



TRENDS IN DIGITAL INNOVATION FOR QUALITY ASSURANCE IN HIGHER EDUCATION: A SCOPUS-BASED BIBLIOMETRIC ANALYSIS (2015-2025)

Desty Hapsari Kirana^{1*}, Kurnia Khafidhatur Rafiah²

^{1,2}Department of Business and Management, Padjadjaran University, Indonesia

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ABSTRACT

This study aims to map the development of research on digital innovation in higher education quality assurance from 2015 to 2025 through a bibliometric analysis of 556 Scopus-indexed articles, with data extracted using Scopus on relevant publications related to digital innovation and quality assurance in higher education. The search strategy was conducted in November 2025, utilizing VOSviewer for keyword co-occurrence and citation analysis, including co-citation and cluster analysis. The results reveal a significant increase in research outputs, especially post-COVID-19, highlighting a shift from basic digitalization to the integration of artificial intelligence and digital assessment tools in quality assurance systems. Five main thematic clusters were identified: higher education, digital transformation, digitalization, e-learning, and COVID-19. Citation analysis shows the most influential literature focuses on institutional digital transformation, technological readiness, online learning quality, and data-driven quality assurance frameworks. These findings provide a comprehensive overview of the evolution of digital-based quality assurance systems in higher education, offering practical contributions by emphasizing the importance of data-driven policies and digital QA indicators for quality assurance leaders to enhance institutional processes.

1. INTRODUCTION

In the last decade, digital transformation has become a major driver of change across various sectors, including higher education. Universities now prioritize digital transformation as a strategic focus, aligning with the central role of universities in supporting societal development and empowerment (Alenezi & Akour, 2023). This development not only affects institutional management but also significantly changes the way educational programs are designed and delivered. Hashim et al. (2022) emphasized that higher education institutions need to adopt emergent strategies in curriculum development to remain agile and responsive to the continuously evolving technological dynamics. This adaptive approach is crucial for maintaining curriculum relevance, enhancing student engagement, and ensuring that students from diverse backgrounds can thrive in an increasingly digitized educational ecosystem.

Digital innovation has also emerged as a crucial factor in enhancing quality assurance (QA) systems in higher education. The integration of digital technologies into the QA process facilitates better management and implementation of quality standards while fostering a culture of continuous improvement within educational institutions. One of the fundamental aspects of digital innovation in QA is the enhancement of data collection and analysis capabilities. Noda et al. (2018) emphasize the importance of internal quality assurance systems, which must be supported by systematic data collection and evaluative frameworks to improve transparency and accountability within institutions. Digital tools facilitate real-time data collection on student performance, course evaluations, and institutional processes, enabling universities to quickly address emerging quality issues. Furthermore, this data-driven approach helps align

*Corresponding author.

E-mail: author1@email.com (First Author)

academic programs with external standards, thereby enhancing accountability, which is a critical factor in maintaining quality in higher education (Hou et al., 2014).

Furthermore, the introduction of cloud-based platforms and educational technologies has changed communication and collaboration within the QA system. Gutiérrez et al. (2024) highlight that the integration of digital platforms enables more inclusive participation from all stakeholders, including faculty, students, and external reviewers, in the QA process. This collaborative approach enriches the evaluation process by incorporating diverse perspectives and encouraging shared responsibility for quality among all stakeholders. The use of such platforms ensures comprehensive engagement in quality discussions, leading to a more robust QA framework.

Digital innovation also facilitates the enhancement of training and development for academic staff, which is essential for maintaining quality assurance standards. Neema-Abooki (2017) discusses the critical role of academic staff competence development as a foundation for effective QA, noting that digital resources can support continuous professional development. Online training modules and virtual workshops can be utilized to ensure faculty members stay updated with the latest QA practices and standards, directly impacting the quality of education offered. The development of staff training contributes significantly to the overall quality of institutions and is vital for adapting to the evolving demands of education.

In the context of open and distance learning (ODL), digital innovation has proven crucial for implementing effective Quality Assurance (QA) systems. Zuhairi et al. (2020) provide insights into QA systems in Asian open universities, showing how technological advancements have facilitated the development and implementation of QA frameworks tailored to the unique challenges of ODL environments. Digital solutions help standardize quality metrics across distance learning programs, ensuring consistency and assisting institutions in maintaining educational standards in remote settings. Additionally, digital transformation plays a key role in aligning educational outcomes with national and international quality assurance standards. Darajat et al. (2015) emphasize the importance of compliance with frameworks that require the integration of digital resources for effective compliance and continuous quality improvement. Maintaining alignment with these standards, supported by digital innovation, helps institutions remain competitive both locally and globally.

Finally, integrating advanced evaluation frameworks into the QA system, as highlighted by Alam, allows institutions to leverage technology to cultivate a quality culture that not only meets but exceeds basic compliance standards (Alam, 2019). By integrating digital solutions into QA practices, higher education institutions can develop a proactive, rather than reactive, approach to quality assurance. This shift is fundamental in navigating the complexities of the modern educational landscape, marked by increasing expectations for accountability and quality control.

Although digital transformation in higher education is a growing area of study, few studies specifically examine the link between digital innovation and quality assurance (QA) frameworks. The gap lies in the lack of comprehensive research connecting digital innovation with QA, beyond just digital learning or technology. This study addresses this gap by focusing on the evolution of QA systems through digital innovation, particularly post-pandemic, and highlights the increasing role of AI and digital assessment tools. The unique contribution of this study is its bibliometric approach, providing insights into the trends and themes shaping digital QA systems from 2015 to 2025. This study addresses several key questions: How has the publication trend of digital innovation in quality assurance in higher education developed over the past decade, What are the contributions of the most influential authors and journals in advancing this field, What are the main themes and keywords that dominate research in this area?

By analyzing data from the Scopus database, this study is expected to provide comprehensive insights into the conceptual evolution and future direction of research on digital innovation in higher education quality assurance systems.

2. METHODS

In the last decade, bibliometric analysis has become an increasingly popular method among researchers in various fields, including higher education. This method is not only useful for mapping and understanding the development of research but also for analyzing trends and collaboration networks within

the academic community. One example highlighting the use of bibliometric analysis is a study by Zhang et al. (2022), which examined the literature on online learning in higher education during the COVID-19 pandemic. They found that the sudden transition to online learning triggered unprecedented research interest from various disciplines, accelerating the exploration of challenges faced in higher education. Additionally, Brika et al. (2021) conducted a bibliometric review to assess the quality of higher education, emphasizing the importance of understanding influential research works and key terms in this field. Bibliometric analysis is also used in the field of educational technology. A study by Irwanto et al. (2023) mapped research trends and the application of gamification in higher education using data from the Scopus database, demonstrating the evolution of ideas and new approaches in increasing student engagement.

In this study, bibliometric analysis is used to map the development of research related to digital innovation in quality assurance (QA) in higher education and to identify publication trends, research focus, and dominant keywords over the past decade. The entire analysis focuses on publications indexed in Scopus, one of the largest academic databases widely used due to its broad coverage and inclusion of international-quality publications. The search was conducted with a publication period limit from 2015 to 2025, in line with the research focus on the last decade of digitalization dynamics in QA in higher education. The search query was conducted with the TITLE-ABS-KEY fields, targeting keywords such as "digitalization," "digital innovation," "ICT in higher education," "quality assurance," and "higher education." The search was restricted to articles published between 2015 and 2025. The final query used was using keywords such as "digitalization" OR "digital innovation" OR "digital transformation" OR "ICT in higher education" AND "quality" OR "quality assurance" OR "quality management" OR "academic quality" OR "institutional quality" OR "total quality management" AND "higher education" OR "university."

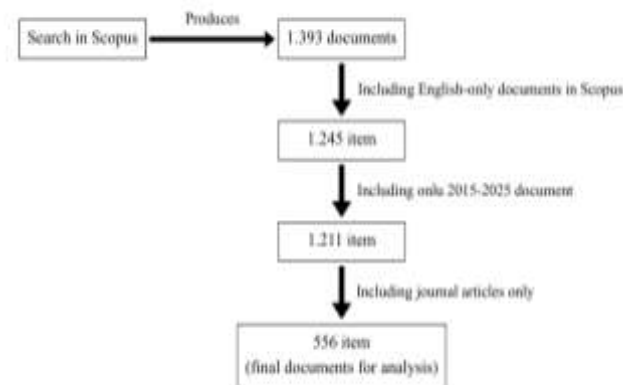


Figure 1. Data Filtering Process for Bibliometric Analysis.

With the dataset already available, the first step was to filter the data by language, selecting only articles in English, which reduced the number of documents from 1,393 to 1,245 documents. Next, the documents were limited to the publication period from 2015 to 2025, resulting in 1,211 documents relevant to the research theme. Then, the dataset was further filtered by selecting only journal articles (excluding conference papers, book chapters, and other documents), ultimately yielding 556 final documents that met the criteria for further analysis. This filtered dataset was then analyzed using VOSviewer, which allows for the exploration of trends, themes, and identification of key contributions in research on digital innovation and quality assurance systems in higher education.

3. RESULTS AND DISCUSSIONS

Results

This section presents the bibliometric analysis results both quantitatively and through visualizations generated from Scopus and VOSviewer. All results are structured to illustrate the

development of research on digital innovation in quality assurance (QA) in higher education during the period 2015–2025.

Research Trends

An analysis of 556 articles obtained from the Scopus database shows that research on digital innovation in higher education has developed consistently throughout the period 2015–2025 (see Table 1). The publication trend from 2015 to 2025 indicates a highly dynamic development in research related to digital innovation and quality assurance in higher education. In the early period (2015–2018), the number of publications was relatively low and stable, reflecting the embryonic stage of digitalization research in the higher education sector. These years were marked by initial interest in e-learning, digital tools, and digital pedagogy, although these topics had not yet become the global research focus. A significant change started to appear in 2019, when the number of publications nearly tripled. This indicates increasing attention to blended learning and digital competencies even before the COVID-19 pandemic occurred.

The strongest momentum occurred in the 2020–2021 period, when the pandemic forced a massive shift to online learning. The sharp rise in publications in 2020 and 2021 shows that the pandemic became a major catalyst for accelerating digital transformation in higher education. After this adaptation phase, research matured from 2022 to 2025, shifting from an emergency response to long-term digitalization strategies. Themes such as artificial intelligence, machine learning, technology acceptance, digital assessment, and sustainability began to dominate. The peak occurred in 2025 with the highest number of publications, confirming that the integration of intelligent technologies (AI) and digital quality assurance systems has now become a strategic and sustainable global research agenda.

Table 1. Publication Trends by Year (2015–2025)

Year	Number of Publications	Change from Previous Year (%)	Qualitative Notes / Key Moments
2015	3	N/A	Early stage of the topic. Initial interest in higher education digitalization.
2016	0	-100%	Decline. No publications; topic not widely developed.
2017	5	N/A	Interest begins to grow. Research on e-learning and digital tools begins to emerge.
2018	5	0%	Stable. Early consolidation of research on digital pedagogy.
2019	14	180%	Pre-pandemic increase. Focus on blended learning and digital competencies.
2020	43	207%	COVID-19 surge. Major shift to online learning globally.
2021	46	7%	Digital adaptation. Focus on the effectiveness of online learning.
2022	65	41%	Digital transformation. Digitalization becomes a permanent institutional strategy.
2023	86	32%	Increased smart technologies. Emergence of AI, ML, and technology acceptance research.
2024	124	44%	Digital QA integration. Strengthening studies on digital assessment & QA.
2025	154	24%	Peak of research. Dominance of AI, sustainability, and digital QA systems.

Source: Processed Data (2025)

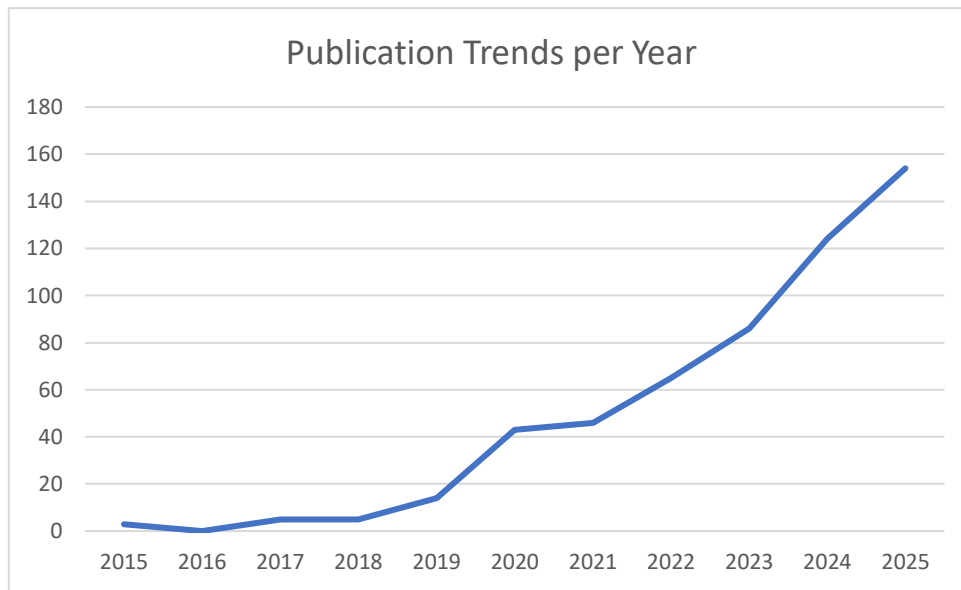


Figure 2. Publication Trends per Year

Figure 1 shows the sharp increase in publications on digital innovation and quality assurance in higher education throughout 2015–2025. Although the number of publications in the early period was relatively low, the graph shows a significant acceleration starting in 2019 and a drastic surge in 2020–2021 due to the global shift to online learning as a result of the COVID-19 pandemic. After that, the trend continued to increase steadily, reflecting that digital transformation is no longer temporary, but has become a permanent strategy in higher education. In the period from 2023 to 2025, the curve rises further, reaching the highest number of publications, indicating that research in this field is becoming more mature and placing significant focus on the integration of intelligent technologies, digital assessment, and technology-based quality assurance systems.

Citation Analysis

Citation analysis was conducted to identify the documents that have made the most significant contributions to the development of research on digital innovation and quality assurance in higher education. Citations are used as indicators of scientific impact, as they show how often a publication is referenced by other research and the extent to which the ideas within it have shaped the direction of scholarly development in a particular field. Table 2 presents the ten articles with the highest citation counts in the 2015–2025 dataset, providing an overview of the themes, approaches, and theoretical contributions that have had the most influence in the analyzed literature.

Table 2. Ten Most Cited Documents in the Field of Digital Innovation and Quality Assurance in Higher Education

Rank	Article Title	Authors	Year	Number of Citations
1	The Futures of Europe: Society 5.0 and Industry 5.0 as Driving Forces of Future Universities	Carayannis, E.G.; Morawska, J.	2022	386
2	The digital transformation of external audit and its impact on corporate governance	Manita, R.; Elommal, N.; Baudier, P.; Hikkerová, L.	2022	320
3	Managing the Strategic Transformation of Higher Education through Artificial Intelligence	George, B.; Wooden, O.	2023	249

Rank	Article Title	Authors	Year	Number of Citations
4	The Need of Integrating Digital Education in Higher Education: Challenges and Opportunities	Alenezi, M.; Wardat, S.; Akour, M.	2023	150
5	The Rise of Corporate Science in AI: Data As A Strategic Resource	Hartmann, P.; Henkel, J.	2020	95
6	Digital gap in universities and challenges for quality education: A diagnostic study in Mexico and Spain	Rodríguez-Abitia, G.; Martínez-Pérez, S.; Ramirez-Montoya, M.S.; Lopez-Caudana, E.O.	2020	92
7	Operation management of academic libraries in Hong Kong under COVID-19	Yu, P.Y.; Lam, E.T.H.; Chiu, D.K.W.	2023	80
8	Distance learning as a resilience strategy during covid-19: An analysis of the italian context	Appolloni, A.; Colasanti, N.; Fantauzzi, C.; Fiorani, G.; Frondizi, R.	2021	75
9	Green purchase behavior of university students in Hungary: An empirical study	Naz, F.; Oláh, J.; Dinu, D.; Magda, R.	2020	72
10	Digitalization of learning resources in a HEI – a lean management perspective	Tay, H.L.; Low, S.W.K.	2017	67

Source: Processed Data (2025)

Table 2 shows that the articles with the highest citation counts tend to be publications that address strategic issues related to digital transformation in higher education and the integration of intelligent technologies in both the learning process and institutional management. The most influential publication, *The Futures of Europe: Society 5.0 and Industry 5.0 as Driving Forces of Future Universities* (Carayannis & Morawska, 2022), received 386 citations and emphasizes the role of advanced technologies such as AI, automation, and the concept of Society 5.0 in shaping the future of universities. This publication became an important reference because it offers a visionary framework on structural changes in higher education. The second-ranked publication, which discusses digital transformation in external audit and governance (Manita et al., 2022), shows how digital technologies influence not only academic aspects but also managerial processes in the educational and organizational ecosystems.

Other publications that appear in the list also show a strong tendency toward themes like AI in education (George & Wooden, 2023), challenges of integrating digital education (Alenezi et al., 2023), and the utilization of data as a strategic resource in AI-based science (Hartmann & Henkel, 2020). These articles are highly cited because they offer conceptual models, empirical findings, or strategic perspectives relevant to global digital transformation. Meanwhile, articles ranked 6–10 show a focus on more specific topics, such as the digital gap, e-learning evaluation, digital library management during COVID-19, and student behavior in the digital context. The dominance of articles from 2020–2023 in this list also indicates that issues related to digitalization and online learning surged during the pandemic and continued to be the focal point of research for several years afterward.

The citation trends per year shown in Graphic 2 illustrate the development of the influence of publications in the field of digital innovation and quality assurance in higher education from 2015 to 2025. The citations received by the publications reflect the extent to which these articles have become important references in the literature and help explain the intellectual contributions of this field over time.

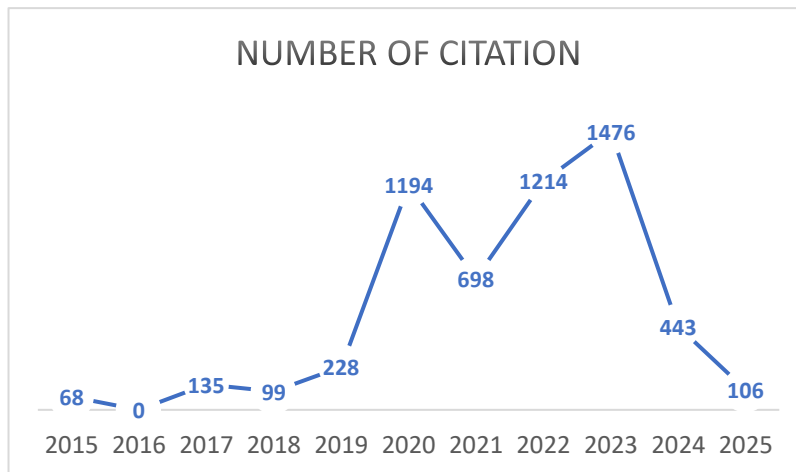


Figure 3. Citation Trends per Year

Graphic 2 illustrates the citation trends per year, showing a fluctuating pattern highly influenced by global dynamics and the relevance of the research topic to the context of its time. Citations were relatively low during the 2015–2018 period, indicating that research related to digitalization in education and quality assurance was still in its early stages and had not yet become a major focus in international literature. A significant increase began to appear in 2019 and surged dramatically in 2020, reaching 1,194 citations, coinciding with the onset of the COVID-19 pandemic, which led to numerous influential studies on online learning and digital education management. After a slight decrease in 2021, citation impact increased again in 2022 and peaked in 2023 with 1,476 citations, showing that the articles published in that year had a broad influence and were quickly adopted as academic references. The sharp decline in 2024 and 2025 more reflects the publication timing, as articles from those years have not had enough time to accumulate citations significantly, rather than a decrease in the relevance of the topic. Overall, this pattern shows that research on digital innovation in higher education has a strong academic impact, particularly during and after the pandemic.

Keyword Analysis

Keyword analysis was conducted to identify the main themes in research on digital innovation for quality assurance in higher education. The visualization of the keyword co-occurrence map generated using VOSviewer shows the relationships between keywords that frequently appear together in the articles analyzed. The following figure illustrates the resulting clusters that emerged from the keywords in the dataset:

Selected	Keyword	Occurrences	Total link strength
<input checked="" type="checkbox"/>	higher education	131	209
<input checked="" type="checkbox"/>	digital transformation	98	117
<input checked="" type="checkbox"/>	digitalization	59	83
<input checked="" type="checkbox"/>	e-learning	29	52
<input checked="" type="checkbox"/>	COVID-19	25	40
<input checked="" type="checkbox"/>	quality	10	31
<input checked="" type="checkbox"/>	online learning	13	20
<input checked="" type="checkbox"/>	educational process	8	25
<input checked="" type="checkbox"/>	students	14	25
<input checked="" type="checkbox"/>	artificial intelligence	20	23
<input checked="" type="checkbox"/>	online education	10	23
<input checked="" type="checkbox"/>	quality assurance	13	23
<input checked="" type="checkbox"/>	educational technology	10	22
<input checked="" type="checkbox"/>	innovation	11	20
<input checked="" type="checkbox"/>	education	17	19
<input checked="" type="checkbox"/>	management	6	19
<input checked="" type="checkbox"/>	sustainability	9	19
<input checked="" type="checkbox"/>	technology	9	18
<input checked="" type="checkbox"/>	digital competencies	7	18
<input checked="" type="checkbox"/>	digital technologies	7	18

Figure 4. List Cluster Visualization

The figure above visualizes the table showing the results of keyword analysis obtained from the co-occurrence visualization using VOSviewer. This table presents the most frequently appearing keywords in the research dataset on digital innovation for quality assurance in higher education. Five thematic clusters have been identified based on the frequency of keyword occurrences, including:

are responding to digital changes, with related topics such as student satisfaction, service quality, and students, which indicate that improving service quality and student satisfaction are receiving significant attention. Brochado (2009) emphasizes the importance of service quality in higher education, where student satisfaction is a key driver for loyalty and institutional recommendations. Additionally, Jiménez-Bucarey (2021) highlights that in recent decades, the quality of online education services has become a primary focus in higher education QA, demonstrating the importance of understanding student satisfaction in this context. This cluster also shows the significant impact of the COVID-19 pandemic, which accelerated the adoption of digital technologies in education. The pandemic prompted a shift from conventional learning to digital platforms, leading to an increase in the use of online learning, blended learning, and e-learning. Findings from Ameylda & Djameludin (2022) reveal that the quality of teaching services and the interaction between faculty and students significantly affect student satisfaction in the context of online learning.

Next, the second cluster, digital transformation, represents a strategic level theme, including keywords such as digital transformation, sustainability, digital technology, teaching and learning, and leadership. Unlike the more technical digitalization cluster, this cluster highlights structural and organizational changes in higher education, including governance, institutional strategy, and long-term innovation. Le et al. (2024) explain that digital transformation requires the implementation of strategies that include human resource development, optimization of learning processes, and curriculum adjustments to remain relevant to contemporary demands. Marks and Al-Ali (2022) developed a framework to assess the maturity of digital transformation that institutions can use to evaluate and manage this process. This framework is crucial in formulating institutional strategies to ensure that digital transformation is not only ongoing but also aligned with the institution's mission and vision.

Meanwhile, the third cluster, digitalization, includes terms like digitalization, digitalization of education, digital pedagogy, and communication. This cluster focuses on studies of the integration of technology into curriculum, learning methods, and the overall educational process. The success of integrating technology into the curriculum is closely related to the development of effective QA models. Liu (2020) shows in his research that QA policies applied in institutions can influence curriculum development. By integrating QA functions and educational development into one bureaucracy, institutions can create a better culture of quality. This cluster is more operational, discussing how technology is beginning to be used in everyday practices at universities.

The fourth cluster, e-learning, shows how e-learning not only focuses on using technology for learning but also includes other important aspects such as digital competence enhancement, the impact of COVID-19, student satisfaction, and the adoption of new technologies supporting higher education. E-learning requires institutions to develop specific QA indicators and models for online learning (Hafeez et al., 2022). Vlachopoulos (2016) adds that designing high-quality e-learning courses should be a primary focus in QA programs. On the other hand, Allehaibi and Albaqami (2017) argue that to maintain and control e-learning quality, QA policies regulating various academic activities in the e-learning environment must be effectively implemented. This means that not only technical aspects need to be regulated, but also pedagogical methodologies and administrative support must be continuously evaluated to meet student learning expectations and international standards. The diversity of themes reflects how research on e-learning continues to evolve to address the challenges, opportunities, and innovations associated with digital learning in the modern era.

The fifth cluster, COVID-19, stands alone with keywords such as COVID-19, COVID-19 pandemic, online education, and distance learning. This cluster shows how the pandemic became a turning point for the rapid adoption of digital tools. COVID-19 was not just a contextual variable, but a driving force for the sudden transformation that shifted learning to an online format, expanding research related to digital pedagogy, well-being, and the effectiveness of distance learning. Jiang et al. (2022) state that the rapid increase in the use of these technologies reflects how COVID-19 acted as a catalyst for institutions to adopt digital tools that had previously been applied on a limited scale. Furthermore, Tóth et al. (2022) emphasize that the COVID-19 pandemic has accelerated the adoption of online education. Through the use of digital tools and increased competencies, higher education institutions were not only able to revolutionize their teaching methods but also ensure the continuity of education quality, even in challenging situations.

Overall, these five clusters show that research on digitalization and quality in higher education has evolved from contextual issues (COVID-19), technical implementations (digitalization, e-learning), to strategic changes (digital transformation) and the adoption of intelligent technologies (AI). This structure illustrates the increasing complexity of research as higher education institutions need to adapt to the global digital transformation.

4. CONCLUSION

This study aims to map the performance and development of research on digital innovation in quality assurance in higher education over the past decade. An analysis of 556 documents shows that although all publications discuss the overarching theme of higher education digitalization, the research focus reveals significant thematic variation. Keyword visualization identifies five main clusters: higher education, digital transformation, digitalization, e-learning, and COVID-19, which represent the shift in research orientation from basic digitalization to the integration of intelligent technologies within quality assurance systems. A sharp increase in publications occurred during the COVID-19 pandemic, confirming that the global health crisis acted as a catalyst for digital transformation in higher education. Additionally, the most influential articles were found to focus on institutional digital transformation strategies, technological readiness, online learning quality, and digital assessment as part of modern quality assurance (QA). In addition to identifying these trends, this study underscores several practical implications for higher education institutions, particularly those looking to strengthen their digital QA frameworks. Institutions can consider developing a "digital QA maturity" model, which would guide the systematic adoption of digital tools in QA processes. Prioritizing the integration of digital assessment and learning analytics within QA frameworks is crucial for enhancing educational quality and improving institutional accountability. Furthermore, with the increasing reliance on data-driven QA models, it is vital for institutions to establish clear governance policies for the use of AI and data, ensuring transparency and fairness in quality assurance practices.

Like other bibliometric studies, this research has several limitations. First, the analysis only used the Scopus database, so the findings are limited to the scope of this database. Future research could expand the coverage by incorporating Web of Science, Dimensions, or Google Scholar to obtain a more comprehensive picture. Second, the content analysis of articles was not conducted in-depth as this study focused on metadata (titles, keywords, citations, and relationship patterns). Future studies could perform content analysis or systematic literature reviews to explore the theoretical and methodological quality of the articles in more detail. Third, the citation analysis in this study only examined the number of citations without assessing the context of citations or self-citation, so future research could evaluate citation quality or scientific impact more precisely. Fourth, this study did not differentiate variations in country or institutional context, even though the implementation of digitalization and QA is highly influenced by infrastructure readiness, national policies, and institutional capacity. Future research could analyze country differences or conduct comparative studies related to digital readiness and its impact on quality assurance systems. Lastly, the integration of new technologies such as generative AI, learning analytics, and automated assessment presents new research opportunities that have not been widely explored. Thus, future research agendas could focus on developing data-driven QA models, evaluating the effectiveness of intelligent technologies, and their implications for governance and accountability in higher education.

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