Anna Sánchez Caballé analyzed 107 documents to focus on digital teaching methods, selecting 23 for an in-depth qualitative review [21]. Moreover, Caspari-Sadeghi Sima explored the application of learning analytics in higher education, summarizing its primary functions such as monitoring, analysis, automatic feedback, prediction, prevention, and intervention [22].

However, these studies mainly focus on specific segments of the higher education landscape, such as universities or healthcare, and relying on traditional manual literature reviews that can be time-consuming and may not capture the full range of available data. Thus, it is necessarily important to adopt a systematic bibliometric method that facilitates the collection and analysis of extensive literature to present the research trend and directions of the digitalization in higher education.

In order to investigate the current state and future development of digitalization in higher education, we used bibliometric analysis techniques to systematically review a large number of academic and conference papers. This method enabled us to trace the development process, identify key milestones, and provide historical perspectives that are important for current digital education strategies. By exploring research themes and identifying hot spots, we reveal the cutting-edge trends that are shaping the future of digitalization in higher education. Moreover, an in-depth analysis of academic cooperation network and the impact of research contributes to our understanding of international cooperation and the academic contributions in this field, thereby fostering a global community of researchers on digitalization in higher education.

This study is driven by the following research questions.

- (1) How is research literature on digitization in higher education distributed globally?
- (2) What are the trends and focus areas of digitization in higher education worldwide?
- (3) What are the emerging trends and potential research directions for future research in higher education digitization?

## 2. Methods and materials

### 2.1. Methods

The Bibliometrix R-package, an open-source software built on R language, is a powerful tool for bibliometric analysis by integrating various bibliometric methods and visualization techniques [23]. The package facilitates the import, cleaning, and visualization of literature data, along with analysis of co-cited documents, cooperative network analysis, keyword analysis [24]. To initiate a bibliometric analysis, researchers must first collect and prepare relevant literature from academic databases, literature indexes, or research libraries. Bibliometrix supports multiple data formats, including BibTex, CSV, and plain text. Data processing such as deduplication, normalization of author names, and handling of missing information is important to ensure data quality and consistency. Through Bibliometrix, researchers can delve into the knowledge structure within the domain of higher education digitalization, discover research hotspots, and provide insights for future research directions and policy formulation.

### 2.2. Materials

Bibliometrics can analyze the most critical literature in a particular field of study [25]. Our study analyzed literature on the digitalization of higher education from databases such as the WoSCC, Scopus, and PubMed. WoSCC is renowned for its broad disciplinary coverage, including natural sciences, social sciences, and humanities, making it ideal for interdisciplinary research [26]. Scopus, recognized as one of the largest abstract and citation databases globally, offers extensive coverage of journals and conference proceedings. PubMed, primarily focusing on life sciences and clinical fields [27], serves as an essential resource for medical studies [28]. Using advanced search mode, we employed the search string (TS= ("digitization" OR "digital" OR "digitalization" OR "digitizing" OR "digitized" OR "digitize" OR "digitalize" OR "digitalized")) AND TS= ("higher education" OR "high education" OR "advanced education" OR "tertiary education" OR "higher education" OR "higher learning education" OR "higher education" OR "higher vocational education"). The time range was all years, and the search time was July 18th, 2023. From the initial retrieval of 11,713 publications across WoSCC (5097 publications), Scopus (6432 publications), and PubMed (184 publications), rigorous title, abstract, and keyword reviews were conducted to refine the selection. After deduplication and specific inclusion criteria focusing on "articles" and "review papers", a final set of 8521 bibliographic data was obtained for detailed analysis.

### 3. Results

#### 3.1. Data analysis and visualization

The consolidated datasets from WoSCC, Scopus, and PubMed included 11,713 research publications related to the digitalization of higher education, contributed by 20,820 authors and generating 16,954 unique author keywords. These keywords are usually less than 10 words, which provide precise summaries of the research themes. The datasets revealed an average citation count of 9.324 per publication, with 1,750 papers attributed to single-author studies. [Table 1](#) shows the aggregated statistics.

#### 3.2. Annual publication volume analysis

[Fig. 1](#) shows the distribution of annual publications in higher education digitalization from 1968 to 2023, with three distinct phases in the research development. The first stage (1968–1997), also known as the embryonic stage, had minimal activity, with publications rarely exceeding single digits annually. This period involved a total of only 39 articles, accounting for 0.5 % of total publications, likely due to that the nascent stage of digital technologies in educational contexts. The developmental phase (1998–2010), marked a steady increase in research interest, involving 510 publications and accounting for 5 % of the total numbers. This showed a growing recognition of the potential of digitalization in higher education. The rapid growth stage (post 2010), with publication numbers soaring into the triple digits, especially highlighted by significant spikes in 2020 and 2022. This surge, accounting for 93.6 % of the total publications, coincides with the broader adoption of digital technologies in education settings, influenced further by external factors like the global pandemic which accelerated online and digital education.

#### 3.3. Analysis of authors, institutions, and country collaborations

##### 3.3.1. Authors, institutions, and collaborative network analysis

[Fig. 2](#) shows the top 10 scholars with the most published articles on digital research in higher education from 2006 to 2023. Cabero-Almenaraj from Spain, as the author with most publications (28 publications), accounting for 0.3 % of the total publications. His main research focus was on assessing the digital competencies of 2262 professors across 9 public universities in Andalusia, Spain. His findings suggest that their digital competence was moderately developed, primarily in digital pedagogy and digital resources [29]. The study highlighted that the faculty's proficiency in employing digital tools varied according to their academic discipline. It was noted that higher levels of digital competency, categorized as leadership, expert, or pioneer, were influenced by factors such as the extent of engagement with creating digital content and spaces, as well as the use of innovative technologies such as virtual reality, robotics, and gamification [30].

The author who was ranked the second was Esteve-mon from Spain with 19 publications, accounting for 0.2 % of the total publications. His research concluded that professors generally considered digital technology as a beneficial addition to their professional environment [31].

Both Khan A. from Pakistan and Li J. from China were ranked the third with 17 articles, accounting for 0.1 % of the total publications. Their main research address the basic digital capabilities [32] and the digital management practices within academic libraries [33].

**Table 1**  
Summary of the literature information.

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	1968:2023
Sources (Journals, Books, etc)	2668
Documents	8521
Annual Growth Rate %	-1.23
Document Average Age	4
Average citations per doc	9.324
References	73247
DOCUMENT CONTENTS	
Keywords Plus (ID)	8264
Author's Keywords (DE)	16954
AUTHORS	
Authors	20820
Authors of single-authored docs	1575
AUTHORS COLLABORATION	
Single-authored docs	1750
Co-Authors per Doc	3.16
International co-authorships %	4.788
DOCUMENT TYPES	
article	8087
review	434

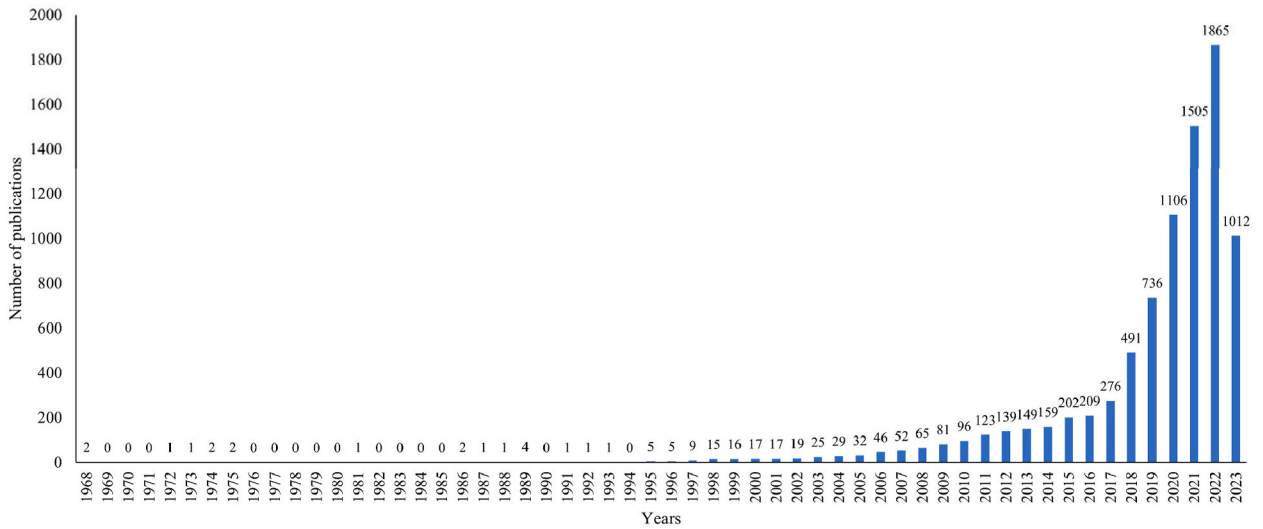


Fig. 1. Annual publication volume of publications: 1968–2023.

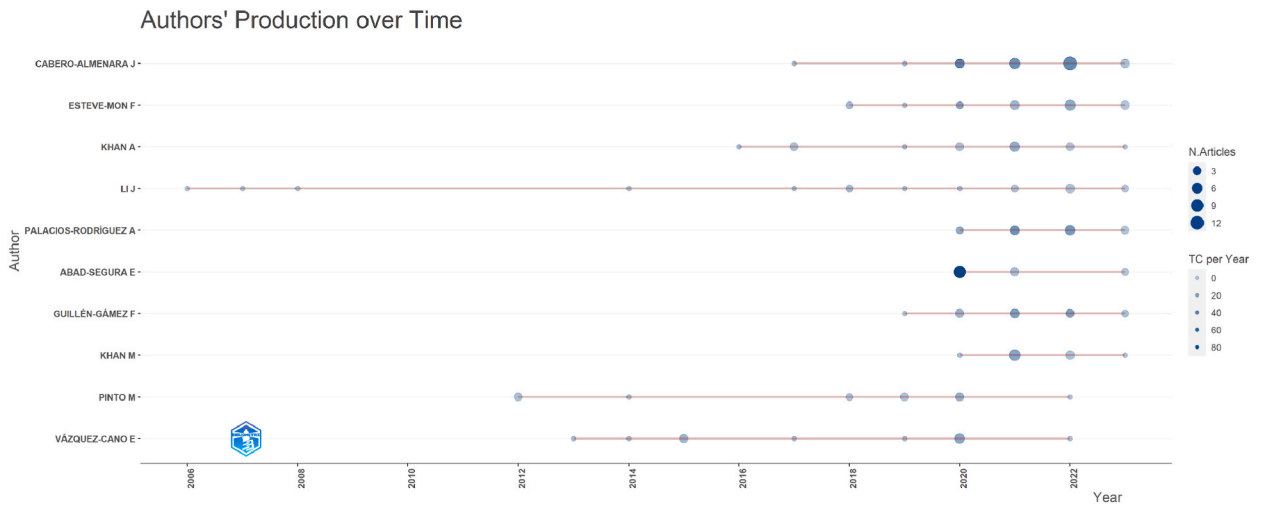


Fig. 2. Top 10 authors by the volume of publications.

This bibliometric analysis examines the publication output of the top 10 institutions contributing to digital research in higher education as shown in Table 2. Australia’s Ministry of Education and Science of Ukraine was ranked first with 328 articles. Their research focuses on the integration of modern information and communication technologies (ICT) within university operations, addressing key challenges such as primary information threats to the digitalization of higher education [34]. Additionally, their work

**Table 2**  
Key institutions in the field of digitalization in higher education.

Affiliation	Articles
Ministry of Education and Science of Ukraine	328
University of Granada	50
Deakin University	48
Sechenov University	46
University of Johannesburg	43
Monash University	42
University of South Africa	42
University of Washington	42
Sechenov First Moscow State Medical University	37
University of Tasmania	37

considers shifts in educational paradigms within digital environments that forms an ecosystem of innovative educational settings [35].

The University of Granada followed next with a contribution of 50 articles, emphasizing the digitalization needs of university students and the important role of digital competencies among teachers [36]. This indicated a broader academic interest in aligning digital education with students' expectations.

In addition, Deakin University, Sechenov University, University of Johannesburg, and Monash University have shown their research interests in this field with research output of 48, 46, 43 and 42 articles respectively. Their research focus on areas such as the application of artificial intelligence in higher education [37], the development of digital resources [38], the expansion of inclusive virtual learning environments [39], and issues related to the digital divide and digital equity among students [40]. These institutions focused on multiple aspects of digital technologies in higher education, including pedagogical innovations, resource management, and digital equality.

Collectively, the research output from these institutions illustrates a global commitment to advancing knowledge on digitalization in higher education. Each institutions has different focus with various approaches to utilizing educational technology, shaping education policy, and addressing the digital divide, all contributing to promote the digital development and improvement of higher education.

We utilized the Biblioshiny user interface to construct collaborative networks, to illustrate the cooperation among authors, institutions, and countries within the field of study [41]. Nodes within the network represent collaborators, and the connections in the nodes denote the cooperation between collaborators, while connections with different thickness indicate the extent of collaborations. Fig. 3(A) shows the networks between individual authors while Fig. 3(B) highlights inter-institutional collaborations. Prominent researchers such as Cabero-Almenara J., Moreira J., Kumar A., Khanm, and Meneses E., demonstrate well-established networks.

The results also showed that teachers' digital skills were an essential factor in contemporary educational methodologies [42]. Digital transformation has dramatically influenced students by fostering the creation of extensive online open courses aimed at enhancing teaching methodologies in higher education [43], thereby increasing students' satisfaction and retention [44]. The integration of digital tools have enabled university students with better communication skills through interactive media, and collaborative online documents handling through mobile devices [45], while the role of higher education in nurturing skills required for the digital economy is increasingly recognized as essential [43].

Similarly, institutions such as Sechenov First Moscow State Medical University in Russia and the Ministry of Education and Science

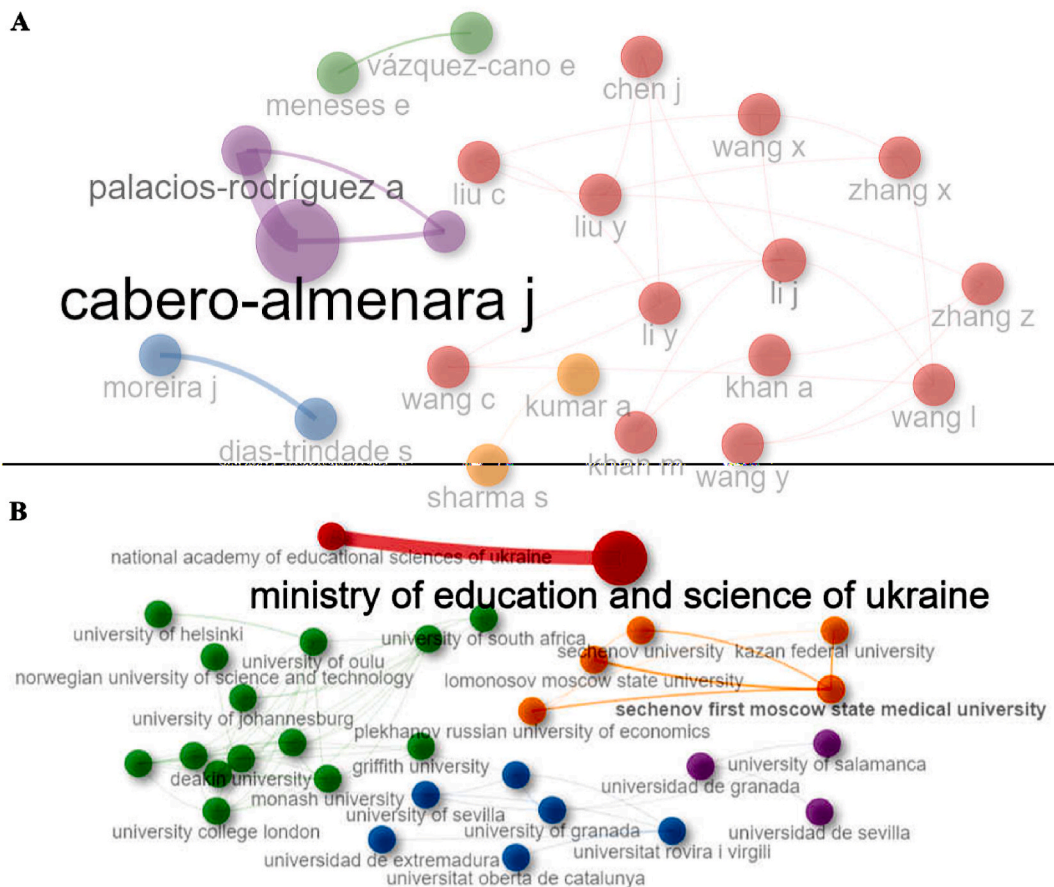


Fig. 3. Author collaboration network (A) and institutional collaboration network (B).

of Ukraine have been at the forefront of developing cooperation networks with other universities. For example, the Sechenov First Moscow State Medical University Cooperation Network has significantly contributed to the social development agenda in overcoming gender stereotypes [46] by creating ICT infrastructure. This supports to develop innovative education [47], and broadens access to digital skills which is particularly beneficial for marginalized groups, such as the elderly, less educated individuals, or those living in rural areas who otherwise face challenges in accessing digital resources [48].

Moreover, the collaboration between the Ministry of Education and Science of Ukraine and the University of Helsinki illustrates how digital strategies are being integrated into educational frameworks, potentially transforming teaching and learning processes. It is essential for policymakers, politicians, education administrators, and professionals to comprehend these changes and their implications to guide the evolution of educational practices in the digital age [49].

Despite the increasing relevance of digitalization in higher education, the personal experiences of educators within this digital landscape remain unexplored. Questions about how digitalization shapes their work environment, the meaning of digitalization for educators [49], and their specific needs in this evolving context are critical for developing responsive educational policies and practices. As we continue to prioritize the digitization of higher education, strategic funding aimed at enhancing the operational efficiency and competitiveness of these institutions through digital technologies is necessary [50].

### 3.3.2. Analysis of country/region cooperation and paper citations

Fig. 4 illustrates the extent of international collaboration by showing the frequency of cooperative research between countries. The thickness of each connecting line represents the number of collaborations, where a thicker connection representing a high frequency of cooperations. China and the United Kingdom are discovered to have close collaborative ties with the United States.

Digitalization serves as a catalyst to promote human capital development across both urban and rural areas. Incremental advancements in the digital index correlate with educational improvements: a 1.37 % increase in rural education and a 3.07 % increase in urban contexts as evidence by the data [51]. The main goal of higher education - preparing future professionals to meet the industry demands and global challenges such as competitive pressures, climate change, and resource limitations-is increasingly supported by digital innovations. These technologies provide educators with novel training methodologies and tools that enhance their capacity to engage with these challenges [52]. By developing digital competencies as their fundamental skills [53], educators can resolve issues and devise practical solutions more efficiently. Additionally, strengthening relationship-building and scaling digital outreach are crucial strategies in the marketing efforts of higher education institutions [54]. Countries like Australia and India are extending their digital educational frameworks to enrich the traditional interactions among students, teachers, researchers and administrative staff, thereby influencing international education dynamics.

However, the transition from face-to-face instruction to online learning platforms presents disparities across economic regions. While institutions in high- and upper-middle-income countries have adapted relatively smoothly to online education, the low- and lower-middle-income nations face significant hurdles. More than half of the global student population (1.5 billion), particularly in developing and emerging countries, have to engage with online educational platforms. The lack of robust internet infrastructure, adequate digital devices, sophisticated learning management systems, experience with online educational practices, and broader socio-economic challenges pose significant barriers to this transition in these regions [55].

## Country Collaboration Map

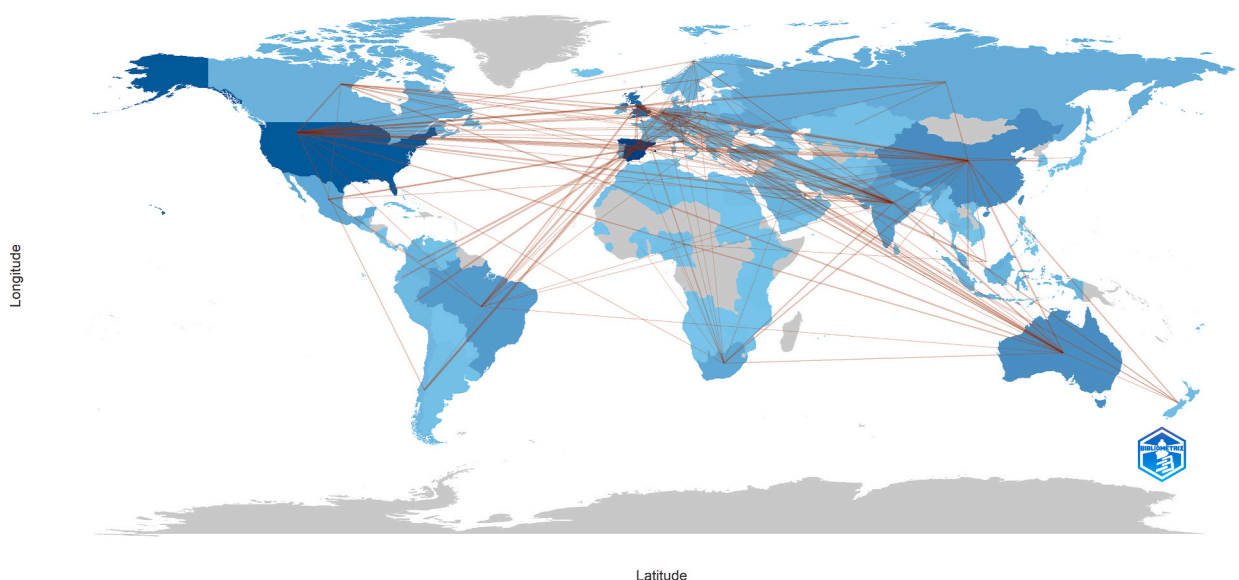


Fig. 4. International cooperation network.

This paper also delves into the highly cited paper in digital research in higher education. Both the number of publications and their citation counts serve as indicators of the importance and impact of a paper [56]. The top three most cited articles globally: Crawford J's article in 2020 with 1030 citations, Rapanta C's article in 2020 receiving 817 citations, and Radianti J's 2020 research with 780 citations. The details of top 10 most cited papers in the research dataset are displayed in Table 3.

The research explores how higher education has adapted to the challenges posed by the pandemic, focusing on designing and organizing better learning experiences, and creating innovative learning environments. By leveraging digital technologies, these initiatives aim to enhance educational practices and resilience in the post-digital era. Additionally, the study investigates the application of virtual reality (VR) in various higher education settings, assessing its potential benefits across different learning contexts.

#### 4. Analysis of key themes in digital research in higher education

This section explores the development of key themes in digital research in higher education tracing how focal points have shifted over time. Our analysis particularly emphasizes the dynamics of keyword evolution and theme trend analysis in scholarly literature, providing a robust framework for guiding future research and promoting academic collaborations.

##### 4.1. Keyword evolution and trend analysis

The analysis of author keywords serves as an essential method to understand and discern the research focus and priorities within a specific research field [57]. These keywords facilitate quick identification of research topics and emerging trends. The word cloud diagram in Fig. 5 shows the most frequent author keywords associated with digital research in higher education. Subsequently, Fig. 6 traces the dynamics of these keywords, noting a significant emergence around 2011 with sustained growth thereafter. Notably, terms such as "higher education" surged in frequency since 2017, while "digital literacy", "blended learning", "digital competence", and "online learning" have experienced rapid growth since 2019. These trends suggest the growing importance of these areas, indicating promising directions for future research around these research topics.

##### 4.2. Analysis of trends and hotspots in higher education digitalization research

This section delves into the research themes, trends, and hotspots in the field of higher education digitalization, based on the keywords used by the authors in the literature dataset. The analysis was conducted with the following parameters: the timespan was set to 2000 to 2023, with Word Minimum Frequency and Number of Words per Year both at 4. These keywords, often abstract summaries of research topics, provide high-level insights into the core areas of academic focus.

The evolution of keyword occurrence revealed evolving hot topics of in digital research within higher education. Fig. 5 illustrates a word cloud that lists prominent keywords, offering a visual representation of thematic prominence. Conversely, Fig. 7 presents a hierarchical arrangement of topics, showing the scholarly discussions that shape the digital landscape of higher education. Notably, in 2016, significant discussions centered around digital libraries, new media, technology-enhanced learning. The focus shifted towards MOOC and open education in 2019, and by 2023, themes such as co-creation, competency, hybrid teaching, and digital writing Emerged as areas of intense research activity.

Was Additionally, a thematic trend analysis was conducted to observe the current state and project the sustainability of future

**Table 3**  
Details of top 10 cited papers.

Authors	Title	Journal	Year	Total Citations
Crawford J	COVID-19: 20 countries' higher education intra-period digital pedagogy responses	Journal of Applied Learning & Teaching	2020	1030
Rapanta C	Online University Teaching During and After the Covid-19 Crisis: Refocusing Teacher Presence and Learning Activity	Postdigital Science and Education	2020	817
Radianti J	A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda	Computers & Education	2020	780
Kennedy Ge	First year students' experiences with technology: Are they really digital natives?	Australasian Journal of Educational Technology	2008	639
Evans C	The effectiveness of m-learning in the form of podcast revision lectures in higher education	Computers & Education	2008	495
Park C	In Other (People's) Words: Plagiarism by university students—literature and lessons	Assessment & Evaluation in Higher Education	2003	495
Spencer Bf	Advances in Computer Vision-Based Civil Infrastructure Inspection and Monitoring	Engineering	2019	428
Kaplan Am	Higher education and the digital revolution: About MOOCs, SPOCs, social media, and the Cookie Monster	Business Horizons	2016	410
Iivari N	Digital transformation of everyday life – How COVID-19 pandemic transformed the basic education of the young generation and why information management research should care?	International Journal of Information Management	2020	400
Kokotsaki D	Project-based learning: A review of the literature	Improving Schools	2016	392



Fig. 5. Visual word cloud of keywords.

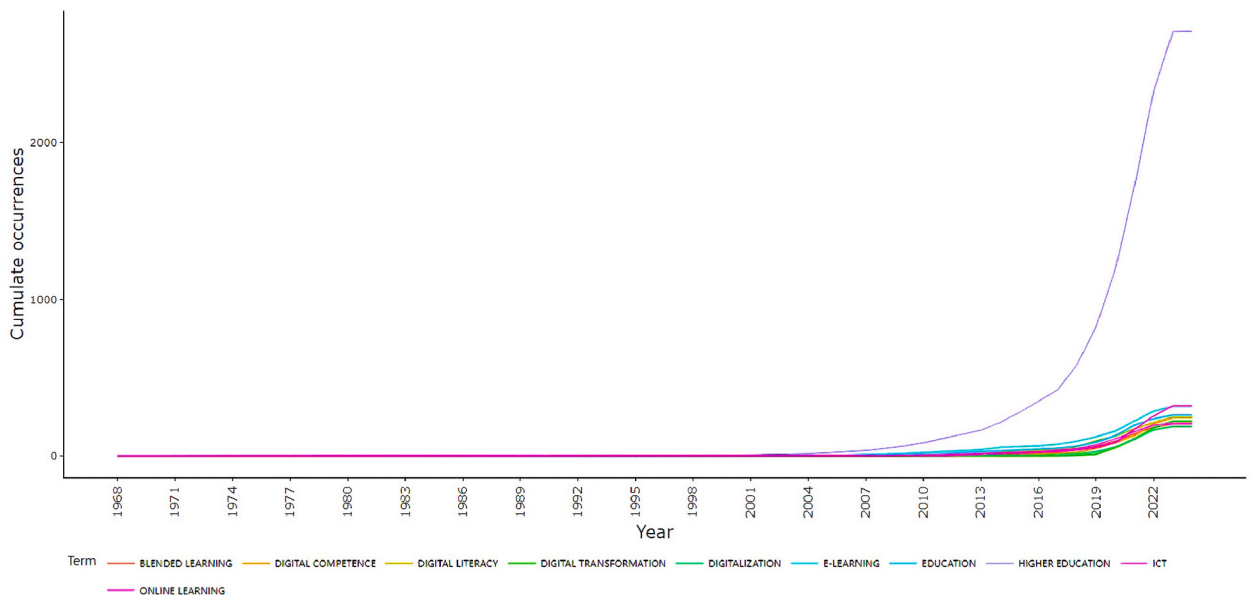


Fig. 6. Dynamic view of authors' keywords.

research within this domain. The thematic map analysis aims to provide insights into ongoing trends and inform relevant research groups and institutions about potential future research development, thereby guiding strategic planning and policy-making in the digitalization of higher education.

The thematic analysis was based on the keywords and their interconnections. A strategic coordinate map is presented in Fig. 8 to illustrate the digital research in higher education. This map uses the density index (ordinate) to indicate the strength of the connection between the basic knowledge units within the discipline. A higher density index represents a stronger connection and greater maturity within the field. Additionally, topic density correlates directly with the maturity of the research theme. The centrality index (abscissa) measures the strength of the connection between topics, with higher values indicating the importance of this topic in the field of



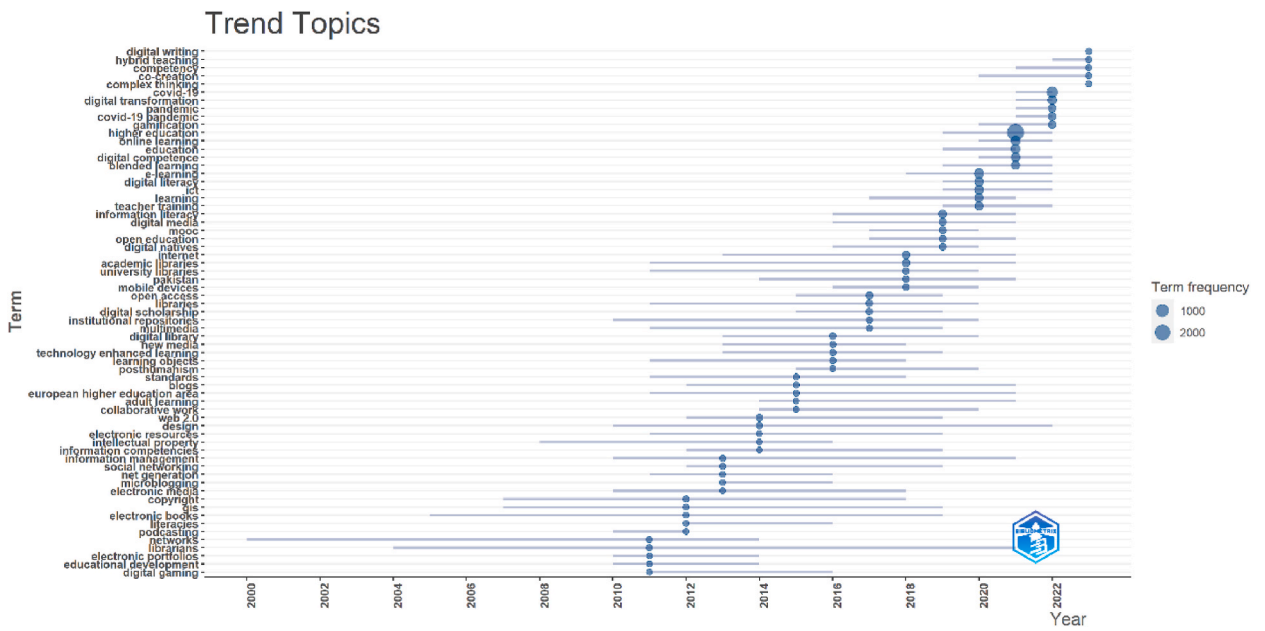


Fig. 7. Trending topics between 2000 and 2023.

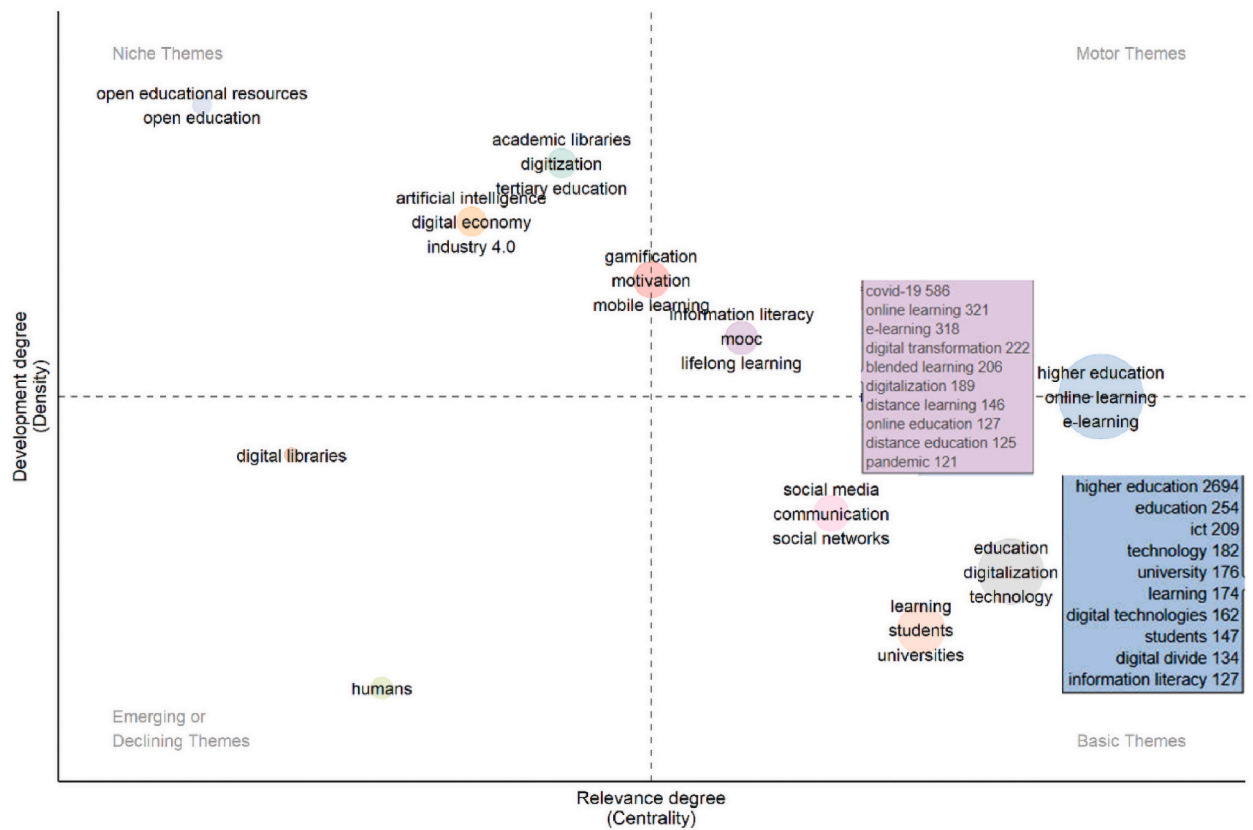


Fig. 8. Strategy coordination map of themes.

research [58].

Fig. 8 shows the strategic map divided into four quadrants, each highlighting distinct research themes.

The first quadrant includes core themes such as “MOOC”, “lifelong learning”, “online learning”, and “higher education”. These themes are at the forefront of educational research which significantly influence both academic and industry developments. The emergence of MOOCs highlights the maturation of online learning as a leading area in education [59]. This quadrant also emphasizes the significance of “lifelong learning” in addressing the rapid pace of knowledge and skills updates required by contemporary society [60]. Another important theme in the first quadrant is “online learning”. Online learning includes not only MOOCs but also online courses, virtual classes, distance education, and other forms. Online learning transcends traditional models of higher education by incorporating virtual classes, distance education and other flexible formats that cater to diverse learner needs, thereby shaping the landscape of higher education. Higher education is a complex system [49] that demands a nuanced approach to management and improvement. On one hand, there is a pressing need to enhance the quality of education and innovation, with the aim to provide students with enriching learning experiences and career development opportunities. On the other hand, the focus must also extend to sustainability and inclusiveness to ensure equal access to higher education. This dual focus helps institutions continuously adapt to a globalized, technologically advanced, and diverse societal landscape, thereby meeting the evolving needs of students and broader community.

The second quadrant, also known as the “Niche Themes”, includes research topics that while not yet achieving widespread recognition and maturity, have shown significant progress and hold potential for innovation. This includes areas such as “open education”, “digital economy”, and “artificial intelligence”. These topics are crucial as the digital transformation of higher education has led to significant shifts in the content of educational resources and methods [15]. Implementing the latest digital technologies in higher education is critical for national development. Moreover, the evolution of open online courses indicates a shift towards a new paradigm in digital open education [61]. The rapid development of the digital economy further pressures higher education systems to digitize their education, scientific research, marketing, and economic activities to stay competitive globally.

Furthermore, it is necessary to safeguard personal data and university systems from cyberattacks and fraud amidst increasing digitization [34]. The COVID-19 pandemic has highlighted the importance of digital networks for communication, learning, and work, and has highlighted the role of artificial intelligence in enhancing the effectiveness of teaching and research [62]. Given these dynamics, the themes within the Niche Themes quadrant require enhanced cross-disciplinary research and collaboration. This interdisciplinary approach will facilitate knowledge exchange across different fields, aiming to bring these themes to maturity and broader recognition.

The third quadrant is “Emerging or Declining Themes”, focusing on dynamic themes such as “digital libraries” and “humans”, which are significantly influenced by the rapid advancement of technology and societal needs. As digital technology evolves, there is a pressing need for new methods to manage and use digital contents. This quadrant addresses how institutional and national policies shape the design and sustainability of digital libraries [63], including e-books and online bookstores [64], which bring new challenges to improving the quality of student services in higher education institutions [65]. While these emerging topics are replete with uncertainties, they require more research to assess their potential for continued growth or risk of obsolescence.

In this quadrant, the obsolescence of certain technologies or concepts may lead some themes to gradually recede from academic focus. Researchers are thus required to make strategic decisions: whether to further invest in these areas or shift their energies towards more promising topics. This represents the continuous evolution and adaptability required within academia, where vigilance and preparedness are essential to seize new opportunities and tackle emerging challenges. Continuous academic research and reasoned decision-making are crucial in integrating and advancing these emergent themes, which are fundamental to pushing the boundaries of scientific research.

The fourth quadrant, “Basic Themes”, delves into fundamental yet underexplored topics characterized by low maturity, such as “digital technologies” [66], which include artificial intelligence, blockchain technology, virtual reality. The development and application of these digital technologies within teaching, research, management, and communication [67], are important in enhancing the operational efficiency and competitiveness of the higher education system [50]. In addition, this quadrant explores research topics such as “Digital Divide” [68] and “ICT” [69], illustrating the need to bridge educational gaps in diverse socio-economic contexts through information technology, thereby fostering more equitable higher education [14].

Additionally, as the advent of “e-learning” [70] and “blended learning” [71] indicate the transformative shifts occurring in education today, offering more flexibility and accessibility. Nonetheless, these innovations introduce challenges related to the security and effectiveness of educational platforms. Researchers in these areas are encouraged to investigate ways to optimize online education to enhance learning experience.

Despite the uncertainties associated with “Basic Themes” such ambiguity fuels innovation and exploration. By engaging in promising research, researchers can contribute to future development and innovation, positioning these fields as likely future scholarly activity.

Overall, the thematic strategy map serves as an important tool for researchers, policymakers, and industry leaders, offering a clear roadmap to understanding and strategically planning the development direction of different research topics in digital education. This map highlights the importance of interdisciplinary collaboration and continuous innovation in addressing changing challenges and opportunities, aiming to guide research and drive sustainable social and economic development effectively.

## 5. Discussion

The findings reveal that research in digitalization within higher education is experiencing a phase of rapid development, with a

significant amount of research literature accumulated in this field. This study uses bibliometric techniques to systematically review the landscape of digitalization in higher education, including analyses of key topics, influential authors and their contributions. It also examines publication patterns and collaborative networks among authors, institutions, countries and regions, presenting the current status and future directions of this field. Our search included WoSCC, Scopus, and PubMed databases generated 8521 papers with prominent themes including “digital writing”, “hybrid teaching”, “co-creation”, and “complex thinking”.

For example, Johnke R mentioned that the emergence of AI-driven writing tools like ChatGPT, which have the potential to shape digital writing and reflect educational values such as openness personal autonomy, and intellectual power [72]. Similarly, Fernandez-Raga M proposed the integration of gamified learning methods in higher education, emphasizing the importance of safety and teaching quality in these gamified learning process [73].

As digital technologies continue to evolve, higher education institutions are expanding their online course offerings, requiring an adaptation in teachers’ skills and the enhancement of digital competencies. These technologies allow students to participate in online courses through the Internet [74], thereby broadening the global reach of higher education. Digital tools are tailored to meet the individual learning needs and pace of each student [75], which boosts academic achievement and reduces dropout rates. Technologies such as virtual reality (VR) [76] and augmented reality (AR) [77] provide enriched learning experiences by simulating laboratory environments or providing immersive historical experiences.

Higher education institutions are leveraging these digital tools to gather and analyze student data, thus improving school management and teaching quality. Predictive analytics help in foreseeing student needs and behaviors, allowing for timely interventions. Digitalization also simplifies the sharing and dissemination of educational resources, marking the field of digital research in higher education as a multifaceted field that covers technology, education, management, and ethics. These developments are set to modernize higher education and improve its quality and accessibility.

In the evolving digital landscape of teaching and learning, higher education institutions are shifting towards online learning and blended teaching models. This transition is gradually replacing traditional face-to-face teaching model, prompting innovations in curriculum design, teaching methods, and teacher training. Institutions need to focus on developing digital competencies among teachers and students, including digital instructional design, online interaction skills, and the use of data analytics to enhance teaching and learning experiences. To support online learning, substantial investments in digital infrastructure like high-speed Internet, learning management systems (LMS), and virtual labs are essential. It is also crucial to ensure equal access to online education resources, taking into account the diversity of the student body.

In terms of teaching quality, it is necessary to ensure that the quality of online and traditional courses are consistent to maintain educational standards. In the future, higher education institutions may consider establishing a new evaluation system tailored to the distinctive characteristics of online education, such as interactivity, student engagement and learning outcome assessments.

Addressing the digital divide, particularly between urban and rural areas and across different socioeconomic groups is important for states. Policymakers should ensure all students have equitable access to online education and enhance the digital infrastructure for low-income families. The shift towards digital education call for a comprehensive revision of national education policies. Governments are demanded with creating standardized regulations to ensure the delivery of high-quality and equitable online education. Furthermore, there is a pressing need for international cooperation to promote the standardization of online education and facilitate the sharing of educational resources. With the expanding use of online learning platforms and digital technologies, issues of data privacy and security are increasingly prominent, demanding robust laws and regulations to protect the privacy of students and teachers and to secure educational data.

## 6. Conclusion

This bibliometric analysis reviewed 8521 literature related to the digitization of higher education using the R-Bibliometrix package. The paper revealed that research interest in this area began in 1968 and has continuously received increasing attention, especially in 2022. Leading institutions in this research field include the Ministry of Education and Science of Ukraine, the University of Granada, and Deakin University. Among the authors, Cabero-Almenaraj, Esteve-monf, and Khan A published the most relevant paper. Spain, the USA, the United Kingdom, and China are the nations contributing the most publications. The prevalent keywords are “online learning”, “e-learning”, “digital competence,” and “digital technologies”, with significant discussions in 2016, around “digital library”, “new media”, and “technology-enhanced learning”. By 2019, “MOOC” and “Open Education” were the focal research themes. That the study predicts that “co-creation”, “competency”, “hybrid teaching”, and “digital writing” will be prominent topics in 2023, while “open education”, “digital economy”, and “artificial intelligence” are anticipated to guide future research directions.

### 6.1. Value, significance, innovation and limitations

Applying bibliometric analysis method to the literature on higher education digitalization provides a comprehensive overview of the knowledge structure, research hotspots, and research trends in this field. This approach helps researchers understand the evolution of the field and potential future developments.

- (1) The analysis of high-frequency keywords reveals core research themes, such as “co-creation”, “competence”, “hybrid teaching”, and “digital writing”, tracing their evolution and suggesting future research directions. Additionally, the study maps international collaboration in the research field of digitization in higher education. We identified key contributors in terms of countries, institutions and authors, providing valuable information about global partnership dynamics. In addition, by summarizing and

analyzing the research themes and hotspots of digitization in higher education, this paper highlights collaboration opportunities and also serves as a reference for academic research and educational policy making, especially in the context of rapid development of digital technology.

- (2) By analyzing the literature related to the digitization of higher education on a global scale, this study provides a systematic overview of long-term evolutionary trends and current research focal points. This analysis is important for new researchers entering the field or established scholars looking to expand their research scope.
- (3) Although numerous studies have addressed digitalization in higher education, systematic bibliometric analysis on a global scale are scarce. Utilizing data from three major databases WoSCC, Scopus and PubMed, this study offers a comprehensive methodological analysis, enhancing the accuracy and depth of insight. Unlike traditional static literature review and review with single database source, this study reveals the evolutionary path of the research hotspots of higher education digitization through the dynamic change analysis of keywords. This dynamic analysis provides a more intuitive view of evolving research trends and explores academic collaboration networks, including inter-country, inter-institutional, and inter-author collaborations. This multidimensional analysis provides academics with a fresh perspective on collaboration patterns and academic influence.
- (4) Despite its strengths, this study faces certain limitations. First, the keyword-based search method occasionally overlooks relevant bibliographic data due to glossary mismatches, which can skew the comprehensiveness of the results. Secondly, the scope of data collection was confined to the three major databases- WoSCC, Scopus, and PubMed – due to the different permissions associated with institutional subscriptions. Consequently, the extent of records collected from the core collection of network science can vary across institutions because of different subscription policies. This potentially leads to the exclusion of relevant records and resulting in an incomplete dataset. To enhance the robustness and breadth of future research, incorporating additional data sources, such as Google Scholar is recommended.

## 6.2. Suggestions for future research

Future research in the digitization within higher education could expand the range of databases to include platforms such as Google Scholar, enhancing the comprehensiveness and representativeness of the data. Further investigation into specific areas, such as blended teaching, digital writing and collaborative creativity is recommended, with a focus on how digital education policies impact teaching practices and student learning experiences. In addition, exploring the effective application of digital technologies in educational practices can potentially improve the quality of education and promote educational equity. Such research are crucial for addressing the challenges and opportunities presented by the digital transformation in education, providing deeper insights and foster responsive strategies.

## CRedit authorship contribution statement

**Bin Zhao:** Writing – original draft, Data curation, Conceptualization. **Jie Zhou:** Writing – review & editing, Supervision.

## Authorship statement

The authors declare no competing financial interests or personal relationships that could influence this work.

## Data availability statement

Data associated with this study has been deposited at OSF project, <https://osf.io/27p8b/>, account: [zhbin202206@163.com](mailto:zhbin202206@163.com), password: Aa369369!

## Additional information

No additional information is available for this paper.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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