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Evaluating Research Trends and Scholarly Impact in Blended Learning and Learning Management Systems: A Bibliometric Study (2003–2025)

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ABSTRACT

Purpose of the study: This study aims to identify global research trends, thematic evolution, and collaboration patterns in blended learning and learning management systems (LMS) from 2003 to 2025 using a bibliometric approach.

Methodology:.A total of 890 peer-reviewed documents indexed in Scopus were analyzed using VOSviewer (v1.6.19) and Biblioshiny (R-based). Bibliometric mapping, keyword co-occurrence, and network visualization techniques were employed following systematic review procedures.

Main Findings: The study identified three distinct research phases: initiation (2003–2008), rapid growth (2009–2019), and stabilization (2020–2025). Research focus shifted from technical implementation to learner-centered pedagogy emphasizing engagement, curriculum integration, and learning analytics. Emerging themes include artificial intelligence and adult learning, while *Computers & Education* remains the most influential source.

Novelty/Originality of this study: This study provides a two-decade bibliometric mapping highlighting thematic evolution and collaboration networks in blended learning and LMS research. It advances understanding by identifying emerging areas such as AI and lifelong learning that inform future directions in digital education research.

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1. INTRODUCTION

The rapid integration of digital technologies into education has transformed traditional teaching models, leading to the emergence of blended learning and the widespread adoption of Learning Management Systems (LMS). Blended learning combines face-to-face and online modalities, offering flexibility and personalization for diverse learners [1]. LMS platforms such as Moodle and Blackboard have become central to managing instructional content and supporting synchronous and asynchronous learning [2]. This shift has intensified since the COVID-19 pandemic, which accelerated digital transformation and reinforced the strategic importance of LMS in higher education and vocational training [3].

Over the past two decades, global interest in blended learning and LMS has grown substantially, reflected in the rising volume of academic publications. Early studies primarily focused on system implementation and user acceptance [5], while subsequent research examined pedagogical effectiveness, student satisfaction, and instructional design [6]. More recent work emphasizes advanced LMS features—such as interactive content, gamification, and AI-driven feedback—to enhance learner engagement and institutional

adaptability [7]-[9]. Despite this proliferation, research remains fragmented, often limited to specific contexts or short-term evaluations.

However, few studies have comprehensively examined the *long-term global evolution* of research on blended learning and LMS. Existing bibliometric analyses tend to focus narrowly on specific tools or short timeframes, overlooking the broader intellectual structure and international collaboration patterns in this field [10], [11]. Consequently, there remains a gap in understanding how research trends, themes, and networks have evolved over time. Addressing this gap is essential to identify emerging directions, influential contributors, and the conceptual development of digital learning scholarship.

Therefore, this study conducts a longitudinal bibliometric analysis of blended learning and LMS research from 2003 to 2025 using data from the Scopus database. It aims to map publication growth, thematic evolution, and collaboration networks to provide a data-driven overview of the field. The study is guided by the following research questions:

(1) How has the volume of publications on blended learning and LMS evolved from 2003 to 2025?
(2) Which journals and sources contribute most to this body of knowledge?
(3) Who are the most influential authors in this field?
(4) Which countries are leading in terms of scientific output?
(5) What are the most prominent and relevant keywords in this area?
(6) What is the current landscape of research on blended learning and LMS?

2. RESEARCH METHOD

This study employed a bibliometric approach to map global research trends related to blended learning and Learning Management Systems (LMS) from 2003 to 2025. Unlike respondent-based studies, the bibliometric method analyzes *document-level data* rather than survey data. It is designed to identify publication patterns, thematic evolution, and scientific collaboration networks within a specific knowledge domain [12]. This approach is particularly relevant for understanding the growth, structure, and conceptual relationships of research fields in education and technology [13].

The data for this study were obtained from the Scopus database (www.scopus.com) because of its comprehensive coverage of peer-reviewed literature and structured metadata. Data retrieval was conducted on June 28, 2025, using the search query: TITLE-ABS-KEY ("blended learning" AND "learning management system"). The initial search produced 932 documents. A two-stage filtering process was then applied to ensure dataset relevance and quality: By publication type: only journal articles, conference papers, book chapters, and conference reviews were retained; non-peer-reviewed materials (editorials, notes, letters) were excluded. By language: only English-language documents were included to maintain consistency and accessibility for global readers. After filtering, 890 documents were selected as the final dataset. This process represents a systematic document sampling technique, ensuring that only relevant and high-quality research outputs were included. The workflow is presented in Figure 1, illustrating the data collection, filtering, processing, and analysis stages.

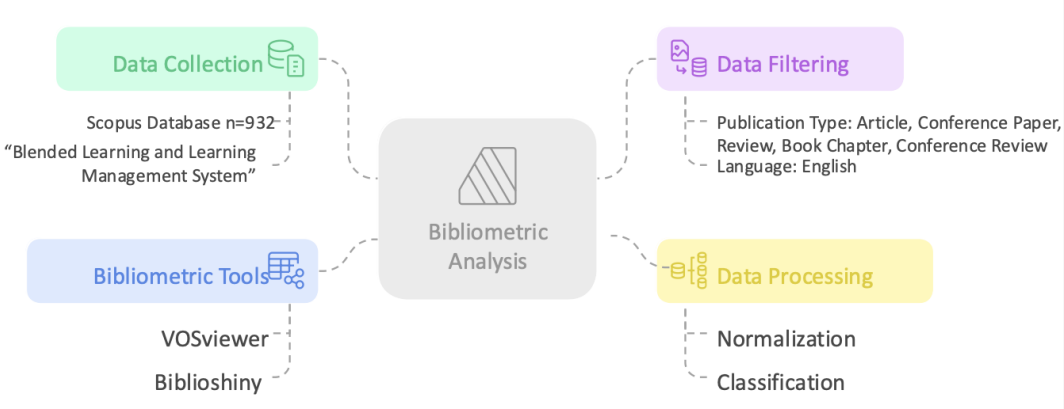

Figure 1. Framework of Bibliometric Analysis for Blended Learning and LMS Research

All selected documents were exported in CSV, BibTeX, and RIS formats to preserve metadata such as author names, institutional affiliations, publication year, source title, and citation count. Data validation was conducted through: Normalization: standardizing variations in author and institution names. De-duplication: removing duplicate or incomplete records. Reproducibility checking: ensuring that search results could be replicated with the same query and date parameters. These steps serve as the bibliometric equivalent of *instrument reliability and validity testing* in quantitative research, guaranteeing the accuracy and consistency of data used in the analysis.

This study utilized several bibliometric indicators to assess research performance, structural relationships, and thematic development within the field. Publication output was examined based on the total number of documents published annually, as recorded in Scopus metadata**.** Citation impact was measured through the total number of citations received per document, using the "Cited by" field available in the Scopus database. Authorship productivity was analyzed by calculating the number of publications attributed to each author, aggregated through Scopus author identification data. To explore conceptual linkages, keyword co-occurrence was evaluated according to the frequency and strength of connections among author-provided keywords, with visualization conducted using VOSviewer software. Country collaboration was assessed through the degree of international co-authorship, quantified using the Multiple Country Publications (MCP) ratio to determine the extent of global research interaction. Lastly, thematic evolution was analyzed to trace the progression of dominant research topics over time, employing thematic mapping and trend analysis features available in Biblioshiny. Together, these indicators provided a comprehensive understanding of the productivity, impact, and intellectual structure of blended learning and LMS research.

Two main tools were used for analysis: VOSviewer (version 1.6.19): used to visualize co-authorship, keyword co-occurrence, and citation networks [15]. Biblioshiny (R-based application): used to perform thematic evolution analysis, co-citation mapping, and trend topic identification based on the Bibliometrix R package [12]. These software tools are widely recognized and validated in bibliometric studies and serve a role analogous to SmartPLS or AMOS in structural modeling but specifically for science mapping and bibliometric visualization. Their combined use provides both statistical rigor and visual interpretability. This study acknowledges potential limitations. Using only the Scopus database may omit relevant literature indexed in other sources such as Web of Science or Dimensions. Additionally, keyword-based searches may overlook papers using alternative terminology. Nevertheless, the systematic data selection, normalization, and use of validated bibliometric tools ensure high methodological transparency, reliability, and reproducibility of findings.

3. RESULTS AND DISCUSSION

3.1. Yearly Tren of Publication and Citations

The analysis of 890 documents retrieved from Scopus reveals a significant dynamic of research growth in the topics of blended learning and LMS during the period 2003-2025. The results of the study show that at the beginning of the observation period, precisely in 2003, there was only one article discussing this topic. However, there was a gradual increase, reaching 25 publications by 2009. More significant growth was observed starting in 2010, coinciding with the increasing demand for online learning systems and the integration of technology in education. The most significant spike occurred in 2019 when the number of publications reached 84 articles. This peak marks the intensive phase of LMS adoption globally, particularly in response to the demands of flexible learning triggered by technological developments and the post-pandemic preparedness for digital education.

Following the period from 2019 to 2021, which saw consistent publication of over 68 articles per year, the trend began to decline. The number of articles in 2022 was recorded at 70, dropping to 58 in 2023 and reaching 24 in 2025. Although the 2025 figure is relatively low, it is essential to note that this data was obtained in the middle of the year, so additional publications may still be forthcoming. This decline can also be interpreted as a sign of the maturity of this topic in academic studies, or a shift in research focus on more sophisticated ones, such as adaptive learning and artificial intelligence-based systems [13]. The temporal pattern of publication output is visually presented in Figure 2, which clearly delineates three key phases: initiation (2003–2008), rapid expansion (2009–2019), and stabilization or decline (2020–2025). These phases illustrate the growing academic recognition of LMS and blended learning as integral elements in the transformation of modern education.

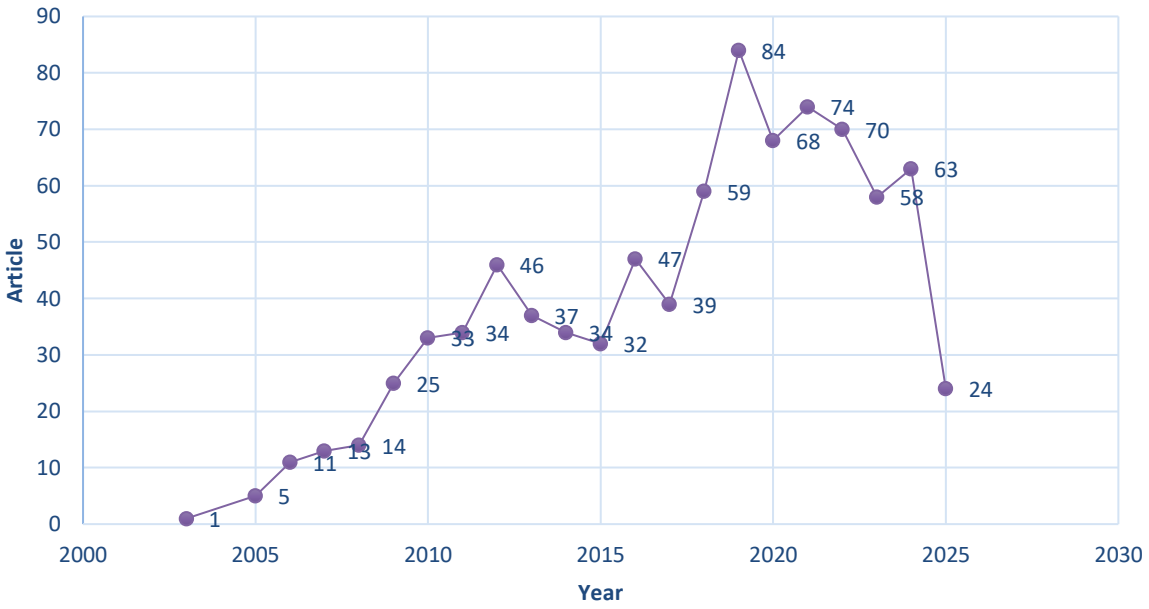

Figure 2. Trend in the number of scientific publications per year from 2003 to 2025

These findings address Research Question 1, confirming a clear longitudinal growth in publications on blended learning and LMS from 2003 to 2025. The pattern of adoption aligns with Rogers' (2003) *Diffusion of Innovation Theory*, which explains that educational technology integration typically progresses from early adoption to maturity as institutional readiness increases.

The momentum behind this topic is further supported by citation data. Table 1 highlights the most highly cited studies within the corpus. For instance, the study by [22] on medical students' perceptions of e-learning during the COVID-19 closures has received 130 citations, indicating its substantial impact. Similarly, [23] explored the determinants of student satisfaction in blended learning environments and received 112 citations. These highly cited works span disciplines from health education to learning analytics and demonstrate the interdisciplinary nature of LMS research.

Table 1. Highly cited blended learning and learning management system research

Rank	Title	Year	Source Title	Cited	Ref.
1	Medical Students' Acceptance and Perceptions Of E-Learning During the Covid-19 Closure Time in King Abdulaziz University, Jeddah	2021	Journal Of Infection and Public Health	130	[22]
2	Who Or What Contributes to Student Satisfaction in Different Blended Learning Modalities?	2017	British Journal of Educational Technology	112	[23]
3	The Role of Social Network Analysis as A Learning Analytics Tool in Online Problem-Based Learning	2019	BMC Medical Education	95	[24]
4	The Relationship Between Student Engagement with Online Content and Achievement in A Blended Learning Anatomy Course	2018	Anatomical Sciences Education	86	[25]
5	"I Am Still Learning": Modeling LMS Critical Success Factors for Promoting Students' Experience and Satisfaction in A Blended Learning Environment	2018	Ieee Access	80	[26]
6	Effectiveness Of Blended Learning in Nursing Education	2020	International Journal of Environmental Research and Public Health	77	[27]
7	Improvement In Student Performance and Perceptions Through a Flipped	2021	Anatomical Sciences Education	72	[28]

Rank	Title	Year	Source Title	Cited	Ref.
	Anatomy Classroom: Shifting from Passive Traditional to Active Blended Learning				
8	Learning Objects in Medical Education	2006	Medical Teacher	72	[29]
9	How The Study of Online Collaborative Learning Can Guide Teachers and Predict Students' Performance in A Medical Course	2018	BMC Medical Education	70	[30]
10	Evidence-Based Principles for Using Technology-Enhanced Learning in The Continuing Professional Development of Health Professionals	2017	Journal Of Continuing Education in The Health Professions	61	[31]

The citation patterns suggest that LMS-related research cuts across multiple disciplines, notably health education, information systems, and pedagogical innovation. This interdisciplinary structure supports Garrison and Vaughan's (2008) model of blended learning, which integrates technological, pedagogical, and social dimensions of education to enhance learning outcomes.

3.2 Most Relevant Sources

In bibliometric studies, analyzing publication sources is an important step in identifying journals or proceedings that consistently contribute to the development of a field. These sources represent the primary repositories of knowledge dissemination and innovation within the academic community. Monitoring the productivity of sources over time also helps to assess the stability and growth of interest in a particular topic. In the context of blended learning and LMS, it is important to know which sources have been active since the beginning and which continue to experience increasing contributions. Figure 3 presents a cumulative visualization of publications from various sources over the period 2003-2025.

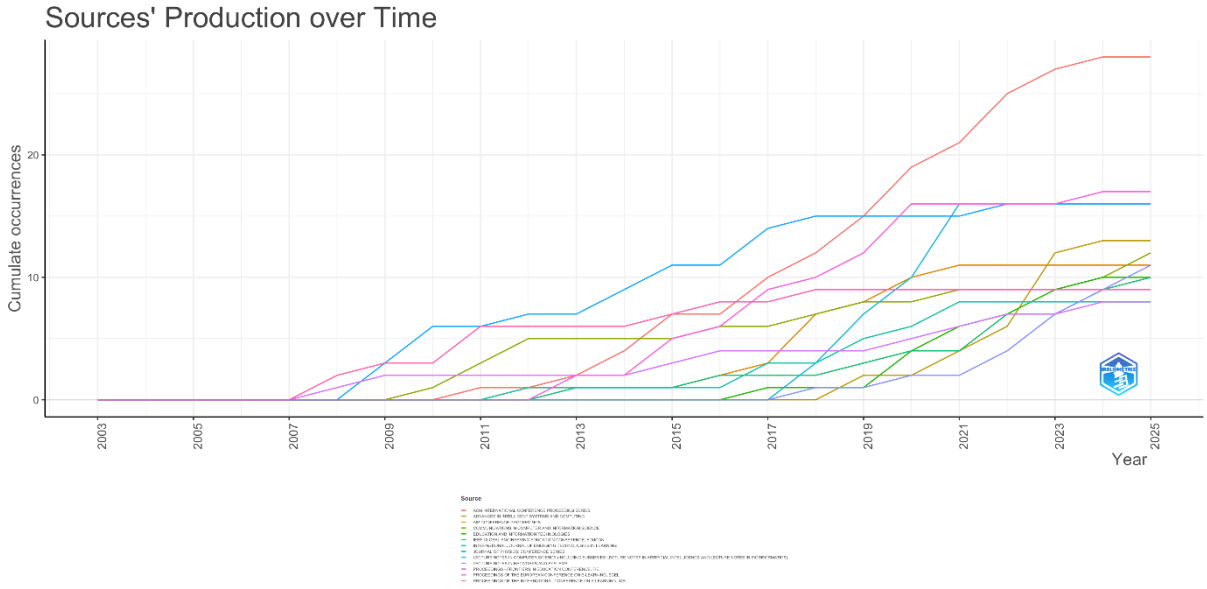

Figure 3. Sources publication trajectories (2003-2025)

According to the visualization, IEEE Access, Computers and Education, and Educational Technology and Society have shown sustained and increasing contributions, particularly since 2010. The sharpest rise occurred post-2018, likely reflecting a surge in digital education discourse following the pandemic. Each trajectory line in the figure represents a specific source, highlighting its publication footprint and sustained scholarly activity over time.

Further insights are offered in Table 2, which presents the top ten most relevant sources based on document count, citation volume, and bibliometric link strength. Notably, Computers and Education, while contributing only six documents, has garnered 1,101 citations, indicating an exceptionally high impact per article. In contrast, IEEE Access, which appears most connected within the bibliometric network, has published seven articles, accumulating 233 citations. Other proceedings, such as Lecture Notes in Computer Science and

Lecture Notes in Networks and Systems, show high document counts but lower citation metrics, suggesting that these contributions might be more technical in nature or still emerging in influence.

Table 2. Top 10 Source Titles Contributing to Blended Learning and LMS

Rank	Relevant sources	Document	Citation	Total link strength
1	Lecture notes in computer science (including subseries lecture notes in artificial intelligence and lecture notes in bioinformatics	16	136	1
2	Educational and information technologies	10	543	2
3	Lecture notes in networks and system	11	20	3
4	Advances in intelligent system and	11	74	0
5	Iee access	7	233	6
6	Computers and education	6	1101	5
7	Educational technology and society	6	288	4
8	International journal of information and education technology	6	47	1
9	Electronic journal of e-learning	5	243	2
10	Turkish online journal of distance education	5	35	1

These results answer Research Question 2 by identifying the primary publication sources shaping the knowledge base of blended learning and LMS research. The prominence of *Computers & Education* and *IEEE Access* illustrates how technological innovation and pedagogical inquiry coexist, echoing Price's and Kirkwood argument that effective technology integration in education depends on both technical and pedagogical advancement [32].

3.3 Most Influential Authors

The identification of leading contributors in the field of blended learning and LMS is critical to understanding the thematic depth and collaborative dynamics within this research landscape. One of the key visual tools used to illustrate this relationship is the Sankey diagram, as shown in Figure 4. This diagram connects three essential elements: the country of the author, the most active individual researchers, and the dominant keywords they use in their publications. Figure 4 presents how scholarly production is distributed across geographic locations and linked to thematic interests.

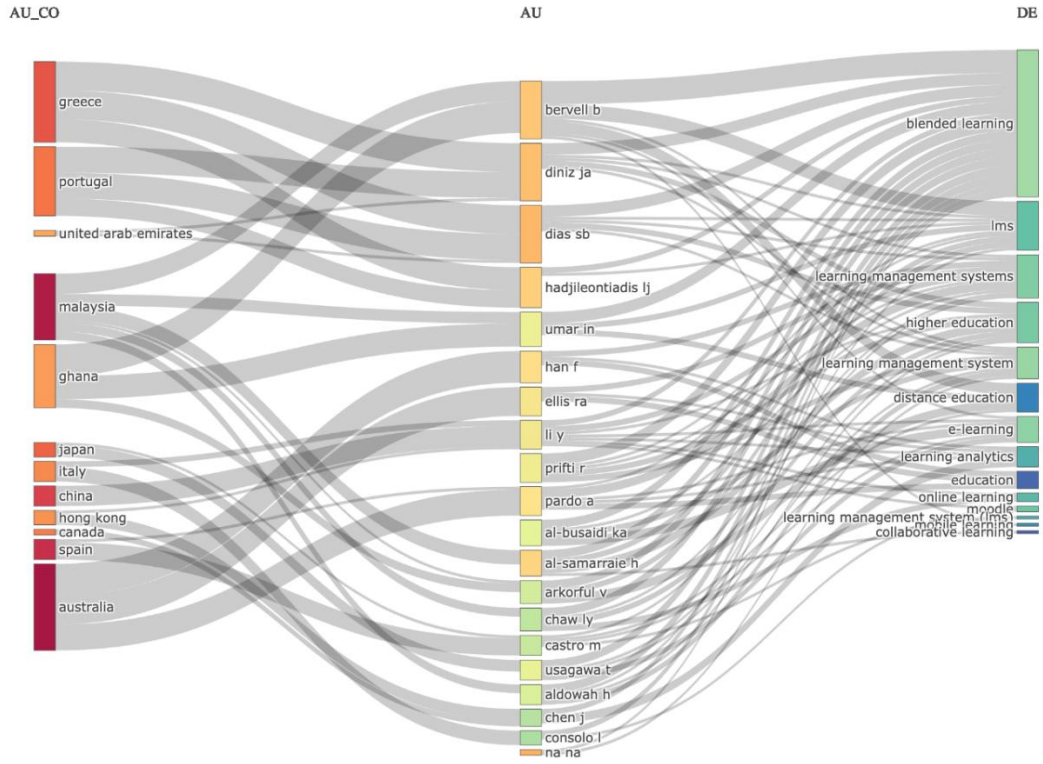

Figure 4. Sankey diagram of country–author–keyword relationships

The diagram illustrates how countries like Malaysia, Portugal, and Australia are notable for producing leading scholars in the field, such as Bervell B and Diniz JA. These scholars have made significant contributions to the development of topics such as blended learning, higher education, and distance education. Each author, while working within similar themes, shows variation in research focus. For example, have been instrumental in developing learning analytics dashboards tailored to higher education settings. On the other hand, [33] delve into personalized blended learning frameworks, particularly for engineering students in China. Authors such as [34] push the boundaries further by exploring how intelligent systems can be embedded into LMS platforms. [35] contribute to the understanding of cross-country adoption models, and [36] emphasize the importance of digital literacy and student engagement in hybrid learning environments. Additionally, the work of [37], [38] ties student self-regulation with learning analytics, offering valuable perspectives on how data can enhance teaching strategies.

Expanding the analysis further, Figure 5 captures the productivity trends of individual authors over the study period from 2003 to 2025. This temporal overview sheds light on the consistency and intensity of scholarly contributions across time. Figure 5 illustrates that authors such as Bervell, Dias, and Diniz have maintained steady research output, particularly between 2017 and 2019. Their work has garnered substantial citation counts, indicating not only volume but also impact. Other contributors, such as [39], emerged strongly during the late 2010, aligning with the peak phase of blended learning research. Some researchers, including [40] and [41], demonstrated shorter but influential publication spans, often producing high-impact work within condensed periods. Conversely, others, such as [42] and [43] reflect more sporadic involvement, contributing to isolated instances. This mix of long-term and episodic contributions portrays a rich and dynamic field, with both established and emerging voices influencing its direction. These findings respond to Research Question 3 by identifying authors whose sustained contributions have shaped the intellectual structure of the field. The consistent productivity of scholars such as Bervell and Diniz indicates the formation of an intellectual core, consistent theory of co-citation clusters, which posits that recurring author networks define the conceptual development of a scientific discipline.

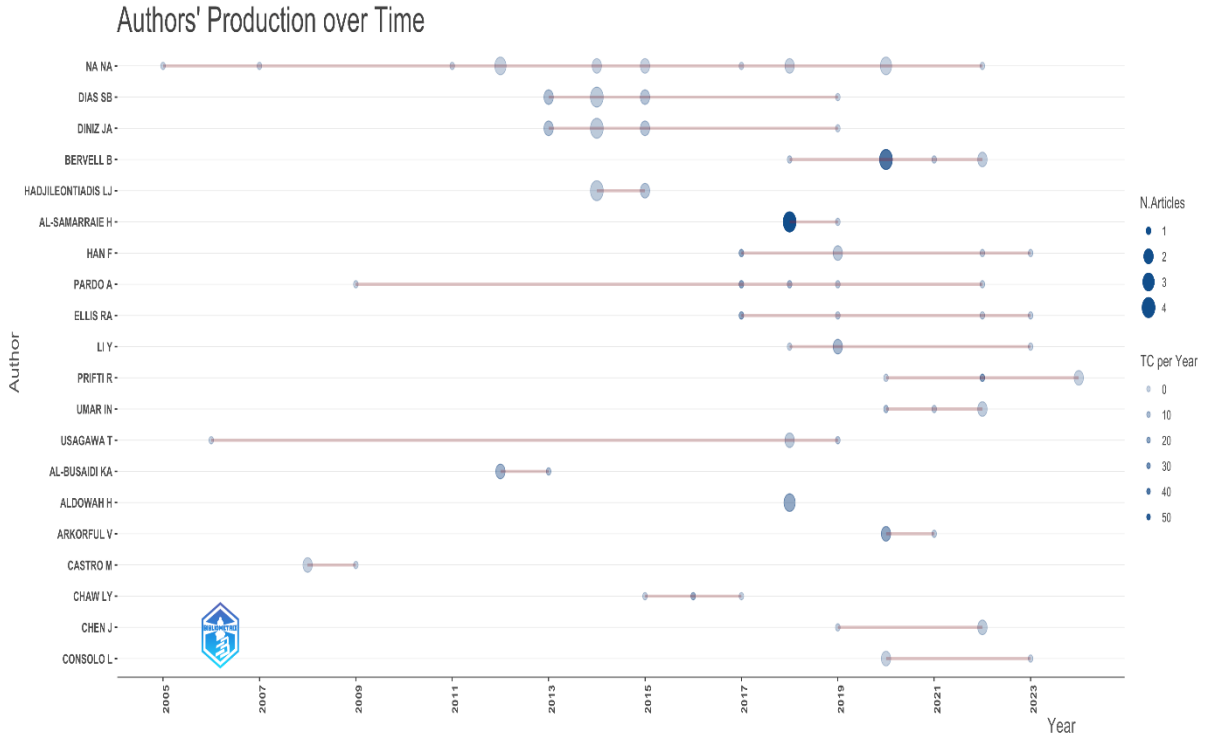

Figure 5. Authors' scholarly productivity over time

3.4 Most Influential Countries

Figure 6 provides a breakdown of national research activity, distinguishing between single-country publications (SCP) and multiple-country publications (MCP). This distinction is crucial for understanding the balance between domestic focus and international collaboration. Data indicate that Indonesia and Australia are among the top contributors in terms of publication volume. These countries exhibit strong domestic research ecosystems that support continuous scholarly output. In contrast, nations such as Saudi Arabia, China, and the United States demonstrate high levels of international collaboration, as reflected in their MCP scores. This suggests a broader engagement with global academic networks and a capacity to influence cross-border research

directions. Countries like Malaysia and India also emerge as important contributors, balancing national publication output with strategic partnerships. These patterns reinforce the idea that both localized research strength and international collaboration are vital for advancing knowledge in the educational technology domain.

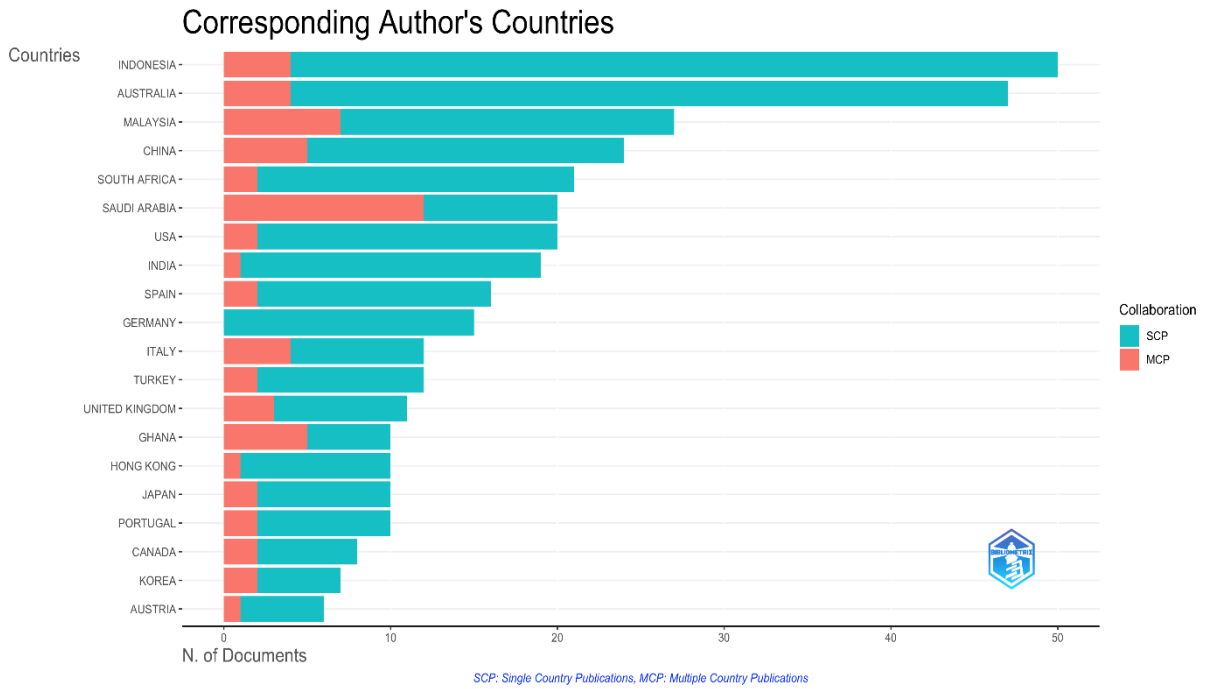

Figure 6. Geographical collaboration: single-country vs multiple-country publication

Further reinforcing this point, Figure 7 presents a bibliographic coupling map that illustrates the interconnectedness between countries. The United States stands out as a dominant node, characterized by its extensive research ties spanning the globe. Indonesia, Australia, and India also display significant connectivity, suggesting that these countries serve as regional hubs for LMS and blended learning research.

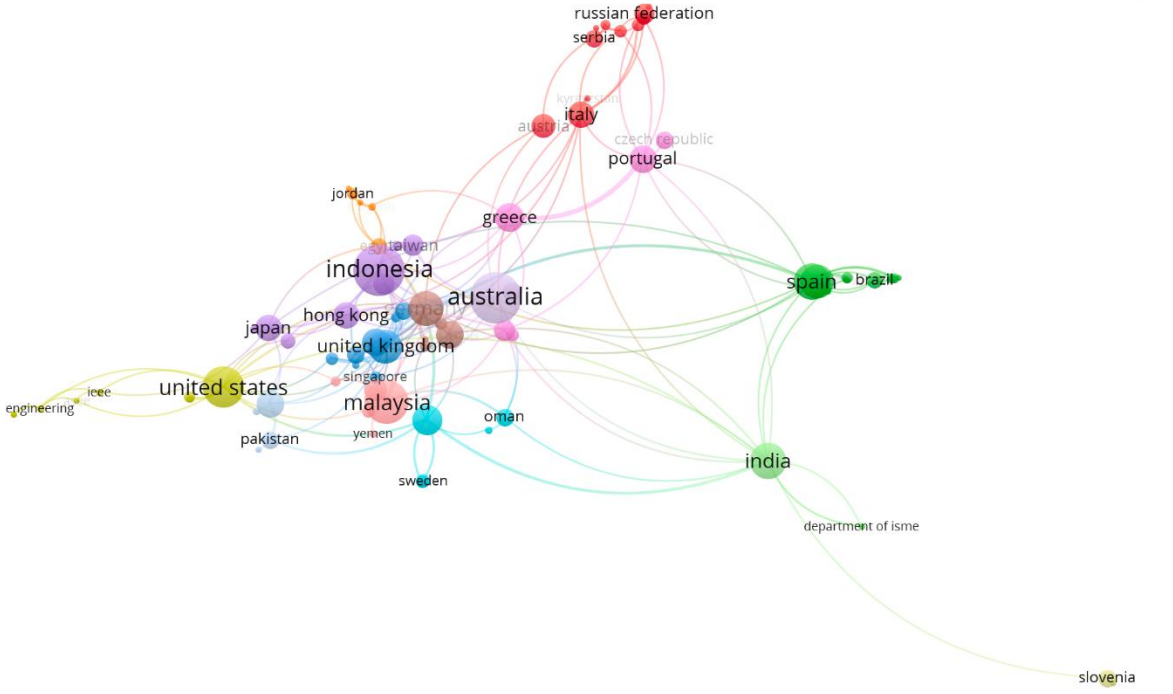

Figure 7. Bibliographic coupling map of countries

The clustering visible in Figure 7, such as the European grouping (Portugal, Italy, Greece), the Asian cluster (Indonesia, Japan, Malaysia), and the Latin American presence (Brazil), reveals how thematic interests

and regional contexts influence global collaboration. These clusters suggest that cultural, policy, and technological similarities may guide research priorities and foster more intensive academic exchange. The results directly address Research Question 4, showing how national research systems and collaborative capacities influence productivity in LMS and blended learning research. Countries with strong international partnerships, such as Indonesia and Australia, demonstrate that collaboration intensity positively correlates with research visibility and impact.

3.5 Most Relevant Keywords

Keyword analysis plays a crucial role in mapping the intellectual structure and thematic evolution of research on blended learning and LMS. The visualization in Figure 8 utilizes a tree map to illustrate the frequency and relative importance of keywords used by authors in this field. Among the terms, "blended learning" stands out with the highest frequency, appearing 448 times and representing approximately 29% of all keyword instances. This underscores its centrality in current academic discourse. Closely following are keywords such as "learning management system" (143 mentions), "e-learning" (135 mentions), and "learning management systems" (84 mentions). This cluster highlights the interdependence between pedagogical frameworks and the digital systems that support them. Additional significant terms like "higher education," "Moodle," "student engagement," "learning analytics," and "mobile learning" indicate a rich diversity of focus areas within the field. These encompass both institutional contexts and pedagogical strategies, reflecting the evolving landscape of digital learning that continues to meet varied educational needs.

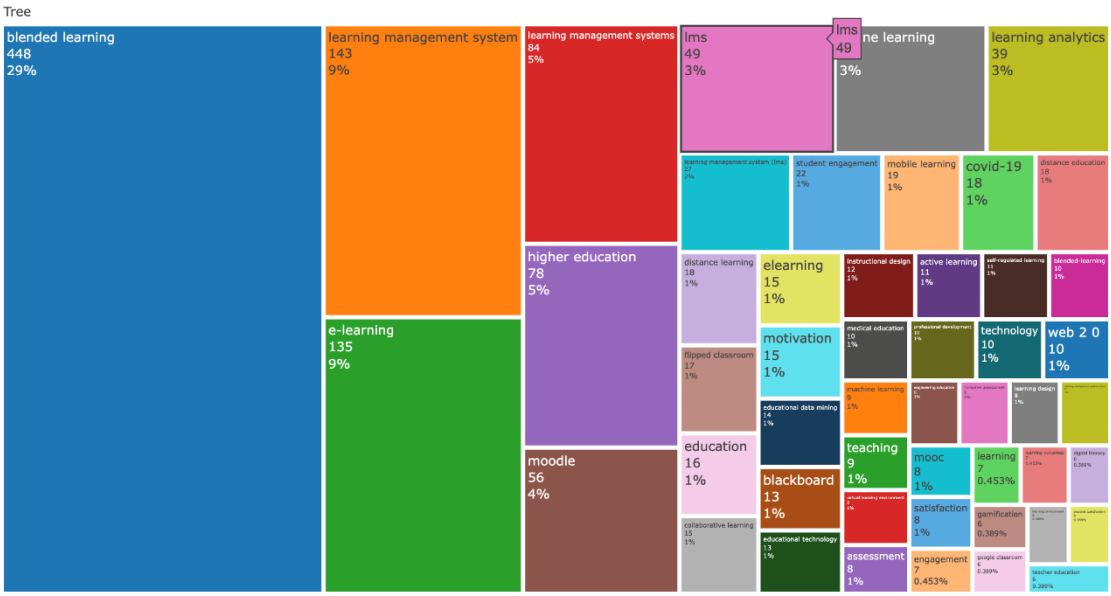

Figure 8. Tree Map of Authors' Keywords

A deeper look into how these keywords interact is shown in Figure 9, which presents a network-based keyword co-occurrence analysis. This visualization not only identifies the most frequently used terms but also explores the relationships between them, forming thematic clusters. At the center of this network lies "blended learning," which serves as a hub connected to terms such as "learning management systems," "computer-aided instruction," "e-learning," and "educational technology." These linkages point to a strong research focus on integrated digital learning environments. Additional clusters reveal thematic emphasis on elements like "learning analytics," "motivation," and "distance learning," signaling ongoing interest in evaluating learner outcomes and designing effective engagement strategies. Another branch within the network focuses on learners' experiences, incorporating terms like "student," "learning," "questionnaire," and "satisfaction." These keywords suggest a growing focus on the social-emotional dimension of digital education, particularly in light of disruptions caused by the COVID-19 pandemic. The inclusion of keywords such as "curriculum," "teaching," and "educational data mining" further indicates a strong concern for instructional design, teacher development, and the strategic use of data to enhance educational outcomes.

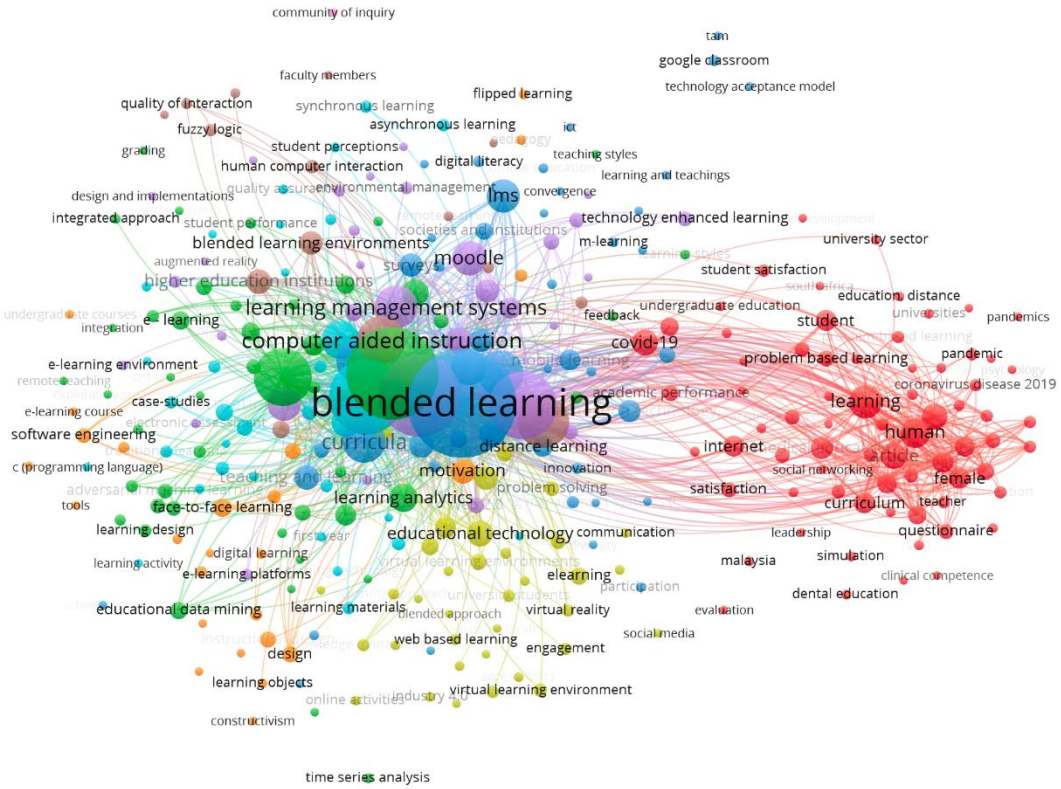

Figure 9. Keywords: co-occurrence analysis by network visualization

The dominance of keywords such as “blended learning,” “e-learning,” and “learning analytics” reaffirms their status as foundational constructs within educational technology. Conceptualization of blended learning as the integration of face-to-face and online modalities, and that LMS adoption reflects institutional digital maturity.

3.6 The Current Research Landscape

To better understand how these thematic trends change over time, Figure 10 provides a trend topics bubble chart. Each keyword is represented as a bubble, whose size correlates with its frequency, while its position indicates the time frame during which it was most prominent in the literature. Keywords such as “blended learning,” “learning management system,” and “learning analytics” dominated the 2016–2020 period, indicating a high point of scholarly attention. In contrast, earlier themes such as “m-learning,” “SCORM,” and “web 2.0” saw their relevance decline or plateau. More recently, terms such as “pedagogy,” “digital learning,” and “COVID-19” have gained prominence, reflecting the pandemic's profound impact on educational delivery and research priorities. This transition marks a shift in focus from technical innovation to the pedagogical and social aspects of technology-enhanced learning.

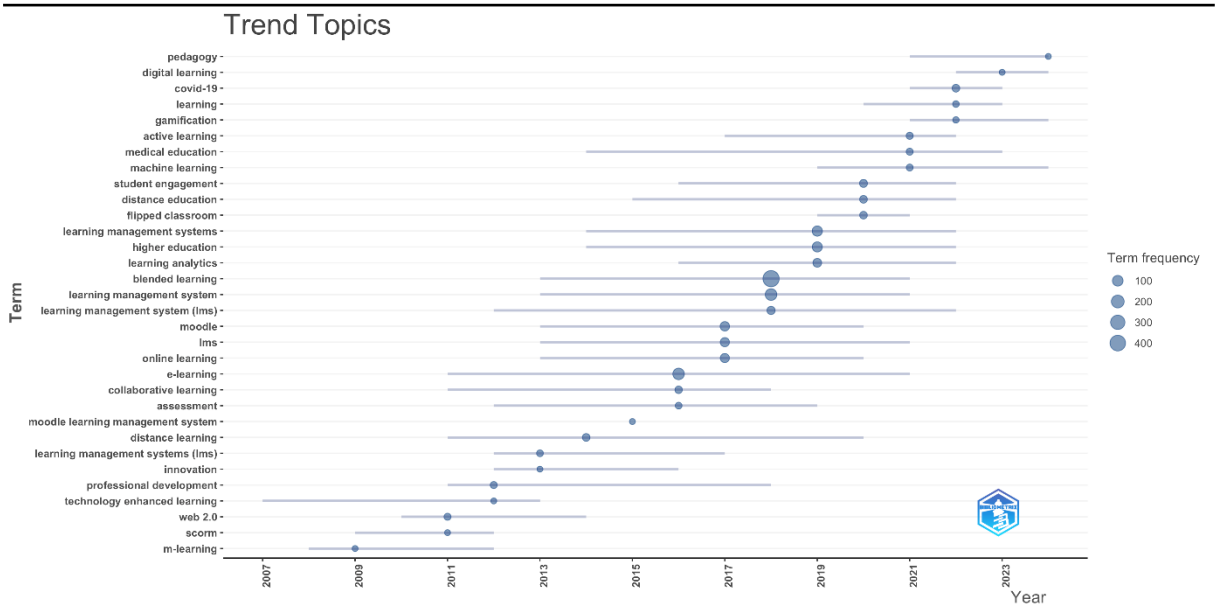

Figure 10. Trend topics of blended learning and LMS

Complementing this temporal analysis, Figure 11 illustrates a thematic map that categorizes research topics based on their centrality and density. This two-dimensional mapping divides topics into four quadrants, providing insight into both their relevance and level of development. In the upper-right quadrant, labeled “motor themes,” we find mature and highly central topics such as “computer-assisted instruction,” “curriculum,” and “humans.” These themes are foundational and act as driving forces in the field. The lower-right quadrant encompasses “basic themes” such as “blended learning,” “learning management systems,” and “e-learning,” which, although not yet highly developed, are central to ongoing discourse. On the upper left, we see “niche themes” such as “application service provision" and "employment opportunities,” which are well-developed but not widely interconnected with other themes. Finally, the lower-left quadrant includes themes like “video conferencing,” “integration,” and “autonomous learning” topics that are either emerging or declining and have limited current influence. This framework helps researchers identify not only where scholarly focus has been but also where future inquiry might be headed.

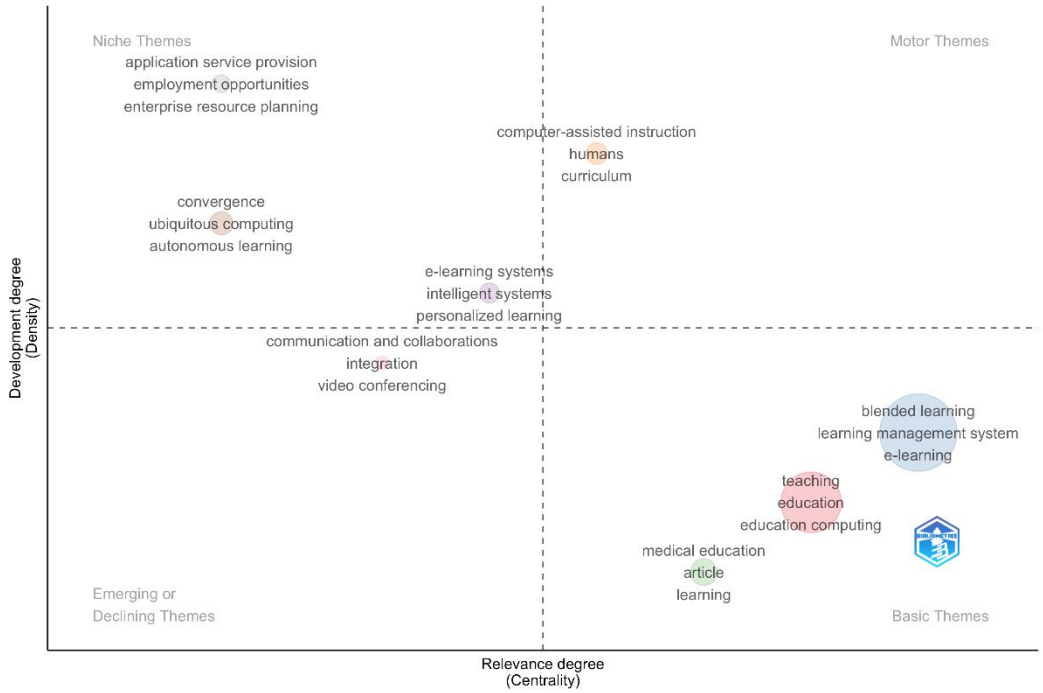

Figure 11. Thematic map of blended learning and LMS

The thematic evolution illustrated in Figures 12, 13, and 14 clearly shows the progressive development and diversification of research themes related to blended learning and LMS across three distinct periods: 2003-2012, 2013-2018, and 2019-2025. In the earliest phase (2003–2012) as shown in Figure 12, the size of each term corresponds to its frequency and significance in scholarly literature, highlighting the areas that have garnered substantial attention. Dominant themes, including "blended learning," "learning management system," "e-learning," and "education," underscore the core focus areas within contemporary research. The significant presence of these terms indicates a widespread scholarly interest in integrating technology-enhanced instructional strategies into educational practices, particularly within higher education contexts. Additionally, terms such as "distance," "online," "virtual," and "moodle" suggest extensive exploration of digital platforms and technologies used to facilitate remote and blended learning environments. The prominence of "assessment," "evaluation," and "student" reveals a robust emphasis on evaluating educational outcomes, learner performance, and student engagement in digitally-supported educational settings. Other terms, including "collaborative," "interactive," "simulation," and "language," reflect the diverse pedagogical methodologies being integrated within LMS frameworks to enhance learning experiences. These keywords indicate an evolving research trajectory emphasizing active, collaborative, and interactive learning modalities, which leverage advanced technologies to provide enriched educational experiences.

Figure 12. Thematic evolution of blended learning and LMS period 2003-2012

Figure 13. captures the evolution of research between 2013 and 2018, during which blended learning and LMS became more deeply embedded in educational discourse. Core concepts such as "blended learning," "learning," "learning management," and "management system" feature prominently, underscoring the centrality of blended educational approaches facilitated by LMS platforms in recent educational research. The significant appearance of terms like "e-learning," "higher education," and "education" highlights a clear scholarly interest in deploying digital and blended learning models, particularly within higher education contexts. Further examination of the cloud reveals themes such as "learning analytics," "technology," "online," and "moodle," reflecting an increased focus on leveraging technological tools and analytical methods to enhance learning experiences and outcomes. The consistent presence of "student," "assessment," and "interaction" demonstrates a strong research interest in evaluating student performance, engagement, and interactive pedagogies within LMS-supported educational frameworks. Moreover, terms such as "mobile," "collaborative," "communication," and "digital" indicate evolving research trends aimed at integrating interactive and collaborative methodologies using various digital technologies. These terms collectively suggest a research trajectory moving towards more comprehensive, personalized, and technology-enhanced educational practices.

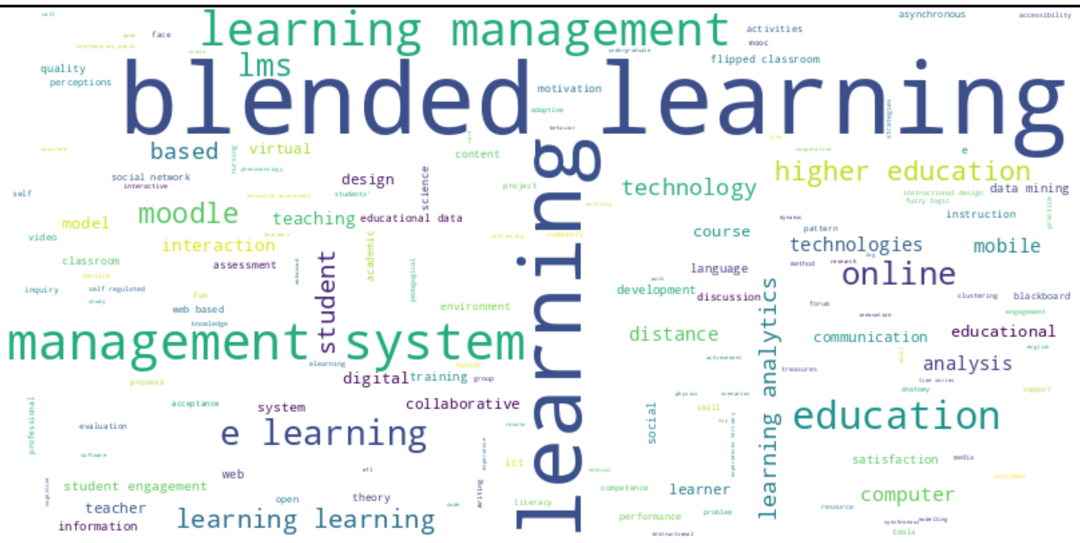

Figure 13. Thematic evolution of blended learning and LMS period 2013-2018

Continuing this trajectory, Figure 14 illustrates the thematic landscape from 2019 to 2025, reflecting current priorities and trends in the field. Terms such as "blended learning," "learning management," "management system," and "education" appear prominently, indicating a significant emphasis within contemporary studies on integrating blended learning methodologies with robust LMS frameworks. The repeated emphasis on these themes reveals the widespread adoption and exploration of digital platforms for delivering education, particularly in higher education contexts. The substantial presence of terms including "e-learning," "online learning," and "student" further highlights a clear scholarly focus on digital educational modalities and their impact on student engagement and outcomes. Additionally, themes like "learning analytics," "performance," and "assessment" indicate a robust interest in applying analytical tools and evaluative methodologies to measure and enhance educational effectiveness within blended learning environments. Furthermore, terms such as "interactive," "technology," "virtual," "mobile," and "collaborative" reveal a strong research inclination towards incorporating interactive and collaborative technologies into educational practices, emphasizing innovative, student-centered, and technology-enhanced pedagogical strategies. In conclusion, this word cloud succinctly captures current scholarly emphases, highlighting the intersection of advanced technologies, data-driven methodologies, and interactive educational practices in the ongoing evolution of blended learning and LMS-supported education.

Figure 14. Thematic evolution of blended learning and LMS period 2019-2025

A bibliometric analysis of 890 documents indexed in the Scopus database reveals a clear trajectory in the development of research on blended learning and Learning Management Systems (LMS) between 2003 and 2025. Three distinct temporal phases emerge: the initiation phase (2003–2008), the rapid expansion phase (2009–2019), and the stabilization phase (2020–2025). During the initial period, research activity was limited,

with a primary focus on system implementation and user acceptance. As digital technologies matured, particularly after 2010, scholarly interest in LMS increased significantly, peaking in 2019 with 84 publications. Similar longitudinal trends in publication growth have also been observed in previous bibliometric analyses of blended learning [44]. This surge can be attributed to the widespread adoption of LMS in higher education and the increasing demand for flexible learning environments, especially during and after the COVID-19 pandemic [1], [17]. Although a slight decline in publication volume is observed after 2020, this does not necessarily indicate a reduction in interest. Instead, it reflects a paradigm shift toward more sophisticated topics, such as AI-powered adaptive learning systems and the integration of lifelong learning [13]. This emerging focus on artificial intelligence and adaptive learning reflects the broader movement toward intelligent digital ecosystems in higher education [45].

Analysis of publication sources reveals that *Computers & Education* stands out in terms of citation impact, despite publishing fewer articles, indicating its strong academic influence. Meanwhile, journals such as *IEEE Access* and *Educational Technology & Society* demonstrate consistent productivity, signifying a sustained commitment to the development of the field. These findings support the argument by Aria and Cuccurullo, that identifying central publication outlets is critical to understanding thematic progress within scientific disciplines. This observation aligns with findings from long-term topic modeling analyses that highlight *Education and Information Technologies* and *Computers & Education* as central journals in educational technology research [46].

The United States, Indonesia, and Australia emerged as the leading contributors in terms of publication output and international collaboration. Bibliographic coupling and multiple country publications (MCP) analysis illustrate the strategic roles of countries such as the U.S., Saudi Arabia, and China as central nodes in the global research network. These results align with those of [18] who highlighted the importance of transnational collaboration in advancing emerging research domains. Further insights from the Sankey diagram demonstrate strong connections between prolific authors and core thematic keywords, with notable institutional contributions from Malaysia and Portugal. This suggests that although the field is globally distributed, its thematic orientation is often shaped by local educational priorities and technological capabilities.

Co-occurrence network and tree map analyses indicate that “blended learning,” “learning management system,” and “e-learning” remain the most frequently occurring keywords, underscoring their centrality in contemporary educational discourse. Emerging terms such as “learning analytics,” “gamification,” and “artificial intelligence” point to a growing interest in data-driven and intelligent education technologies [1], [4]. This pattern echoes recent reviews emphasizing the role of learning analytics and engagement metrics in enhancing learner-centered design [47]. Keyword trend analysis illustrates a thematic evolution: earlier studies focused on foundational technologies such as “Web 2.0” and “SCORM,” whereas recent research emphasizes learner-centered innovations including “digital pedagogy,” “active learning,” and “adult learning.” These trends align with the findings of [6] who documented a pedagogical shift from system-centric to learner-centric design. Recent bibliometric syntheses confirm that these core concepts continue to dominate global blended learning research, reflecting a sustained pedagogical and technological integration trend [48].

Thematic mapping positions “blended learning” and "LMS" within the basic themes’ quadrant, indicating their foundational yet continually evolving significance. In contrast, themes such as “computer-assisted instruction” and “curriculum” appear as motor themes, reflecting their maturity and influence within the field. However, recent critiques caution that the growing dominance of analytical approaches sometimes overshadows pedagogical depth in learning design [49]. Niche themes, including “application service provision” and “employment opportunities,” are emerging but remain peripheral. Thematic evolution analysis supports this progression. Early studies (2003–2013) emphasized infrastructural development and system implementation. The middle phase (2014–2019) saw pedagogical integration of LMS into teaching practices. The most recent phase (2020–2025) is characterized by a focus on “teaching,” “students,” and “adult learning,” signifying an expansion of LMS application beyond formal education to lifelong and professional learning contexts [8].

This study's main contribution lies in its comprehensive, longitudinal bibliometric mapping of global research on blended learning and LMS. It captures the field’s evolution across time, identifies influential contributors, and highlights underexplored areas. Notably, future studies are encouraged to investigate themes such as autonomous learning, the application of LMS in non-formal education, and the integration of artificial intelligence topics that currently remain marginal but hold significant transformative potential. As suggested by [16], [17] incorporating additional databases such as Web of Science or Dimensions may enhance the robustness and generalizability of future analyses. Moreover, interdisciplinary research approaches could offer richer contextual interpretations and broader applicability across diverse educational domains. In summary, this study presents a data-driven and globally representative knowledge map that can inform future strategies for adaptive, inclusive, and future-ready digital education systems, benefiting educators, researchers, and policymakers alike. Unlike previous short-range bibliometric analyses [50], this research provides a two-decade overview, capturing a broader thematic and structural evolution of the field.

4. CONCLUSION

This study provides a longitudinal bibliometric analysis of blended learning and learning management systems (LMS) research from 2003 to 2025, revealing how global scholarship has evolved over two decades. The findings indicate three major developmental phases initiation, rapid expansion, and stabilization demonstrating a shift from system-oriented implementation toward learner-centered, data-driven pedagogies. Theoretical contributions of this study lie in its integration of bibliometric evidence with educational technology theories. By aligning publication and thematic patterns with the *Diffusion of Innovation Theory* and *Technology Acceptance Model*, this research deepens understanding of how technological innovation in education transitions from experimentation to institutionalization. It also contributes methodologically by mapping the intellectual structure and collaboration networks that shape this domain, providing a foundation for future bibliometric and meta-analytical studies. Practical and policy implications emerge from the identification of global research trends and collaboration patterns. The prominence of countries such as the United States, Indonesia, and Australia underscores the role of national policy and institutional support in advancing digital learning. These insights can guide governments, universities, and funding agencies in designing evidence-based strategies for capacity building, digital infrastructure, and cross-national research partnerships. While this study offers a comprehensive perspective, it acknowledges several limitations, including the reliance on Scopus as a single database and potential omissions of non-English publications. Future research should integrate data from multiple databases and employ advanced analytical methods, such as topic modeling or machine learning, to refine the understanding of thematic evolution.

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