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Review Article

Mapping the Shift from Digitisation to Digital Transformation: A 20-Year Bibliometric Analysis of Higher Education Research

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Abstract: Digital transformation has become a defining force in higher education, fundamentally reshaping teaching, learning, and institutional strategies worldwide. This study conducts a bibliometric analysis of research on digital transformation in higher education published between 2005 and 2024, using 726 documents from 405 scholarly sources indexed in Scopus. The analysis employed Biblioshiny to examine publication trends, citation patterns, and thematic evolution. Results indicate an annual growth rate of 32.57%, reflecting an acceleration in scholarly engagement. Collaboration is extensive, with 23% of publications involving international co-authorship and an average of 6.87 authors per paper, underscoring the global relevance of this research domain. The thematic analysis reveals a shift from early e-learning initiatives towards advanced concepts such as artificial intelligence (AI), virtual reality (VR), and sustainability, signalling a transition from incremental digitisation to systemic institutional change. These findings highlight the interdisciplinary maturity of the field and provide a foundation for future research aimed at addressing regional disparities and leveraging emerging technologies for inclusive and resilient higher education systems.

Keywords: Bibliometric analysis, digitisation, digital transformation, educational technology, higher education, thematic evolution.

1. Introduction

Since the late twentieth century, technology has steadily reshaped higher education, with rapid advancements occurring in recent decades (George & Wooden, 2023). This evolution follows a continuum: digitisation, which converts analogue resources into digital formats (Qolamani & Mohammed, 2023); digitalisation, which leverages these digital resources to streamline processes and improve efficiency (Kuzu, 2020); and digital transformation, which represents a systemic reconfiguration of institutional strategies, culture, and value creation (Alenezi & Akour, 2023). While converting and optimising existing systems through digitisation and digitalisation offers incremental benefits, digital transformation fundamentally reshapes institutional structures, enabling new strategies, personalised education, and immersive technologies (Vial, 2019).

The COVID-19 pandemic served as a catalyst, accelerating the adoption of online learning and compelling universities to reconfigure their teaching and learning models on a large scale. This shift marked a transition from teacher-centred approaches to student-centred, constructivist learning environments supported by interactive and flexible digital tools (Reddy et al., 2020). However, this transformation has been uneven. Developed countries, equipped with robust infrastructure and higher levels of digital literacy, lead in the implementation of advanced technologies, while emerging economies struggle with systemic barriers such as limited connectivity, inadequate resources, and insufficient training (Moloi & Salawu, 2022). These disparities highlight the need for inclusive strategies that bridge the digital divide and promote equitable access to technology-enhanced learning.

The urgency for inclusive strategies is underscored by evidence that digital transformation initiatives often exacerbate existing inequalities rather than resolve them. Institutions in low-resource contexts face persistent challenges such as inadequate infrastructure, limited bandwidth, and insufficient faculty training, which hinder the effective adoption of advanced technologies (Moloi & Salawu, 2022; Karunanayaka et al., 2021). Global reports further reveal that while high-income countries rapidly integrate artificial intelligence and immersive technologies into teaching and learning, many developing regions remain constrained by systemic barriers, thereby creating a widening digital divide (Timotheou et al., 2022; Zou et al., 2025). These disparities affect not only access but also the quality of learning experiences, raising critical questions about equity, sustainability, and institutional resilience in the face of technological disruption. Addressing these concerns requires more than isolated case studies; it demands a systematic understanding of how research on digital transformation has evolved globally. Despite growing scholarly attention, conceptual ambiguity persists.

This study responds to that need by conducting a bibliometric analysis of research on digital transformation in higher education published between 2005 and 2024. Drawing on 726 documents indexed in Scopus, the analysis examines publication trends, citation patterns, and thematic evolution. Findings reveal an accelerating growth trajectory and a shift from early e-learning initiatives toward more advanced concepts, including artificial intelligence, sustainability, and immersive technologies. These insights provide a foundation for future research and policy aimed at fostering inclusive, resilient, and innovative higher education systems.

1.1 Problem statement

The integration of digital technologies in higher education has evolved from digitisation and digitalisation towards systemic digital transformation, promising significant pedagogical and operational benefits. However, scholarly discourse remains fragmented and conceptually ambiguous. Terms such as *digitisation*, *digitalisation*, and *digital transformation* are often used interchangeably, creating theoretical inconsistencies and limiting the development of coherent institutional strategies and policy frameworks (Reddy et al., 2020; Vial, 2019). This lack of clarity has practical consequences: institutions struggle to differentiate incremental technological adoption from holistic transformation, resulting in misaligned investments and uneven implementation.

Moreover, existing research tends to focus on isolated case studies or technology adoption rather than mapping the broader intellectual structure of the field. Few studies systematically analyse how scholarship has evolved over time, which sources exert the greatest influence, and what emerging themes signal future directions. This gap restricts stakeholders' ability to understand global research trajectories, identify influential contributions, and anticipate trends that inform policy and practice. Addressing this issue through a bibliometric analysis is crucial for clarifying conceptual boundaries, informing institutional strategies, and fostering inclusive, innovative, and resilient higher education systems. Hence, the following research questions were addressed.

- What are the publication trends, growth patterns, and collaboration networks in digital transformation research within higher education?
- Which sources and documents exert the greatest influence on shaping the field, as reflected in citation dynamics?
- How has the thematic focus evolved over time, and what emerging research directions indicate a transition from digitisation and digitalisation to systemic digital transformation?

2. Materials and Methods

This study employed a bibliometric analysis to systematically map research trends in digital transformation within higher education. Bibliometric methods are extensively utilised to quantify scholarly output, identify citation dynamics, and explore thematic evolution, thus providing a

comprehensive understanding of the progression of research in this domain over time (Donthu et al., 2021).

2.1 Data source, rationale and strategy

The Scopus database was selected as the primary source due to its extensive multidisciplinary coverage, rigorous indexing standards, and compatibility with bibliometric tools such as Biblioshiny. Scopus is widely recognised for providing high-quality metadata essential for accurate citation and co-authorship analysis (Falagas et al., 2008). A Boolean search string was employed to ensure the precise retrieval of relevant documents. Boolean operators (AND, OR) allow researchers to systematically combine keywords, thereby enhancing search accuracy and comprehensiveness (Gusenbauer & Haddaway, 2020). The exact search string applied was TITLE-ABS-KEY (technology AND "higher education" AND (digitisation OR digitalisation OR "digital transformation")). This query was used in the Title, Abstract, and Keywords fields to capture studies addressing digital transformation in higher education.

2.3 Screening and Inclusion Criteria

The article selection process followed the PRISMA guidelines for systematic reviews. Figure 1 below illustrates the PRISMA flow diagram, showing the number of records identified, screened, and included in the final analysis. The initial search yielded 2,238 records. To enhance relevance and quality, the following filters and criteria were applied:

- Publication Stage: Final publications only (2,207 documents).
- Language: English-language articles (2,048 documents).
- Source Type: Peer-reviewed journal articles (944 documents).
- Publication Date Range: 2004–2024 (730 documents).
- Exclusion Criteria: Conference papers, editorials, and incomplete records were removed.

After duplicate removal and metadata cleaning, the final dataset comprised 726 documents.
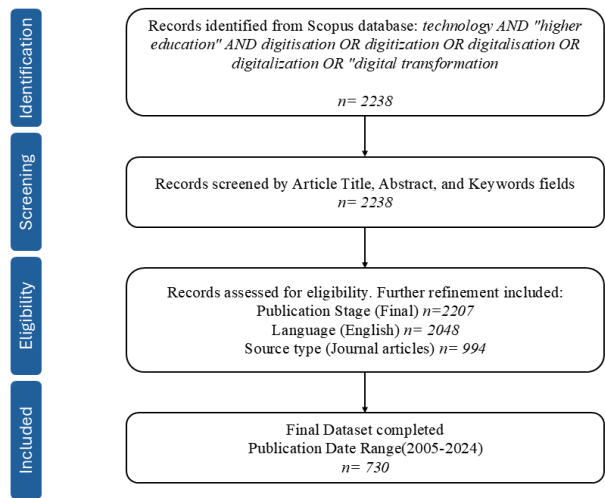

Figure 1: PRISMA flow for the selection process of the articles for bibliometric analysis

The diagram above illustrates the systematic filtering process, beginning with 2,238 initial records retrieved from Scopus. Successive screening steps eliminated non-final publications, non-English documents, and non-journal sources, narrowing the pool to 944 peer-reviewed journal articles. Further refinement, based on the publication date range (2004–2024) and the exclusion of incomplete records, resulted in 730 documents. After cleaning and removing duplicates, 726 articles were

retained for analysis. This structured approach ensures transparency and rigor, aligning with PRISMA standards and enhancing the reliability of the bibliometric findings.

2.4 Data processing and tools

After applying the screening criteria, the final dataset of 726 documents was exported in BibTeX format from Scopus to ensure compatibility with bibliometric software. The analysis was conducted using Biblioshiny (version 4.0), an R-based graphical interface built on the bibliometrix package. This tool was chosen because it offers robust functionalities for performance analysis, science mapping, and thematic evolution, enabling both descriptive and network-based insights.

Step 1: Data import and cleaning

The BibTeX file was imported into Biblioshiny, where metadata such as authors, affiliations, keywords, citations, and source titles were standardised. During preprocessing, duplicate entries and incomplete records were removed to ensure accuracy in subsequent analyses.

Step 2: Performance analysis

This stage quantified research productivity and influence over time. Key indicators included:
- Annual Scientific Production: Tracking publication growth trends across the 2005–2024 timespan.
- Citation Patterns: Measuring average citations per year and identifying highly cited documents.
- Source Impact: Ranking journals by article count and citation influence.

These metrics provided a foundational understanding of the field's maturity and scholarly engagement.

Step 3: Science mapping

Science mapping explored structural relationships within the research domain:

- Co-authorship Networks: Visualising collaboration patterns among authors and countries.
- Country Collaboration Maps: Highlighting transnational research partnerships.
- Keyword Co-occurrence: Detecting clusters of frequently associated terms, which indicate thematic concentrations.

This step revealed the global and interdisciplinary nature of digital transformation research.

Step 4: Thematic evolution (detailed process)

Thematic evolution analysis played a central role in understanding how research priorities have evolved over time. Biblioshiny divides the dataset into time slices (e.g., 2005–2013, 2014–2019, 2020–2024) and applies co-word analysis to identify the dominant themes in each period. The process involves:

- Keyword Extraction: Both author keywords and Keywords Plus were analysed to capture conceptual breadth.
- Clustering: Keywords were grouped using algorithms such as Louvain modularity to form thematic clusters.
- Linkage Across Time Slices: The Inclusion Index and Weighted Inclusion Index measured continuity between themes across periods. For example, early clusters like *e-learning* evolved into later clusters emphasising *digital transformation*, *AI*, and *sustainability*.
- Stability Index: Assessed how persistent or transient themes were over time.
- Visualisation: While Sankey diagrams and thematic maps are commonly used to illustrate transitions, this study opted for a tabular representation (Table 2) to provide a clear, text-based summary of thematic shifts. The table illustrates how foundational topics (e.g., e-

learning, higher education) have given rise to advanced concepts (e.g., *artificial intelligence*, *knowledge management*, *virtual reality*).

This approach moves beyond static keyword analysis by revealing conceptual trajectories, enabling the researcher to trace the intellectual evolution from digitisation to systemic digital transformation.

3. Results and Discussions

This section presents the findings derived from the bibliometric analysis and interprets their significance in relation to the study's objectives and research questions. Positioned as the core analytical component of the paper, it responds directly to the objectives outlined earlier by examining publication trends, citation dynamics, collaboration networks, and thematic evolution within the domain of digital transformation in higher education. The discussion not only highlights key patterns and emerging themes but also situates these insights within the broader context of institutional strategies and global educational developments. By integrating descriptive statistics with interpretive commentary, this section provides a comprehensive understanding of how research in this field has evolved over time and what these trends imply for future scholarship and policy directions.

3.1 Dataset overview and key insights

Table 1 below provides an overview of the dataset, which spans two decades (2005–2024) and comprises 726 records drawn from 405 distinct sources, including books, journals, and other scholarly publications. The annual growth rate of 32.57% indicates a rapidly expanding body of research in this domain. With an average document age of 3.03 years, the dataset is relatively recent, suggesting that most contributions reflect current technological developments. Each publication averages 19.93 citations, pointing to substantial scholarly engagement and influence. The dataset contains 6,287 references, underscoring its strong academic foundation. In terms of content, it includes 1,281 Keywords Plus and 2,132 author-supplied keywords, highlighting a diverse thematic landscape. Collaboration is a defining feature of this research area, as evidenced by the fact that 2,551 authors contributed to the dataset, with no single-authored papers identified. On average, each document lists 6.87 co-authors, and 23% of publications involve international partnerships, emphasising the global relevance of technology integration in higher education. Most documents are journal articles (667), followed by reviews (46), with smaller proportions of editorials (4), conference papers (2), and data papers (1). The presence of errata (3), retractions (2), and notes (1) reflects the self-correcting nature of scholarly publishing.

Table 1: Overview of the dataset

Description	Results
Main Information About Data	
Timespan	2005:2024
Sources (Journals, Books, etc.)	405
Documents	726
Annual Growth Rate %	32.57
Document Average Age	3.03
Average citations per doc	19.93
References	6287
Document Contents	
Keywords Plus (ID)	1281
Author's Keywords (DE)	2132
authors	
Authors	2551
Authors of single-authored docs	0

AUTHORS COLLABORATION	
Single-authored docs	0
Co-Authors per Doc	6.87
International co-authorships %	23
Document Types	
Article	667
conference paper	2
data paper	1
Editorial	4
Erratum	3
Note	1
Retracted	2
Review	46

This dataset portrays a dynamic and internationally collaborative research field. High growth rates, strong citation metrics, and diverse authorship patterns suggest that technology integration in higher education is not only maturing but also becoming central to educational innovation and policy. The predominance of multi-authored and cross-border studies further illustrates the complexity and global scope of the challenges and opportunities in digital education.

3.2 Annual scientific production

Figure 2 below shows that over the past two decades, the annual scientific output on technology integration in higher education has exhibited a clear exponential growth trajectory. From 2005 to 2015, publication activity remained minimal and constant, with only 0 to 3 articles per year, reflecting the nascent stage of scholarly interest in the field. A noticeable uptick began between 2016 and 2018, marked by a rise from 7 to 17 articles, indicating early enthusiasm for digitalisation and the initial adoption of educational technologies. Between 2019 and 2021, the volume of publications grew sharply, rising from 34 to 83 articles, a surge largely attributed to the global transition to online learning during the COVID-19 pandemic. This phase catalysed a shift from theoretical exploration to practical implementation. The most significant growth occurred between 2022 and 2024, as the number of publications rose from 114 to 212, reflecting the widespread adoption of digital transformation research and the increasing prominence of advanced technologies within the education sector. This trend shows sustained and accelerating scholarly engagement, driven by global events and technological innovations, and signals continued momentum in digital education research and policy development.
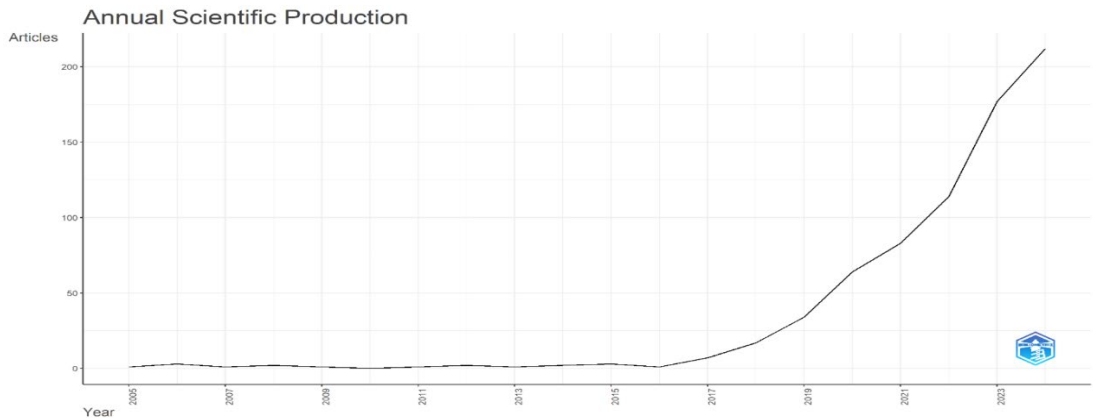

Figure 2: *Annual scientific production for the digital transformation in higher education research (2005-2024)*

3.3. Average Citations Per Year

The citation pattern over the past two decades, as shown in Figure 3 below, demonstrates distinct phases in the influence of research on the integration of technology in higher education. During the initial period (2005–2014), the impact was minimal, with a mean total of 0.06 to 1.17 citations per year, indicating limited scholarly attention despite the extended time for citation accumulation. A growth phase emerged between 2015 and 2017, during which citation averages rose to 3.09 in 2015 and 3.40 in 2016, reflecting an increasing interest in digital transformation and early policy initiatives surrounding technology-enhanced learning. The highest citation velocity occurred during 2018–2020, coinciding with the global disruption caused by the COVID-19 pandemic. Citation rates peaked at 8.43 in 2018 and 8.48 in 2020, with 2018 recording the highest mean citations per article (67.47). This indicates that studies published during this period became seminal references that shaped subsequent research. In the most recent years (2021–2024), although the volume of publications expanded significantly, citation averages declined from 6.60 in 2021 to 2.47 in 2024. This reduction does not imply diminished relevance but rather reflects the typical lag in citation accumulation for newer works, which are likely to gain prominence over time. Overall, the trend underscores how scholarly attention surged during the pandemic-driven digital shift, with foundational works from 2018–2020 continuing to dominate citations, while recent contributions are expected to grow in influence as the field evolves.
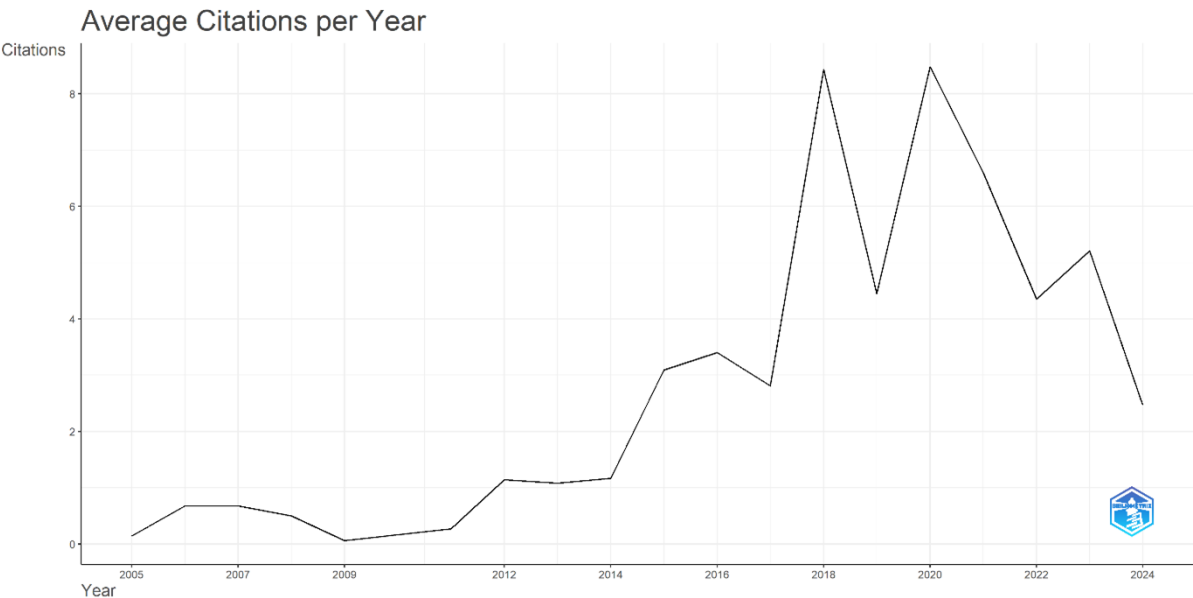

Figure 3: Average citations per year for the digital transformation in higher education research (2005-2024)

3.4 Most cited documents

The citation analysis in Figure 4 below reveals that Iivari (2020) is the most influential paper, with 655 citations and an impressive 109.17 citations per year, underscoring its role as a foundational study on digital transformation during the pandemic. Other highly cited works, such as Bond (2018) and Castaneda (2018), maintain strong relevance, indicating their importance in shaping early frameworks for educational technology. Notably, recent publications like George & Wooden (2023) and Alenezi (2023) exhibit exceptional citation velocity and high normalised citation scores (14.59 and 12.41, respectively), suggesting rapid uptake and growing interest in emerging themes such as AI-driven transformation and institutional strategies. The data highlights a clear shift from conceptual discussions in earlier years to applied research during and after the COVID-19 pandemic,

with themes of sustainability and resilience gaining prominence. This trend reflects the accelerating scholarly focus on practical solutions for digital integration in higher education.
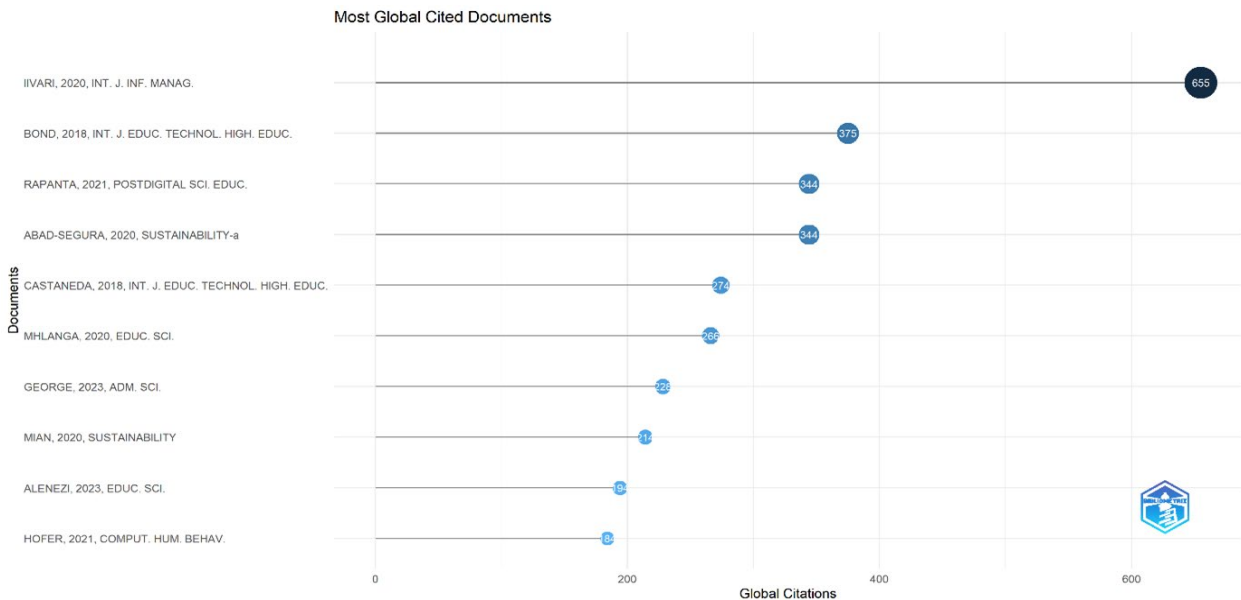

Figure 4: Most cited documents for the digital transformation in higher education research (2005-2024)

3.5. Most relevant sources

Figure 5 below shows the most relevant sources of the dataset. The analysis of source distribution reveals that research in the field is concentrated in a few key journals. Sustainability (Switzerland) leads with 54 articles, indicating a strong focus on linking digital transformation to sustainability and institutional resilience. Education Sciences ranks second with 25 articles, reflecting its emphasis on pedagogical innovation and the integration of technology. Frontiers in Education (19 articles) and Education and Information Technologies (15 articles) highlight the growing interest in advanced educational technologies and digital learning environments. Other notable sources include the European Journal of Contemporary Education (10 articles) and journals focused on curriculum, teaching practice, and emerging technologies, each contributing between 7 and 8 articles. This data indicates that the dominance of Sustainability suggests digital transformation is increasingly framed within sustainability and development goals. Specialised education technology journals (e.g., Education and Information Technologies, International Journal of Emerging Technologies in Learning) indicate a strong technical and applied research orientation. The diversity of sources, from sustainability to curriculum-focused journals, reflects the interdisciplinary nature of digital transformation research.
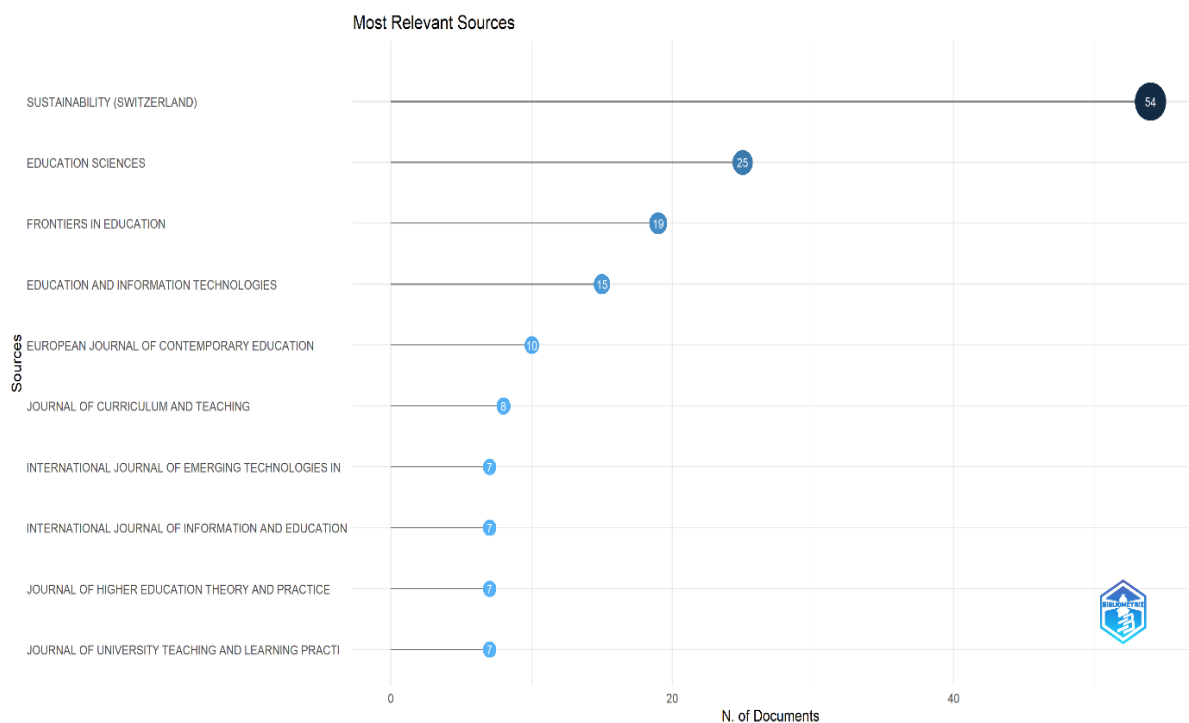
Figure 5: *Most relevant sources for the digital transformation in higher education research (2005-2024)*

3.6 Thematic evolution

The thematic evolution analysis in Table 2 below demonstrates a clear progression in research priorities over the two decades examined. Early themes (2005–2023) were dominated by concepts such as e-learning, students, and higher education institutions, reflecting an initial emphasis on online learning systems and digital pedagogy. This period was characterised by incremental digitisation efforts aimed at converting traditional resources into digital formats and supporting basic virtual learning environments. In contrast, recent themes (2024) reveal a marked shift towards digitisation, digital transformation, and technology adoption, signalling a transition from isolated technological interventions to systemic institutional change. Emerging keywords, such as artificial intelligence, curricula, knowledge management, and virtual reality, indicate a growing interest in advanced technologies that enable personalised, immersive, and data-driven learning experiences. This evolution aligns with global trends emphasising the integration of AI and immersive technologies into education for enhanced flexibility and engagement.

The linkage between higher education and digitisation now incorporates sustainability-oriented terms such as innovation and Sustainable Development Goals (SDGs), suggesting that digital transformation is increasingly framed within broader development agendas. Similarly, the connection between teaching and higher education encompasses keywords such as COVID-19, training, and student engagement, underscoring the pandemic's catalytic role in accelerating digital adoption and reshaping pedagogical practices.

This thematic shift reflects the maturation of the research field, moving from foundational studies on e-learning towards comprehensive frameworks that integrate technology, pedagogy, and institutional strategy. It also highlights the interdisciplinary nature of digital transformation research, bridging educational technology with sustainability, policy, and organisational change.

Table 2: Thematic evolution for the digital transformation in higher education research (2005-2024)

| From	To	Words	Weighted Inclusion Index	Inclusion Index	Occurrences	Stability Index
E-learning--2005-2023	Digitisation--2024-2024	digital technologies; engineering education; artificial intelligence; curricula; personnel training;' current; decision making; knowledge management	0,22	0,03	12	0,01
E-learning--2005-2023	Higher education--2024-2024	e-learning; students; high educations; digital transformation; learning systems; higher education institutions; education computing; computer aided instruction; information management; university students; case-studies; colleges and universities; digital devices; e-learning; teachers'	0,75	0,04	40	0,01
E-learning--2005-2023	Teaching--2024-2024	Leadership	0,01	0,03	2	0,01
Higher Education--2005-2023	Digitisation--2024-2024	higher education; digitization; university sector; sustainability; sustainable development; innovation; educational development; sustainable development goal; China; stakeholder; technological change; literacy; technology adoption	0,51	0,03	57	0,01
Higher Education--2005-2023	Higher education--2024-2024	virtual reality	0,03	0,04	3	0,01
Higher Education--2005-2023	teaching--2024-2024	teaching; learning; COVID-19; education; student; training	0,29	0,03	41	0,01
Human--2005-2023	Digitisation--2024-2024	digitalization; internet	0,07	0,03	9	0,01
human--2005-2023	teaching--2024-2024	human; article; curriculum; humans; adult; female; male; controlled study; digital technology; university; questionnaire; tertiary education; coronavirus disease 2019; social media; surveys and questionnaires; universities; psychology; teacher	0,48	0,03	18	0,01

3.7 Co-occurrence network

The co-occurrence network map illustrates the relationships among key concepts in research on technology integration within higher education (see Figure 5). The visualisation is organised into three distinct clusters, each representing a thematic area. The first cluster, shown in red, centres on teaching and higher education. This group includes related terms such as learning, COVID-19, educational development, and technology adoption. Its prominence suggests that much of the scholarly discourse focuses on pedagogical practices and institutional strategies for integrating

technology. The presence of COVID-19 underscores the pandemic's significant role as a catalyst for digital adoption, driving systemic changes in teaching and learning.

The second cluster, depicted in blue, revolves around e-learning, students, and digital transformation. Associated keywords include virtual reality, learning systems, and computer-aided instruction. This cluster focuses on research into technology-enabled learning environments and advanced tools that enhance flexibility and personalisation. It indicates a shift from basic online learning towards comprehensive digital ecosystems that support immersive and adaptive education. The third cluster, in green, is anchored by terms such as "human," "article," and "humans," along with demographic and methodological keywords like "curriculum," "controlled study," and "tertiary education." This cluster represents the human-centred dimension of research, emphasising empirical studies, participant characteristics, and the design of educational interventions. Its weaker connectivity to the other clusters suggests that while human factors remain essential, they are often treated separately from technological and pedagogical themes.

With the co-occurrence network explained above, the map demonstrates strong interconnections between the red and blue clusters, underscoring the integration of teaching practices with digital technologies. The green cluster's peripheral position suggests that methodological considerations support, but do not dominate, the discourse. Emerging keywords, such as virtual reality and digital transformation, indicate a growing interest in advanced technologies, while sustainability-related terms suggest alignment with global development goals. This thematic structure reflects a research landscape that is evolving from isolated e-learning studies towards holistic frameworks combining pedagogy, technology, and institutional change.
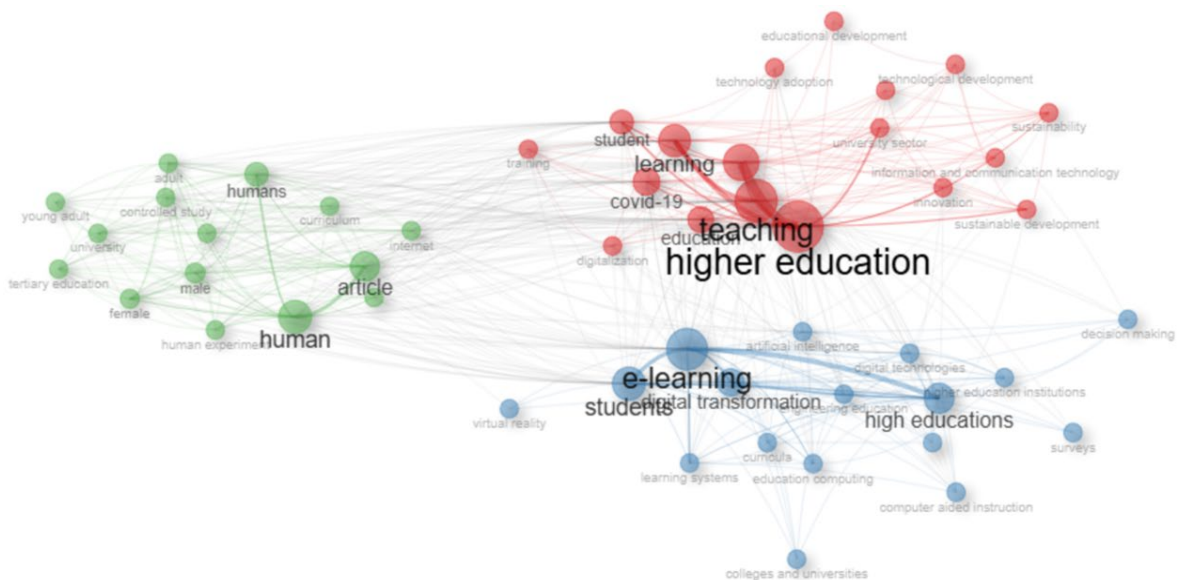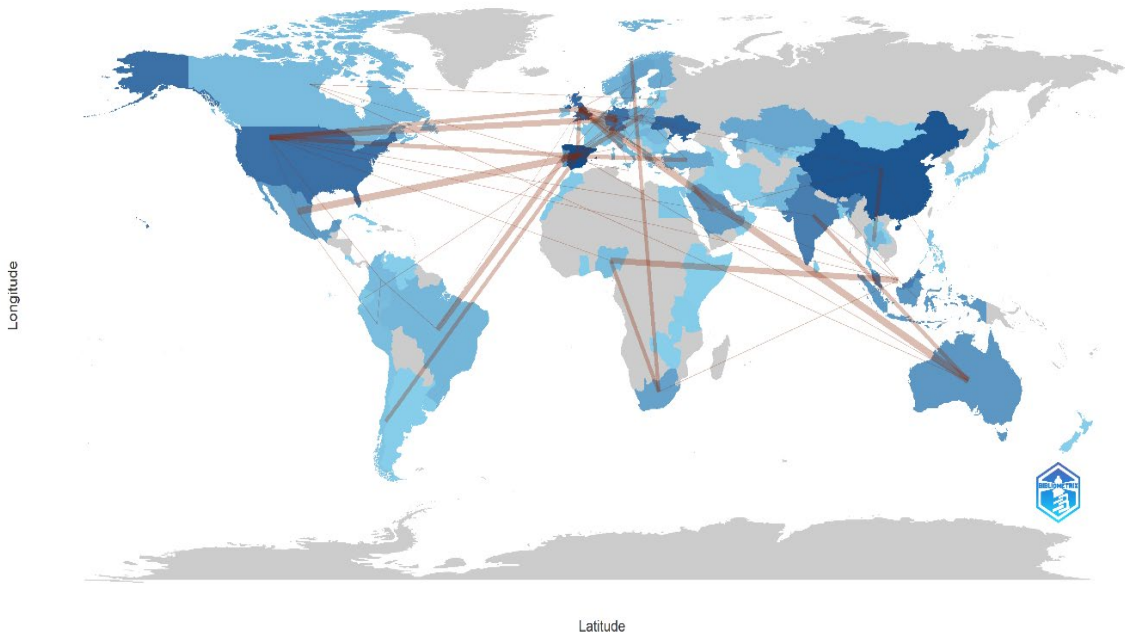

Figure 6: Co-occurrence network for the digital transformation in higher education research (2005-2024)

3.8 Countries' collaboration world map

The strongest collaborations, as shown in Figure 6 below, are between Asia, North America, and Europe. The United Kingdom and the United States emerge as central hubs, forming multiple connections with countries such as China, Australia, and Germany. These links suggest that research in this field is concentrated in technologically advanced regions, where institutions have the resources and infrastructure to engage in international projects. China's prominent position reflects its growing investment in educational technology and global partnerships, while Australia's active

involvement underscores its role in promoting digital learning across the Asia-Pacific region. European countries, particularly Germany, France, and Spain, demonstrate significant collaboration both within Europe and with partners in North America and Asia. This pattern indicates a strong transcontinental exchange of knowledge and practices, likely driven by shared interests in sustainability, innovation, and policy development for higher education. In contrast, African and Latin American countries exhibit lighter shades and fewer connecting lines, signalling limited participation in global research networks. This disparity highlights ongoing challenges related to infrastructure, funding, and access to collaborative opportunities in emerging economies.

Figure 7: countries' collaboration world map for the digital transformation in higher education research (2005-2024)

4. Forward-looking Insights

This section synthesises the findings from the bibliometric analysis and projects their implications for the future of higher education in the context of digital transformation. Building on the trends identified in the previous section, such as the thematic shifts towards artificial intelligence, immersive technologies, and sustainability, this part explores how emerging innovations and policy frameworks are likely to shape institutional strategies, teaching practices, and student experiences in the years to come. By connecting these forward-looking perspectives to the study's objectives, the discussion aims to provide actionable insights for researchers, policymakers, and educational leaders seeking to foster inclusive, resilient, and technologically advanced learning ecosystems.

4.1 Evolving digital trends

The trajectory of higher education is increasingly intertwined with the advancement of digital technologies. Several innovations are expected to reshape institutional learning and governance. Artificial intelligence (AI) is anticipated to play a paramount role in customising learning experiences, streamlining administrative tasks, and supporting intelligent tutoring systems that respond to individual learner needs (Reddy et al., 2020). These developments not only enhance

pedagogical practices but also equip students with essential digital competencies for the contemporary workforce (Zou et al., 2025).

Beyond AI, adaptive learning platforms leveraging machine learning will provide real-time feedback and personalised guidance, allowing students to progress at their own pace. Immersive technologies are creating interactive environments that promote engagement and experiential learning (Zou et al., 2025). Furthermore, blockchain technology offers significant potential for secure credentialing and assessment, enabling the seamless sharing of verifiable digital certificates with employers and institutions. Collectively, these innovations signal a transition toward flexible, data-driven, and globally connected educational ecosystems.

4.2 Policy implications and recommendations

To fully leverage emerging technological opportunities, policymakers and institutional leaders must adopt comprehensive, forward-thinking strategies that address structural barriers and promote equitable access to digital learning (Chakroun & Keevy, 2018). These strategies should not only focus on technology adoption but also on creating an enabling ecosystem that supports sustainable digital transformation.

First, higher education institutions, assisted by national governments, should develop national and institutional frameworks that prioritise robust digital infrastructure, including high-speed internet connectivity and reliable hardware. Without these foundational elements, advanced technologies such as artificial intelligence (AI), virtual reality (VR), and adaptive learning platforms cannot be effectively deployed. Second, capacity building is critical. Institutions should implement continuous professional development programmes for lecturers to enhance digital literacy and pedagogical competence in technology-enabled environments. Similarly, students must be equipped with digital skills that prepare them for the demands of a knowledge-based economy. Third, financial investment is essential. Targeted funding should support the acquisition of educational technologies, the development of open educational resources (OER), and the integration of inclusive design principles to ensure accessibility for learners with diverse needs. Partnerships with private sector stakeholders can further accelerate innovation and resource mobilisation. Fourth, data governance and cybersecurity must be prioritised. As institutions increasingly rely on digital platforms, robust data protection protocols and ethical guidelines are necessary to safeguard sensitive information and maintain trust among stakeholders. And finally, these measures should align with global development agendas, such as the Sustainable Development Goals (SDGs), to ensure that digital transformation contributes to equity, sustainability, and resilience in higher education systems. Implementing these recommendations can enable institutions to create inclusive, future-ready learning ecosystems that empower learners to thrive in an increasingly digitalised society.

5. Conclusion

Digital transformation in higher education is a systemic shift that redefines institutional strategies, pedagogical practices, and student engagement. This bibliometric analysis of 726 publications over a two-decade period reveals rapid growth, strong international collaboration, and a thematic progression from e-learning towards advanced technologies, including artificial intelligence, virtual reality, and sustainability frameworks. By mapping these trends, the study clarifies conceptual ambiguities and provides actionable insights for policy and practice. Specifically, it recommends investment in robust digital infrastructure, capacity-building programmes for educators and learners, inclusive policies aligned with global development agendas, and strong data governance measures. These findings contribute to theory by reinforcing the continuum from digitisation to digital transformation and to practice by guiding institutions towards inclusive, resilient, and future-ready learning ecosystems. Future research should address regional disparities, explore emerging technologies, and integrate multiple databases to enrich global perspectives.

6. Declarations

Conflicts of Interest: The author declares no conflicts of interest.

Data Availability: This review is based entirely on publicly available data and information sourced from peer-reviewed articles, reports, and other academic publications cited in the manuscript. No new primary data were generated or analysed during this study. Readers may refer to the cited sources for detailed information.

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