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Curriculum Innovation for Future Workforce Preparation in Higher Education: A Systematic Literature Review Using Text Mining

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Abstract

Background of study: The rapid growth of Industry 4.0 and global labor market shifts push higher education to redesign curricula toward innovation, digitalization, and sustainability. Equipping graduates with 21st-century skills, employability, and adaptability is essential to prepare them for an increasingly complex workforce.
Aims and scope of paper: This study aims to identify global trends in curriculum innovation for future workforce preparation in higher education (2020–2024). It examines dominant research clusters, the alignment of curriculum reforms with SDGs, and highlights areas that remain underexplored.
Methods: A systematic literature review (SLR) combined with text mining was conducted using Scopus as the primary database. A total of 247 peer-reviewed documents were analyzed through bibliometric mapping, keyword co-occurrence, topic modeling using Latent Dirichlet Allocation (LDA), and semantic mapping via multidimensional scaling (MDS).
Result: The findings show substantial publication growth, dominated by four key clusters: curriculum design and pedagogy, technology integration, sustainable curriculum, and blended/online learning. Emerging but less explored topics include curriculum decolonisation, problem-based learning, methodological literacy, and digital assessment. International collaboration is moderate (17.81%), though Southeast Asia and Africa show growing potential. Highly cited studies focus on digital transformation during COVID-19, online assessment integrity, and AI integration into curriculum frameworks.
Conclusion: This study shows that curriculum innovation is mainly driven by digitalization and sustainability, while areas like decolonisation and methodological innovation are still lacking. The results provide theoretical, practical, and policy implications for designing adaptive, future-oriented curricula and open avenues for global collaboration and longitudinal studies in the field.

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INTRODUCTION

In recent years, the dynamics of global transformation have compelled higher education institutions to adapt to the challenges ushered in by the Fourth Industrial Revolution. The rapid advancement of digital technologies, such as artificial intelligence, big data, machine learning, and the Internet of Things, has significantly reshaped the landscape of the workforce. These developments demand that university graduates not only possess strong academic knowledge but also exhibit the flexibility to adapt within an increasingly dynamic and unpredictable environment (Crittenden et al., 2019; Paśko et al., 2022).

In this context, higher education must evolve beyond its traditional role as a center for learning to become a producer of human capital that is prepared to navigate a complex, digital, and sustainable world of work. Consequently, curriculum innovation has emerged as an urgent necessity, particularly in aligning content, pedagogy, and learning approaches with the competencies required

in the 21st century (Crittenden et al., 2019; N. C. Jackson, 2019; Luckett & Shay, 2020). Higher education curricula must respond to these shifts through transformative, integrative, and contextual designs that equip students with relevant, applicable skills for real-world challenges. This imperative is further underscored by the strategic role of higher education in advancing the United Nations Sustainable Development Goals (SDGs).

Over the past decade, the literature on curriculum innovation and graduate employability has grown considerably. Recent studies have highlighted a range of innovative pedagogical approaches, including project-based learning, flipped classrooms, hybrid learning models, and technology-enhanced instructional design, as strategic responses to contemporary challenges (Chua & Islam, 2021; Sanchez-Muñoz et al., 2022; Zarouk et al., 2020). Emerging evidence suggests that no single model of employability is universally applicable; instead, higher education curricula must be tailored to specific local contexts and industry demands, particularly emphasizing sustainable skills aligned with the needs of Industry 5.0 (Mohan et al., 2025).

However, other studies have pointed to the limited effectiveness of many employability programs in comprehensively developing work-ready competencies. This is often attributed to insufficient industry engagement and the lack of authentic work-integrated learning experiences for students (D. Jackson, 2015). Furthermore, the integration of SDG-related goals within higher education remains largely symbolic and structurally disconnected from curriculum design and learning outcome assessment (Avelar et al., 2023). Additional research highlights the persistent gap between the competencies fostered in academic settings and the skillsets demanded by the labor market (Aljohani et al., 2022). Strachan et al. emphasize that higher education can play a strategic role in achieving sustainable development goals if curriculum innovation is directed toward interdisciplinary collaboration, community engagement, and the cultivation of social leadership (Strachan et al., 2021).

Nonetheless, several critical gaps persist in the current body of literature. A preliminary review indicates that while some previous studies have employed a systematic literature review (SLR) approach to examine curriculum innovation and graduate employability, the majority of these remain predominantly descriptive in nature. Their primary focus tends to be on listing relevant skills or outlining curriculum strategies, without deeply analyzing thematic patterns, conceptual interrelations, or the longitudinal and contextual evolution of research in this domain.

For instance, Carminati et al. concentrate on cataloging essential skills for the future workforce in the context of Industry 5.0 (Carminati et al., 2024). While Shahidi Hamedani et al. examine the shift toward Education 5.0 and its implications for university curricula (Shahidi Hamedani et al., 2024). Meanwhile, Oliveira et al., in their systematic review of co-creation and innovation in higher education, emphasize stakeholder engagement, both internal and external, highlighting three major clusters: knowledge transfer, university–industry collaboration, and the university's third mission (Oliveira et al., 2024). While these studies contribute meaningfully to literature mapping, they tend to remain descriptive and fall short of offering deeper analytical insights into thematic interconnections or longitudinal research dynamics.

To address these gaps, the present study employs a Systematic Literature Review (SLR) using a text mining approach, enabling a more comprehensive exploration of publication trends, dominant themes, and semantic relationships across global scholarly literature published between 2020 and 2024. This analytical approach not only clarifies the current state of research but also reveals underexplored areas within the academic discourse (Chen et al., 2023; Gurcan, 2025).

Specifically, this study aims to: (1) identify global publication trends from 2020 to 2024 concerning curriculum innovation in higher education for future workforce preparation; (2) explore dominant research themes and topic cluster structures using text mining methods; and (3) uncover significant research gaps related to curriculum innovation and employability. The findings are expected to provide an empirical foundation for understanding the evolving global research agenda on curriculum innovation, particularly how digitalization, pedagogical innovation, and sustainability are shaping the future of higher education.

METHOD

As articulated by Moher et al., the objective of a systematic review is to collect and synthesize all relevant empirical evidence that meets predetermined inclusion criteria to address a specific research question (Moher et al., 2016). This study adopts a hybrid methodological approach, integrating conventional systematic review procedures with text mining techniques. This semi-automated approach enables the identification of latent thematic patterns, topic clusters, and semantic associations within large corpora of academic texts (Dina et al., 2021; Lee et al., 2024).

Inclusion and Exclusion Criteria

All publications analyzed in this study were sourced from Scopus, a widely recognized international bibliographic database known for its multidisciplinary coverage and high-quality indexing of scientific publications (Pranckutė, 2021; Susilana et al., 2025). The search was limited to articles published between January 2020 and December 2024. The inclusion criteria specified that only peer-reviewed articles in final press status were eligible for analysis. The types of publications included journal articles and indexed academic conference proceedings, provided they demonstrated methodological rigor and scholarly contribution (Rullyana et al., 2025). To ensure linguistic uniformity in text processing and compatibility with the employed semantic and lexical analysis tools, only English-language articles were considered (Rullyana et al., 2024). As part of the data quality control process, only articles with complete bibliographic metadata, including title, author name(s), institutional affiliation, keywords, abstract, and publication source, were retained for text mining analysis.

Literature Search Strategy

The literature search employed the following Boolean keyword combinations: “curriculum innovat* OR “curriculum digital” OR “curriculum transformation” OR “pedagogical innovat*” OR “curriculum modernization” OR "curriculum redesign" AND “higher education” OR “tertiary education”. This search was conducted in September 2025, yielding a total of 723 articles. After an initial screening to remove duplicates and thematically irrelevant publications, a refined set of 247 articles was selected for further analysis. The screening process followed the PRISMA 2020 protocol (Figure 1), which served as the standardized framework for the systematic literature review process.

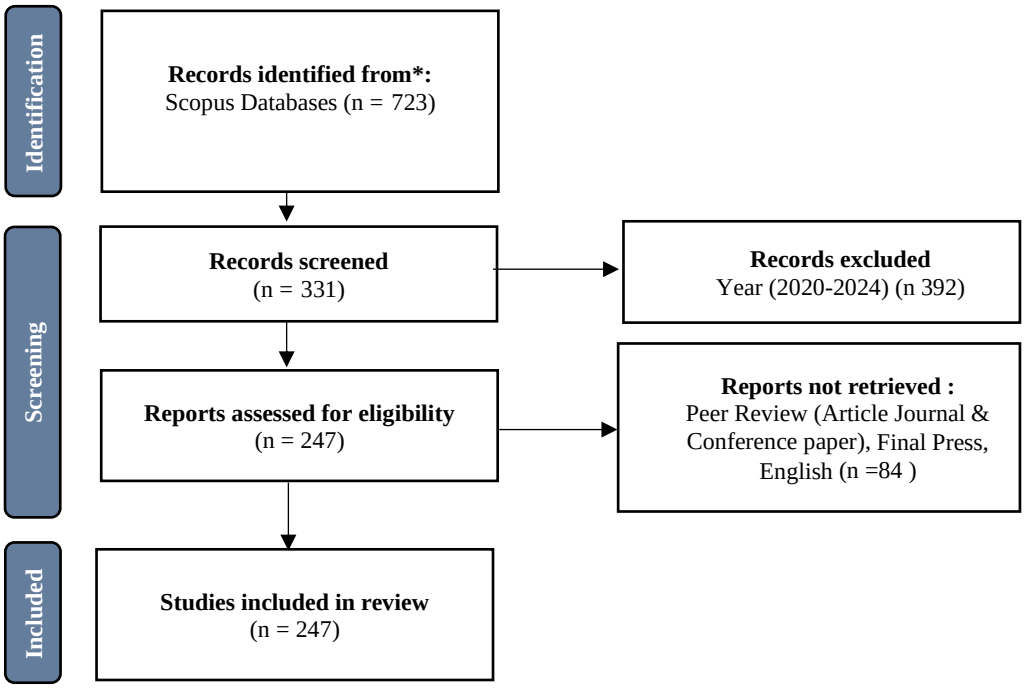

Figure 1. PRISMA flow diagram

Data Analysis and Text Mining Process

Data analysis was carried out through text mining of the titles and abstracts of articles that met the inclusion criteria. To facilitate quantitative and visual exploration of large-scale textual data, we utilized Orange Data Mining, an open-source visual analytics platform designed to support interactive data analysis, machine learning, and thematic visualization (Shahidi Hamedani et al., 2024). This analytical workflow enabled the extraction of high-level patterns, clustering of related topics, and identification of semantic linkages across the dataset, ultimately providing insights into prevailing research themes and their interconnections within the global scholarly discourse on curriculum innovation and future workforce preparedness.

Text Preprocessing

The initial stage of analysis involved text cleaning of the titles and abstracts using the Text Preprocessing widget in Orange Data Mining. This process encompassed tokenization, stopword removal, and word normalization through both stemming and lemmatization. The stemming feature in Orange reduces words to their root forms, while lemmatization returns them to their base lemma following linguistic conventions (Kathuria et al., 2021). The combination of these two techniques aims to consolidate morphological variations, reduce redundancy, and enhance the accuracy of topic modeling.

Frequency and Co-occurrence Analysis

Following preprocessing, a word frequency analysis was conducted using the Word List widget in Orange to identify the most frequently occurring terms and phrases within the corpus related to curriculum innovation and future workforce preparation in higher education. Only terms appearing at least 50 times were retained in the thematic dictionary to ensure analytical focus on semantically substantive keywords. Subsequently, topic modeling was performed using the Latent Dirichlet Allocation (LDA) algorithm embedded in Orange. LDA facilitates the identification of semantic clusters that represent dominant themes in the global literature.

Cluster and Factor Analysis

To explore deeper conceptual structures, the study employed LDA-based topic clustering, whereby documents are automatically grouped into thematic clusters based on keyword distributions. Each topic is represented as a probabilistic combination of the most relevant terms. This approach allows for terms to appear across multiple topics, reflecting the polysemic and context-sensitive nature of discourse in curriculum innovation within higher education.

Semantic Mapping and Visualization

To clarify inter-topic relationships, semantic mapping was carried out using Multidimensional Scaling (MDS) maps. These maps project semantic relationships among topics into a two-dimensional space, where topics with high semantic proximity are positioned closer together, while those with weaker connections appear more distant. This visualization results in a thematic landscape that delineates central and peripheral themes, enhancing interpretability of the latent structures within the academic discourse.

RESULTS AND DISCUSSION

Results

Descriptive Bibliometric

Between 2020 and 2024, a total of 247 documents related to curriculum innovation and future workforce preparation in higher education were published and analyzed. These documents originated from 162 unique publication sources, involving contributions from 1,583 authors, resulting in an average of 9.12 authors per document. Notably, only one publication was authored individually, indicating a strong trend toward academic collaboration. The international

collaboration rate reached 17.81%, reflecting cross-national engagement with this critical issue.

Figure 2 illustrates annual fluctuations in publication volume and citation count. The highest number of citations occurred in 2020, totaling 1,031 citations, while 2024 marked the peak in publication output, with 88 documents published. These findings suggest that early publications during this period served as foundational references, garnering high impact and shaping subsequent research directions.

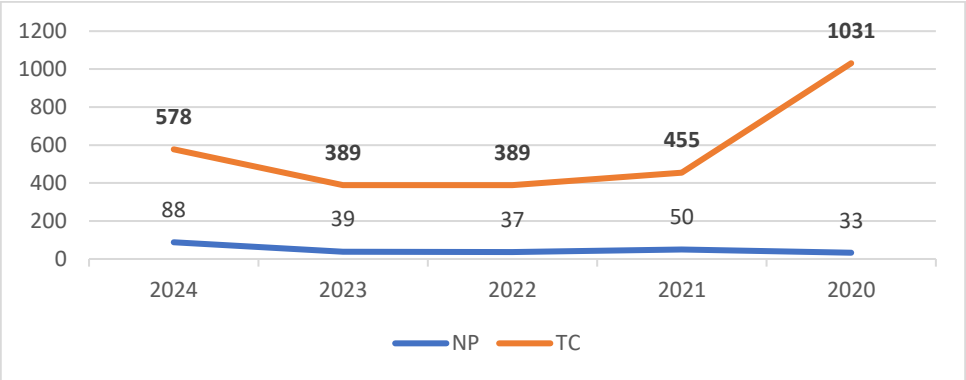

Figure 2. Number of publications per year (NP) and total citations (TC) in the 2020–2024 period

A bibliometric analysis of the 247 documents revealed that several authors made significant contributions to research in this domain. Based on publication frequency, the most prolific contributors during the study period are listed in Table 1. Among them, Singh A. emerged as the most productive author with four publications, followed by Chaka C., Halili S.H., and Suleman Q., each contributing three publications. Other authors, including Sánchez-Rivas J., Hashim H., and Marope M., were credited with two publications each.

Table 1. Most productive authors by number of documents (2020–2024)

Rank	Authors	Affiliation	Country	TP
1	Amante, Susana	Polytechnic University of Viseu (IPV)	Portugal	3
2	Cardoso, Luís Miguel	Politécnico de Portalegre	Portugal	2
3	Clougher, Derek	Hospital Universitario Araba	Spain	2
4	Fardilha, Margarida	Universidade de Aveiro	Portugal	2
5	Fernandes, Rosina I	Polytechnic University of Viseu (IPV)	Portugal	2

An analysis of productivity by country and institutional affiliation reveals that the topic of curriculum innovation and future workforce readiness in higher education has attracted substantial global academic attention. Table 2 presents the top ten countries and institutions ranked by publication output during the 2020–2024 period.

The findings show that Portugal ranked as the most productive country with 31 publications, followed by South Africa (28), United Kingdom (28), United States (23), and Australia (21). These figures reflect the active engagement of institutions across Europe, Africa, North America, and Oceania in advancing the curriculum transformation agenda, particularly in aligning higher education competencies with the dynamic requirements of 21st-century labor markets.

Table 2. Top ten most productive countries and affiliates by number of publications (2020–2024)

Rank	Country	TP	Rank	Affiliation	TP
1	Portugal	31	1	Universidade de Aveiro	9
2	South Africa	28	2	Universitat Oberta de Catalunya	6
3	United Kingdom	28	3	University of Cape Town	4
4	United States	23	4	University of Johannesburg	4
5	Australia	21	5	Universidade do Porto	4
6	Spain	16	6	Instituto Politécnico de Viseu	4

Rank	Country	TP	Rank	Affiliation	TP
7	China	9	7	Universidade do Minho	4
8	France	9	8	Centro de Investigação Didática e Tecnologia na Formação de Formadores	4
9	India	9	9	CNRS Centre National de la Recherche Scientifique	3
10	Russian Federation	9	10	University of KwaZulu-Natal	3

In terms of institutional affiliation, high productivity was observed from institutions such as the Universidade de Aveiro, Universitat Oberta de Catalunya, and the University of Cape Town, which appeared as the primary affiliations in a majority of publications. This trend highlights the direct involvement of leading higher education institutions, particularly in developed countries, in driving academic discourse on educational innovation. The pattern of international collaboration in research on curriculum innovation and workforce preparation is becoming increasingly globalized. Figure 3 presents the Country Collaboration Map, which visualizes the intensity and structure of international co-authorship networks over the 2020–2024 period.

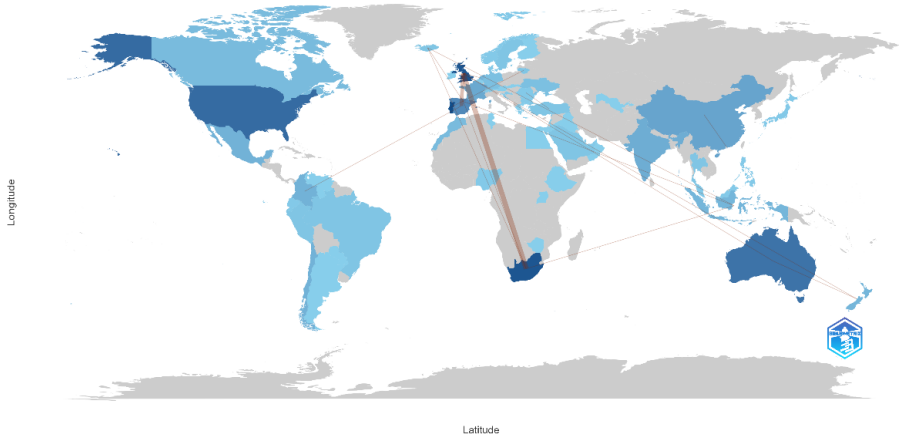

Figure 3. Country collaboration map

The visualization reveals that the most active research collaborations occurred among countries in Southeast Asia and Southern Africa, with Indonesia, Malaysia, and South Africa emerging as regional collaboration hubs. In addition, strong partnerships were evident among the United Kingdom, Australia, and several Western European nations, underscoring the involvement of institutions from high-income countries in shaping global curriculum agendas.

With an international collaboration rate of 17.81%, nearly one in five publications involved cross-border cooperation. While the subject of curriculum innovation often involves context-specific considerations, these findings suggest that the development of solutions and implementation strategies is increasingly transnational in nature. International collaboration contributes to idea exchange, methodological innovation, and the global relevance of curriculum development efforts.

Further analysis identified the most highly cited documents, offering insights into the most influential works within the global discourse on curriculum innovation and future workforce preparation. Table 3 presents the top 10 most-cited documents between 2020 and 2024. High citation counts indicate that these studies serve as key references for subsequent research and have made significant contributions to both theoretical advancement and practical application.

The document titled "Navigating the Confluence of Artificial Intelligence and Education for Sustainable Development in the Era of Industry 4.0" ranked highest, with a total of 119 citations. This article explores the intersection of artificial intelligence, education, and sustainable development, while also raising critical ethical considerations in the application of technology in educational contexts. Its prominence highlights the urgency and relevance of integrating advanced technologies into higher education curricula to address both the challenges and opportunities presented by Industry 4.0.

Table 3. The ten most influential documents based on total citations (2020–2024)

Rank	Tittle	Authors	Sources	Years	TC
1	Navigating the confluence of artificial intelligence and education for sustainable development in the era of Industry 4.0: Challenges, opportunities, and ethical dimensions	(Abulibdeh et al., 2024)	Journal of Cleaner Production	2024	350
2	Emergency remote teaching during Coronavirus pandemic: the current trend and future directive at Middle East College Oman	(Mohmmed et al., 2020)	Innovative Infrastructure Solutions	2020	237
3	A systematic review of online examinations: A pedagogical innovation for scalable authentication and integrity	(Butler-henderson & Crawford, 2020)	Computers and Education	2020	176
4	The provision of student support on English Medium Instruction programmes in Japan and China	(Galloway & Ruegg, 2020)	Journal of English for Academic Purposes	2020	159
5	Exploring Applications of ChatGPT to English Language Teaching: Opportunities, Challenges, and Recommendations	(Kostka & Toncelli, 2023)	TESL-EJ	2023	142

Text Mining Analysis

The word cloud visualization presented in Figure 4 illustrates the frequency and weight of the most prominent keywords in the literature concerning curriculum innovation and future workforce preparation in higher education. Larger words in the visualization indicate higher frequency of occurrence within the analyzed corpus.

Figure 4. Word cloud of dominant keywords in the study on workforce preparation in higher education (2020–2024)

Key terms such as “education,” “students,” “learning,” “curriculum,” and “teaching” dominate the semantic landscape, reflecting the global discourse’s emphasis on learning processes, curriculum design, and student engagement in the context of higher education transformation. Additionally, terms like “pedagogical,” “innovation,” “development,” “skills,” and “university” indicate a strong association with the 21st-century skills agenda and the integration of innovative approaches in instructional practices. Subsequent topic modeling analysis, based on text mining, identified ten major topic clusters, revealing the semantic structure of the global literature on curriculum

innovation for future workforce preparation. Each cluster represents a dominant theme, determined by the frequency and co-occurrence patterns of keywords within the documents.

Table 4. Dominant topics based on keyword analysis (text mining clustering)

No	Topic Label	Topic Keywords
1	Curriculum Design & Pedagogical Approaches	education, students, learning, curriculum, study, academic, approach, quality, pedagogy, pedagogical
2	Innovative Teaching in Engineering Education	learning, education, curriculum, study, students, engineering, teaching, innovation, approaches, online
3	Technology Integration in Higher Education	learning, students, education, pedagogical, innovation, study, university, technology, design, development
4	Curriculum Transformation & Decolonisation	development, curriculum, study, decolonisation, education, transformation, knowledge, professional, political, practice
5	Sustainable Curriculum and University Pedagogy	education, learning, students, teaching, curriculum, design, pedagogical, university, development, sustainability
6	Engineering Pedagogy and Innovative Learning Processes	education, learning, teaching, pedagogical, innovation, study, students, process, innovative, engineering
7	Curriculum Innovation and 21st Century Skills	education, learning, pedagogical, innovation, students, study, design, methodology, skills, teaching
8	Blended and Online Learning in Universities	learning, education, students, teaching, study, curriculum, pedagogical, online, university, teachers
9	Critical Thinking and Problem-Based Learning (PBL)	students, education, critical, thinking, based, pbl, institutions, teaching, science, geoinformatics
10	Online Assessment and Professional Education	education, students, online, study, development, learning, assessment, pedagogical, tourism, institutions

Figure 5 displays the marginal probability distribution of each topic generated through Latent Dirichlet Allocation (LDA). These values reflect the proportional prevalence of each topic across the corpus (Jelodar et al., 2019). Overall, the distribution indicates a dominance of technology-driven and sustainability-oriented themes, surpassing more critical or transformative approaches. This finding underscores the current trajectory of curriculum innovation, which is largely shaped by digital integration, pragmatic thinking, and a focus on learning efficiency. However, it also reveals an opportunity to strengthen dimensions related to ethics, social justice, and local knowledge systems.

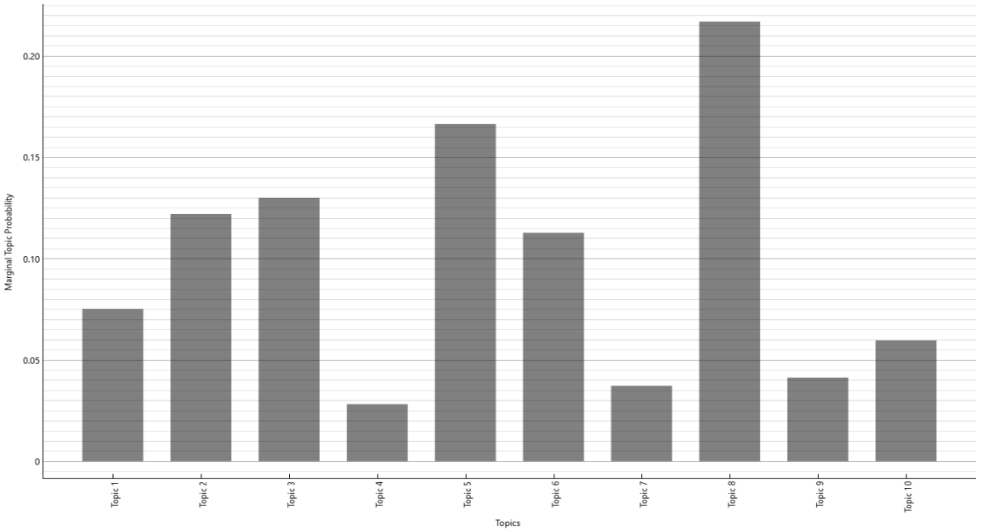

Figure 5. Marginal topic probabilities for 10 dominant topics in the study on curriculum innovation and future workforce preparation (2020–2024)

Figure 6 presents a Multidimensional Scaling (MDS) map that visualizes the relationships among the topics identified through LDA. The color and position of each node reflect semantic proximity, while the distance between nodes represents the strength of thematic associations (Feng et al., 2021). Topics that appear closer together are more frequently co-mentioned within the same documents, whereas more distant topics exhibit weaker thematic connections.

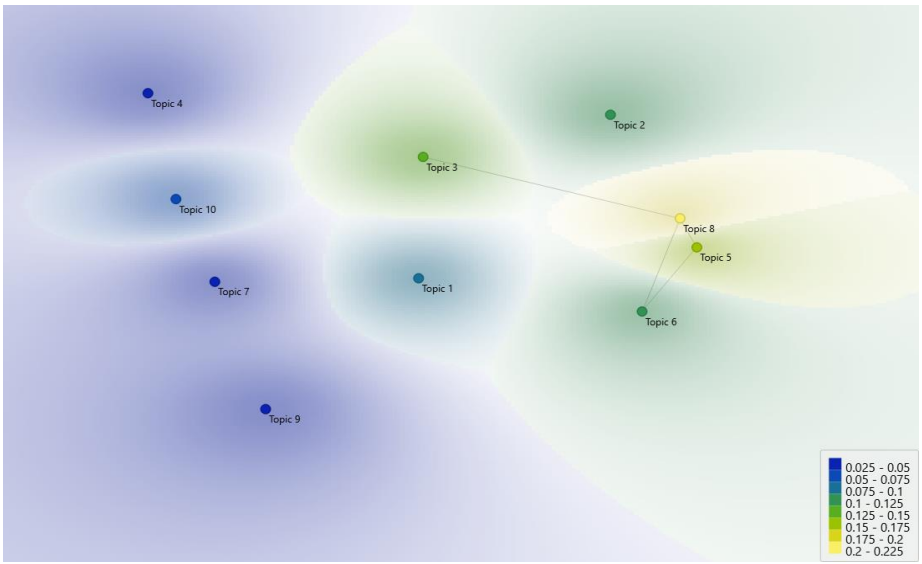

Figure 6. Mapping of thematic relationships between topics based on MDS analysis (2020–2024)

Taken together, the MDS results suggest that digitalization, innovative pedagogy, and sustainable curriculum design serve as the central gravitational themes in current curriculum innovation research. In contrast, critical issues such as decolonization, methodological skills, and project-based learning (PBL) occupy secondary positions, indicating untapped potential for deeper exploration in future scholarly work.

Discussion

The analysis of the literature reveals a substantial growth in research on curriculum innovation and future workforce preparation in higher education, with 247 documents published across 162 sources. The high average of 9.12 authors per article, coupled with the minimal number of single-authored papers, confirms the predominance of collaborative research models. However, the relatively modest international collaboration rate of 17.81% suggests that the majority of contributions remain situated within local or national contexts, despite a growing trend toward cross-border academic engagement.

From a temporal perspective, the trend in publications and citations presents an interesting trajectory. While the number of publications peaked in 2024, the highest citation count occurred in 2020, indicating that early studies in the review period served as conceptual cornerstones and key references, particularly in relation to the digital learning transition triggered by the COVID-19 pandemic. In terms of individual contributions, scholars such as Singh A., Chaka C., Halili S.H., and Suleman Q. emerged as the most prolific authors. However, author productivity appears relatively evenly distributed, reflecting the openness and inclusivity of the field toward contributions from diverse academic communities.

Geographically, Portugal, South Africa, the United Kingdom, the United States, and Australia stood out as the most productive countries. This reflects a balanced global distribution of research activity between Global North and Global South institutions. Universities such as Universidade de Aveiro (Portugal), University of Cape Town (South Africa), and Universitat Oberta de Catalunya (Spain) played central roles, highlighting the significance of Southern European and African institutions in driving the curricular transformation agenda. The Country Collaboration Map revealed regional hubs in Southeast Asia and Southern Africa, with Indonesia, Malaysia, and South Africa acting as key regional contributors. Transcontinental networks involving the UK, Australia,

and Western European countries further emphasize the transnational dimension of curriculum innovation research. These patterns align with the global consensus that while curriculum must remain contextually grounded, it should also facilitate international knowledge exchange.

In terms of scientific impact, the most-cited documents focus on themes central to the Industry 4.0 era and post-pandemic education transformation. The top-cited work, titled "Navigating the Confluence of Artificial Intelligence and Education for Sustainable Development in the Era of Industry 4.0" (Abulibdeh et al., 2024), with 350 citations, underscores the intersection of AI, education, and the SDGs, positioning advanced technologies and sustainability as core to the discourse. Similarly, studies on emergency remote teaching. Similarly, studies on emergency remote teaching (Mohmmed et al., 2020) and pedagogical innovation in online assessments (Butler-henderson & Crawford, 2020) became pivotal references, affirming that global crises often catalyze major curricular innovations. Collectively, the literature indicates not only quantitative growth but also a thematic shift, from traditional pedagogical concerns toward digitalization, employability, sustainability, and curriculum decolonization..

The text mining analysis reveals thematic patterns that resonate with global higher education priorities. The word cloud visualization highlighted dominant terms such as "education," "students," "learning," "curriculum," and "teaching", suggesting a sustained focus on pedagogical interaction, curriculum design, and the role of students as both learners and active agents. Frequently occurring terms like "technology," "digital," "online," and "engineering" reflect the increasing integration of technological elements in curriculum design, while "employability," "entrepreneurship," and "future" indicate a strong emphasis on career readiness. The presence of "sustainability," "transformation," and "decolonisation" highlights emerging interest in the ethical, global, and justice-oriented dimensions of modern curriculum reform.

Topic modeling identified four dominant clusters: Curriculum Design & Pedagogical Approaches (Topic 1), Technology Integration in Higher Education (Topic 3), Sustainable Curriculum & University Pedagogy (Topic 5), Blended/Online Learning in Universities (Topic 8). These clusters form the core discourse of curriculum innovation. Topic 1 functions as the implementation arena for Topic 3, which is frequently operationalized via Topic 8, increasingly framed by institutional sustainability concerns as represented by Topic 5. Peripheral but important themes, Curriculum Decolonization (Topic 4), Methodological Skills (Topic 7), Project-Based Learning & Critical Thinking (Topic 9), and Digital Assessment & Professional Practice (Topic 10), remain underrepresented in current knowledge production, despite their relevance. This imbalance is likely due to the urgent post-pandemic need for scalable digital solutions (Alarcón López et al., 2021; Liu & Shirley, 2021).

The dominance of Topic 8 points to a structural shift in curriculum practice toward hybrid and online modalities, necessitating the redesign of teaching strategies, assessments, and student support systems. The most cited works in the corpus reinforce this finding. For instance, the study on emergency remote teaching in Oman emphasized institutional readiness, faculty competencies, and sustainability of post-crisis practices as key quality determinants (Mohmmed et al., 2020). Assessment quality also emerged as a critical issue; a systematic review of online examinations stressed the need for authentic, secure, and scalable digital assessment solutions (Butler-henderson & Crawford, 2020; Golubovskaya et al., 2021).

Support systems for English Medium Instruction (EMI) in Japan and China revealed that context-specific academic mentoring facilitates successful transition into digitally mediated internationalized learning environments (Galloway & Ruegg, 2020). The latest wave of AI-driven learning offers possibilities for personalization and real-time feedback, yet raises concerns regarding ethics, fairness, and assessment validity (Abulibdeh et al., 2024; Kostka & Toncelli, 2023). Micro-credentialing initiatives focused on employability skills, particularly competency-based e-portfolios, have enhanced the transparency of graduate skill recognition and stimulated pedagogical innovation in higher education (Johan et al., 2025; Maina et al., 2022).

Topic 3 further confirms that curriculum innovation is now inseparable from technological stacks, including LMS platforms, learning analytics, and AI applications. Influential studies highlight not only the potential for learning efficiency, but also the ethical and sustainability dimensions of these tools, underscoring the need for ethics-by-design frameworks in curriculum integration (Antonio et al., 2024; Gulyamov et al., 2024). Topic 5 reflects the shift from sustainability as a rhetorical device to a pedagogically embedded agenda (Clifford, 2024). Its strong semantic proximity

to Topic 8 in the MDS map suggests that digital platforms are central to mainstreaming the SDGs. This finding implies that learning outcomes and assessment rubrics should be directly aligned with measurable SDG indicators, with institutional reporting frameworks that merge academic and sustainability metrics.

Topic 1 remains the conceptual backbone of curriculum innovation, requiring constructive alignment among goals, activities, and assessments. However, evidence indicates it is also the primary bottleneck, particularly under rapid digital acceleration. Weaknesses were especially apparent in assessment design and learning support during the transition to online learning (Dhawan, 2020; Guzzo et al., 2023). This underscores the need to adopt competency-based education and authentic assessment models that ensure not only skill acquisition but also demonstrable student performance (Dieguez et al., 2023; El Boudamoussi, 2022).

Among peripheral topics, Topic 4 (Decolonization) remains underexplored despite its potential to challenge Eurocentric legacies in curriculum design. Its low connection density on the MDS map indicates opportunities for future inquiry into digital decolonial pedagogy, community co-design, and context-aware AI. Topics 7 and 9 highlight the need to deepen methodological literacy to ensure that problem-based and project-based learning truly cultivate transferable skills. Topic 10 emphasizes the importance of ensuring valid, equitable, and scalable digital assessments (Osabutey et al., 2024; Pagone et al., 2024).

The findings of this study present several strategic implications for higher education. The prevalence of blended and online learning, alongside the widespread integration of technology, underscores that curricula can no longer be developed in isolation from the broader digital ecosystem. Institutions must therefore design learning environments that prioritize flexibility, authentic assessment, and AI literacy as essential elements of the student experience.

Furthermore, the increasing emphasis on sustainability, particularly through alignment with the Sustainable Development Goals (SDGs), demands a shift beyond a narrow employability focus toward embedding social values, ethics, and justice-oriented perspectives. This is consistent with global trends that emphasize digital service-learning and internationalized classrooms as mechanisms for SDG integration. Although the level of international collaboration remains relatively low (17.81%), the emergence of regional research networks in Southeast Asia and Southern Africa points to the potential of South–South cooperation in enhancing local relevance while fostering global engagement.

Methodologically, this study contributes to the literature in three key ways. First, by combining systematic literature review (SLR) with text mining techniques, it moves beyond descriptive analysis to uncover latent thematic structures using topic modeling and multidimensional scaling (MDS). Second, it offers a new conceptual framework through the identification of four dominant clusters, Curriculum Design and Pedagogical Approaches, Technology Integration, Sustainable Curriculum, and Blended/Online Learning, that define how curriculum innovation supports future workforce readiness. Third, the study identifies critical gaps related to curriculum decolonization, digital assessment, and methodological skills, which remain underrepresented in current research despite their centrality to advancing an equitable, holistic approach to curriculum development.

Nonetheless, the study has several limitations. The analysis relied solely on data from Scopus, thereby excluding potentially relevant contributions from other bibliographic databases such as Web of Science (WoS) or ERIC. It also covered only the 2020–2024 period, limiting insight into longitudinal trends, particularly those that emerged prior to the COVID-19 pandemic. Moreover, the text mining process, based only on titles and abstracts, may have missed deeper conceptual nuances typically embedded in full-text articles. Future research should therefore expand the data sources to include broader databases, extend the temporal scope to capture long-term trends, and employ full-text mining or qualitative content analysis to explore more nuanced and emerging themes, particularly in areas such as decolonial pedagogies, context-sensitive AI integration, and authentic assessment strategies.

CONCLUSION

This study set out to map global publication trends on curriculum innovation in higher education within the context of future workforce preparation, employing a systematic literature review (SLR) enhanced by text mining techniques. The findings from bibliometric and textual analyses indicate a marked growth in publications between 2020 and 2024, the identification of dominant research clusters, and a thematic mapping that clarifies the trajectory of curriculum innovation in global academic discourse.

Specifically, four major clusters, Curriculum Design & Pedagogical Approaches, Technology Integration in Higher Education, Sustainable Curriculum and University Pedagogy, and Blended/Online Learning in Universities, emerged as the core of current scholarly conversations. These clusters underscore that curriculum transformation is increasingly driven by digitalization, innovative pedagogy, and a sustainability-oriented agenda. Simultaneously, peripheral yet significant themes such as decolonization, digital assessment, methodological skills, and problem-based learning remain underexplored, presenting avenues for further investigation.

Accordingly, this study not only affirms the anticipated trends and directions outlined in the introduction, but also contributes conceptually to the literature by positioning curriculum innovation as a dynamic ecosystem, one that integrates 21st-century competencies, technological affordances, graduate employability, and sustainability imperatives. The practical implications of these findings offer valuable insights for universities, policy-makers, and industry stakeholders in designing adaptive, inclusive, and future-oriented curricula, while reinforcing the strategic role of higher education in advancing the global Sustainable Development Goals (SDGs).

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AUTHOR CONTRIBUTION STATEMENT

Conceptualization: RS, GR; Methodology: RS; Data collection: GR; Data analysis and interpretation: RS, GR; Writing, original draft preparation: GR; Writing, review and editing: RS; Supervision: RS. Both authors have read and agreed to the published version of the manuscript.

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