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Trends in Hybrid Learning Research: A Bibliometric Study of Technology-Enhanced Education (2008–2025)

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ABSTRACT

Hybrid learning, supported by technology-enhanced learning (TEL), has become a key instructional strategy in the post-pandemic era to promote flexibility, continuity, and pedagogical resilience across educational settings. Despite rapid growth in related publications, the structure, main contributors, and thematic development of hybrid learning research remain poorly mapped. This study aims to explore the development, impact, and thematic trends of hybrid and blended learning research within the broader field of technology-enhanced education from 2008 to 2025. A bibliometric analysis was performed on 55 Scopus-indexed journal articles collected through a PRISMA-guided search. Performance indicators, including total publications, citation counts, authorship patterns, and impact scores, were combined with science-mapping methods such as keyword co-occurrence and thematic clustering to identify major research streams and emerging topics. The results show a significant rise in research output after 2019, with publication volume peaking in 2025, indicating increased scholarly focus during and after the COVID-19 pandemic. A core group of highly cited studies forms the foundation of the field, focusing primarily on learning effectiveness, student engagement, instructional design, and digital transformation. However, perspectives from educators, institutional preparedness, and equity issues are less explored. These findings offer a structured overview of the evolution and influence of hybrid learning research and suggest evidence-based directions for future studies and policy in technology-enhanced education.

1. Introduction

Over the past twenty years, education systems worldwide have undergone structural changes driven by rapid advances in digital technology. Teaching and learning processes are now increasingly facilitated by online platforms, learning management systems, data analytics, and networked communication tools. In pursuit of flexibility, resilience, and scalability, institutions have shifted instructional models that combine digital and physical elements from supplementary options to central components of educational reform.

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Within this shift, hybrid learning has become a key instructional model that blends face-to-face and online participation within a unified course design. Often seen as an extension of blended learning, hybrid formats merge synchronous and asynchronous activities to broaden access while enabling interaction and personalized engagement [1,2]. The rapid growth of digital infrastructure, combined with institutional adaptation during the COVID-19 pandemic, accelerated adoption across primary, secondary, and higher education sectors [3,4].

Empirical and review studies have explored the pedagogical effectiveness of hybrid and blended approaches. Kazu and Yalçın [2] showed, through a meta-analysis, that hybrid instruction often yields academic outcomes comparable to or better than those of traditional face-to-face teaching. Castañón *et al*., [3] argued that maintaining structured in-person interaction while providing remote participation options is essential for instructional continuity. Gamage *et al*., [5] identified increased engagement and flexibility as key benefits, especially when synchronous and asynchronous components are carefully aligned. However, other research indicates that hybrid delivery can increase instructional complexity, faculty workload, and technological demands [4,6].

Recent research also places hybrid learning within broader digital transformation and institutional readiness processes. Li *et al*., [7] noted that although faculty recognize the strategic potential of hybrid models, challenges related to managing interaction and workload persist. Wood *et al*., [8] further documented the cognitive and emotional pressures faced by instructors in synchronous hybrid settings. These findings suggest that the success of hybrid learning relies not only on technological infrastructure but also on coordinated pedagogical design and ongoing institutional support.

Despite the growing volume of research, the literature remains fragmented. Many studies focus on effectiveness, engagement, or localized implementation, yet few systematically analyze the intellectual structure, key contributors, citation networks, and thematic development of hybrid learning research over time. Although bibliometric studies have addressed broader topics such as blended learning [9,10] and technology-enhanced education in general [11], a detailed bibliometric map specifically focused on hybrid learning within the technology-enhanced learning field for the period 2008–2025 is still missing.

Therefore, this study performs a systematic bibliometric analysis of research on hybrid and blended learning in technology-enhanced education from 2008 to 2025, based on Scopus-indexed publications. The analysis reveals publication trends, influential authors and sources, collaboration networks, highly cited works, and both established and emerging thematic clusters. By mapping the field's intellectual structure, this study clarifies the development of hybrid learning scholarship and provides evidence-based guidance for future research and institutional planning.

1.1 Literature Review

Research on hybrid learning within technology-enhanced education has expanded rapidly, covering conceptual definitions, pedagogical design, student outcomes, and institutional transformation. However, this literature remains dispersed across disciplines and research traditions. A concise synthesis is therefore needed to clarify key themes and identify gaps, particularly regarding the overall development and structure of hybrid learning scholarship. This section reviews prior studies to establish the context and rationale for the present bibliometric analysis.

1.1.1 Conceptualising hybrid learning and technology-enhanced learning

Hybrid learning is commonly described as the deliberate integration of campus-based and online instructional activities within a single course, aiming to leverage the strengths of both environments rather than simply transferring content from one to the other [4]. In contrast to emergency remote teaching, hybrid formats are typically planned in advance, refined iteratively, and often guided by explicit pedagogical models, such as flipped classroom approaches or active learning designs, that structure how the modalities are combined [4]. In hybrid arrangements, some students attend in person while others participate online, sometimes simultaneously, which requires careful coordination of content, communication, and interaction.

Technology-enhanced learning (TEL) is a broader umbrella term that encompasses digital tools and platforms used to support teaching and learning, including learning management systems, video conferencing, adaptive learning software, and learning analytics [11]. A hybrid course can therefore be viewed as a particular application of TEL in which spatial and temporal flexibility are embedded in the learning design. In such courses, technology is not a supplementary element but a primary medium through which a substantial portion of learning occurs.

Recent systematic reviews indicate that hybrid teaching models can offer benefits in terms of flexibility, accessibility, and time management for learners, while also introducing new challenges. For example, increased flexibility may be accompanied by reduced social presence and more fragmented engagement, particularly for students who join remotely [8,13]. Instructors also report increased workload because hybrid delivery requires planning for two participation contexts and managing more complex technical arrangements [7,13]. Teaching a hybrid class often involves coordinating interactions between students in the classroom and students online, adapting assessment practices across contexts, and troubleshooting technology during delivery. These demands emphasise the importance of institutional support, such as training, technical assistance, workload recognition, and clear design principles to guide implementation [4,7,8]. Across the literature, hybrid learning is thus framed not as a simple mixture of online and offline activities, but as a technology-intensive mode of education that reshapes roles, relationships, and expectations in the learning environment.

1.1.2 Hybrid learning, graduate attributes and student outcomes

The impact of online and hybrid teaching on student outcomes and graduate attributes has received growing attention in recent years. Gamage *et al*., [12] reviewed how remote and hybrid instruction influence the development of graduate attributes, including critical thinking, collaboration, communication, and digital literacy. Their findings suggest that hybrid modes can help students achieve higher-level competencies by providing authentic, technology-rich tasks and collaborative learning opportunities. However, these outcomes depend on specific conditions, particularly intentional scaffolding, sufficient opportunities for synchronous interaction, and strong alignment between the online and face-to-face components of the curriculum [12]. Without deliberate pedagogical planning, hybrid formats may become a disconnected set of activities that reduces coherence and increases learner overload. If the online and in-person elements are poorly integrated, students may struggle to understand the overall structure of their learning, leading to confusion or disengagement.

Complementary evidence comes from an institution-wide evaluation of hybrid learning, which relies on the coherent orchestration of learning activities from an academic perspective [7]. In this mixed-methods study at a Hong Kong university, many instructors reported strong technical

readiness and acknowledged the potential of hybrid formats to support flexible participation. At the same time, they observed lower levels of student interaction, participation, and motivation in hybrid classes compared with traditional face-to-face offerings [7]. Faculty reported challenges related to monitoring and engaging online learners during class, sustaining meaningful discussion across physical and virtual contexts, and balancing attention between co-located and remote participants. These findings align with reviews of synchronous hybrid learning, which state that, although flexibility is a core benefit for students, the format places significant cognitive and emotional demands on instructors who must manage complex multimodal teaching environments [8].

Taken together, this body of work indicates that the success of hybrid learning relies not only on access to technology but also on careful pedagogical planning and institutional measures, including policies, workload distribution, and training, that acknowledge the complexity of dual-mode instruction. It also emphasizes the need to go beyond short-term satisfaction measures to assess longer-term outcomes, such as graduate skills and workforce readiness [12].

1.1.3 Digital transformation and institutional readiness

The growth of hybrid learning is closely connected to broader processes of digital transformation in higher education. Case studies of post-pandemic strategies show that decisions to adopt hybrid or blended modalities often occur alongside investments in infrastructure, faculty development, governance, and quality assurance mechanisms [14]. In a study of a private Spanish university, Paños-Castro *et al*., [14] found that the COVID-19 pandemic accelerated digital transformation but also revealed gaps in digital maturity. Although leadership positioned hybrid and online education as strategic priorities, levels of preparedness and support varied across units. Reported challenges included coordinating teaching innovation support, ensuring reliable classroom connectivity and hardware, and sustaining resources for new digital initiatives over time [14]. In this sense, hybrid and online offerings became settings where tensions between strategic ambition and operational realities were particularly visible.

Extending this line of inquiry, researchers have proposed models for assessing institutional preparedness to implement technology-enhanced education at scale. Bravo-Jaico *et al*., [15] developed a theoretical–methodological framework for evaluating digital transformation maturity in higher education institutions. The model, based on the literature and qualitative input from stakeholders, has multiple dimensions, including strategy and leadership, technological infrastructure, pedagogical processes, stakeholder engagement, and organizational culture. The framework indicates that institutions with higher digital maturity tend to integrate hybrid and technology-enhanced practices into policies, routines, and support structures, rather than treating them as isolated experiments [15].

This implies a reciprocal relationship. Well-designed hybrid initiatives can accelerate digital transformation by identifying areas for investment and change, whereas institutional readiness and maturity significantly impact hybrid learning success. Overall, the literature highlights the importance of aligning classroom-level pedagogical innovation with institutional-level strategies. When hybrid learning is pursued under supportive conditions, including reliable technology, clear policy, and professional development, it is more likely to produce positive outcomes and be maintained over time. Bibliometric analysis, as used in the present study, can help identify how often these institutional issues appear in scholarly discourse on hybrid learning and which research communities link educational technology adoption with organizational change.

1.1.4 Bibliometric and text-mining perspectives on technology-enhanced education

Given the rapid growth of research in technology-enhanced learning, bibliometric methods and text mining techniques are increasingly used to map the field's intellectual landscape. Chen *et al*., [11] conducted a large-scale bibliometric analysis of technology-enhanced higher education research using a text mining approach. Analyzing 609 papers published between 2004 and 2022, their study examined publication trends, collaboration networks, and thematic clusters. They reported sustained growth since the mid-2000s, with strong contributions from countries including Spain, the United States, the United Kingdom, Australia, Germany, China, and Turkey [11]. Co-authorship analysis suggested that institutions often form collaborative clusters within geographic regions, and the authors encouraged stronger cross-regional collaboration. Topic modeling also identified established and emerging themes, including MOOCs, artificial intelligence and big data in education, gamification for engagement, learning effectiveness and outcomes, and the pivot to online learning during COVID-19 [11]. Newer themes included academic integrity and the use of learning analytics to support teaching and assessment, reflecting evolving priorities after widespread remote assessment during the pandemic [11].

Other scholars have concentrated on specific methodologies in technology-enhanced learning. Text mining, which overlaps with natural language processing, is increasingly utilized to analyze large amounts of educational text, such as discussion posts, essays, and feedback. Takaki and Dutra reviewed applications of text mining in distance higher education [16]. They reported that these techniques are used to infer patterns of engagement, performance, and emotional indicators from learner-generated text [16]. For example, analysis of forum posts and chat transcripts can support the detection of sentiment or stress signals that may help educators identify students who need support [16]. Such work aligns with learning analytics, which uses data, including unstructured text, to improve teaching and learning processes at scale. Ahadi et al. reviewed two decades of text mining in education [17]. They documented rapid expansion in areas such as learning analytics, MOOC data analysis, and automated writing evaluation, while noting that other approaches remain underused. They also called for stronger interdisciplinary connections between technical developers and education researchers to ensure methodological advances remain aligned with pedagogical needs and theory [17].

Notably, existing bibliometric studies have rarely focused on hybrid learning as a distinct category. Hybrid and blended learning are often grouped with online learning more broadly, making it difficult to isolate patterns specific to hybrid formats [11,13]. While narrative and systematic reviews have examined hybrid learning from pedagogical and experiential perspectives [8,12], comprehensive bibliometric mapping of the hybrid learning subfield remains limited. The present study responds to this gap by focusing on hybrid learning and closely related blended learning within the broader context of technology-enhanced education. In doing so, it builds on prior bibliometric and text-mining work while providing a more granular view of how hybrid learning scholarship has evolved, who the main contributors are, which outlets publish this work, and which conceptual themes and influential publications shape the field.

By addressing the gaps identified in earlier studies, the current research provides a more accurate and current perspective on technology-enhanced learning, focusing on hybrid and blended learning in higher education. We assembled a comprehensive set of relevant literature through systematic search and selection methods, ensuring that the analysis covers the various terminology (hybrid, blended, HyFlex, etc.) used in this field. The study uses a combination of performance metrics and science-mapping techniques to identify emerging trends, leading contributors (authors, institutions, countries), key publication venues, highly cited landmark papers, and the main and emerging

thematic clusters in this area. In doing so, it directly responds to the stated Research Questions (RQs) and broadens the existing knowledge base. The results of this bibliometric analysis are expected to provide a strong foundation for future research by scholars and to offer educators and policymakers a synthesized view of the hybrid learning research landscape. Ultimately, this thorough analysis aims to deliver valuable insights that can guide future studies and help make strategic decisions to improve the use of digital technologies in teaching and learning. A summary of selected previous bibliometric studies on hybrid and technology-enhanced learning is presented in Table 1.

Table 1
Previous bibliometric studies on hybrid learning and technology

Authors	Objective	Data Source & Year Cover	TDE (Total Document Entries)	Bibliometric Attributes Examined
Raman, A., Thannimalai, R., Don, Y., & Rathakrishnan, M. [10]	Conduct a bibliometric analysis of blended learning in higher education, focusing on perception, achievement, and engagement, while mapping global scholarly networks and trends in this field.	Scopus database; documents retrieved using the keywords “blended learning," "perception," "achievement," "engagement," and “higher education”; publication years 2000–2019.	1,064 documents.	Document and source types; research productivity over time; language of publications; subject areas; most active journals; author-keyword occurrence and co-occurrence; geographical distribution by country; number of authors per document; most active authors and co-authorship networks; most influential institutions; citation analysis and highly cited articles.
Chen, H., Sun, D., Yang, Y., Looi, C-K., & Jia, F. [9]	To identify and visualize research trends in blended learning over the past decade, including development patterns, influential researchers and institutions, as well as key studies and topics in the field.	Web of Science Core Collection (SSCI); title search using “blended learning”; publication years 2013–2022.	719 studies.	Annual distribution of publications and citations; key research areas of blended learning; prolific and influential authors, institutions, and countries or regions; document co-citation networks to identify important studies and themes; and topic clusters such as course design, institutional adoption, achievement, higher education, active blended learning, flipped classroom, and communication skills.

2. Methodology

This study used data from the Scopus database as of 9 December 2025. Scopus was deliberately selected as the primary data source due to its reputation as one of the most extensive and detailed abstract and citation databases for peer-reviewed literature. Its wide disciplinary coverage, including computer science, social sciences, engineering, medicine, and the arts and humanities, is significant for this study’s focus on hybrid learning and technology-enhanced learning in education, which spans multiple fields and contexts. Scopus is also recognised for its rigorous quality control procedures and broad geographical representation, making it a suitable platform for conducting a robust bibliometric analysis. The database’s ability to provide rich metadata, such as citation counts, author affiliations, and source information, further justified its use in this research [18]. The extracted dataset encompassed various elements, including document type, source type, language, subject area,

publication year, average number of authors per document, institutional contributions, country-level distribution of publications, and dominant author and index keywords.

2.1 Search Strategy

The PRISMA-based study selection process, including identification, screening, eligibility, and inclusion stages, is illustrated in Figure 1. The review adopted the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, as recommended by Page et al. [19]. The Scopus database was used for the comprehensive search strategy, which included a refined, highly specific query to ensure precision and relevance. The following search string was entered into the Scopus search engine:

TITLE-ABS-KEY (("hybrid learning" OR "blended learning" OR "mixed learning" OR "integrated learning") AND ("student achievement" OR "academic performance" OR "learning outcomes" OR "educational success") AND ("engagement" OR "motivation" OR "participation" OR "involvement") AND ("technology" OR "digital tools" OR "e-learning" OR "online education") AND ("assessment" OR "evaluation" OR "measurement")) AND (EXCLUDE (PUBYEAR , 2026)) AND (LIMIT-TO (SUBJAREA , "SOCI") OR LIMIT-TO (SUBJAREA , "COMP")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English"))

This search strategy restricted the scope to documents indexed in the Social Sciences and Computer Science subject areas, limited to peer-reviewed journal articles, open-access publications, English-language studies, and documents in final or in-press publication stages. In addition, only articles explicitly indexed with the selected blended and technology-enhanced learning keywords were retained, ensuring that the dataset reflected the precise conceptual and practical boundaries required for a rigorous bibliometric analysis.

The search process initially identified 172 records in Scopus. During the identification stage, no duplicate records were found; however, two records from 2026 were excluded as they fell outside the time frame of this review. Scopus filtering tools automatically excluded an additional 45 records because they were tagged as ineligible due to subject area (i.e., not classified under Social Sciences, Computer Science, or Arts and Humanities). This left 125 records to screen.

During the screening phase, these 125 records were examined, and 88 were excluded by automation tools because they were not journal articles (e.g., conference proceedings, book chapters, or other non-article document types). This refinement resulted in 57 reports being requested for retrieval.

The majority of reports were successfully retrieved during the retrieval stage; however, one record could not be obtained in its entirety due to a lack of open access. The remaining reports went through the eligibility process. In total, 57 reports were reviewed for eligibility, with two being rejected because they were not written in English.

The final dataset, therefore, comprised 55 studies, all of which met the inclusion criteria. These studies were indexed in Scopus, focused on blended and technology-enhanced learning in education, written in English, openly accessible, and classified according to the relevant subject areas.

In summary, the PRISMA guided selection process provided a systematic, transparent, and replicable method for identifying and evaluating the literature. The careful application of the search string and inclusion criteria ensured that the final dataset was both conceptually rigorous and methodologically robust, forming a strong foundation for the subsequent bibliometric and thematic analyses presented in this review.

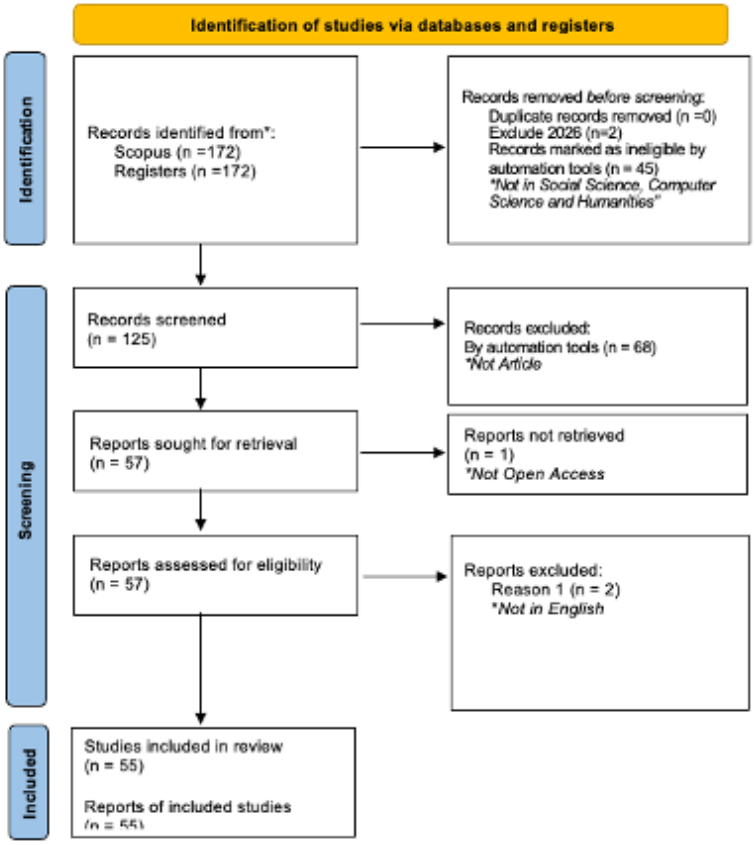

Fig. 1. Flow diagram of the search strategy

2.2 Data Cleaning and Harmonisation

Data cleaning and harmonisation are pivotal in bibliometric analysis and critical to ensuring the accuracy and reliability of results. In this study, OpenRefine and biblioMagika® were used to refine and align disorganised data, particularly author names, affiliations, keywords, and other key bibliographic fields. These tools were essential for achieving precision and consistency, especially given the diversity of publications and the potential discrepancies within the Scopus dataset regarding hybrid and technology-enhanced learning.

The cleaning procedure began with exporting the Scopus records in comma-separated values (CSV) format. The relevant files were then selected for refinement, and specific columns such as author names, institutional affiliations, and keywords were targeted for correction using the clustering functions available in OpenRefine. biblioMagika® was subsequently used to compute bibliometric indicators, including total publications (TP), number of contributing authors (NCA), number of cited publications (NCP), total citations (TC), citations per publication (C/P), citations per cited publication (C/CP), citations per author (C/A), authors per publication (A/P), citations per year (C/Y), citable years, h index, g index, m index and the citation sum within the h core, across categories such as years, source titles, authors, institutions and countries. The software also helped to identify missing or inconsistent entries. These entries were manually verified and completed, further strengthening the harmonisation process. The researchers used these tools to ensure the dataset's integrity and, as a result, the robustness of the analyses. The resulting cleaned and harmonised database provides a detailed and coherent representation of research on hybrid, blended, and

technology-enhanced learning in education, forming a solid foundation for the subsequent bibliometric and thematic examinations.

2.3 Data Analysis

The data analysis was structured to address all research questions and to map the scholarly landscape of blended and technology-enhanced learning in education. The authors used the Scopus dataset to first profile the current state of the field, examining document type, source type, language, subject area, and key citation metrics. The results were then organised using a variety of criteria, according to multiple criteria, including annual publication volume, contributions from leading authors, institutions, and countries, as well as the most active and influential source titles. To provide a rigorous assessment of impact and significance, the analysis applied a range of bibliometric indicators such as total publications, number of cited papers, total citations, citations per publication, citations per cited publication, h-index, g-index, m-index, and the total citation count within the h-core. In addition, to clarify the dominant themes and conceptual structures within the field, co-occurrence network analysis, thematic mapping, and factorial analysis of authors' keywords were employed, enabling the identification of topic clusters, the detection of underlying patterns, and the exploration of relationships among distinct research subfields.

2.4 Tools

The study employed a range of specialised tools to ensure a rigorous bibliometric analysis, selecting each for its role in enhancing data accuracy and interpretability. Microsoft Excel was used to clean and organise the initial data, allowing for efficient sorting and structuring of Scopus results. BiblioMagika® standardised metadata, resolving inconsistencies in author names, institutional affiliations, and country attributions.

3. Results

This section reports the bibliometric findings on hybrid learning and technology-enhanced learning in education. Using Scopus-indexed records published between 2008 and 2025, the analysis first summarises overall publication output, authorship patterns, and citation impact, and then examines temporal trends in publications and citations. It then identifies the most active source titles and highlights highly cited documents that represent influential contributions to the dataset. Together, these results address the research questions and provide an overview of the field's development, the publication venues that most frequently disseminate this work, and the studies that have received the greatest scholarly attention.

3.1 Current State of Research

To address the first research question (RQ1), which examines the overall development, productivity, and scholarly influence of the field, citation metrics generated from the dataset spanning 2008 to 2025 were analysed. These bibliometric indicators provide insights into publication trends, patterns of author collaboration, and citation impact, thereby offering a comprehensive overview of the field's maturation over 19 years.

Over the 19 citable years, the dataset recorded 55 publications, indicating sustained research activity in the field. The involvement of 170 contributing authors suggests a strong level of

collaborative engagement and reflects the multidisciplinary and increasingly collective character of scholarship in this area. Out of all publications, 42 papers have been cited, indicating that a substantial part of the overall output has received scholarly recognition.

In terms of citation performance, the dataset accumulated 1,434 total citations, yielding an average of 26.07 citations per paper. This value indicates consistent scholarly uptake across the body of work. The average of 34.14 citations per cited paper further suggests that publications that attract attention tend to receive substantial academic recognition. In addition, the field shows an active citation trajectory, with an average of 84.35 citations per year, highlighting increasing interest and growing recognition over time.

From an authorship perspective, an average of 8.44 citations per author and 3.09 authors per paper reflects the collaborative nature of the field. The citation sums within the h core, which totals 1,419, indicate that the most influential set of publications accounts for almost the entire pool of citations, underscoring the presence of a highly impactful core literature. Overall, these metrics depict a research area that has developed steadily over nearly two decades, supported by strong author participation, increasing citation impact, and a concentration of influential scholarly outputs as summarized in Table 2.

Table 2
Citation metrics

Main Information	Data
Publication Years	2008 - 2025
Total Publications	55
Citable Year	19
Number of Contributing Authors	170
Number of Cited Papers	42
Total Citations	1,434
Citation per Paper	26.07
Citation per Cited Paper	34.14
Citation per Year	84.35
Citation per Author	8.44
Author per Paper	3.09
Citation sums within h-Core	1,419

3.2 Publication Trends

To address the second research question (RQ2), which examines the temporal development and emerging trends within the field, the annual distribution of publications and citations from 2008 to 2025 was analysed. The combined evidence from Figure 2 and Table 3 provides a comprehensive overview of how research activity, scholarly engagement, and citation impact have evolved. Overall, the dataset indicates that the field is gradually maturing, with fluctuating but generally upward patterns in publication output, as well as several peaks in citation performance.

In the early years (2008–2018), publication activity remained modest, with annual output ranging from 1 to 2 publications. Despite the low volume, several early works attracted substantial attention. For example, the single publication in 2008 received 182 citations (C/P = C/CP = 182.00), whereas the paper published in 2011 accrued 40 citations (C/P = C/CP = 40.00). In 2017, there was a particularly notable spike, with one publication receiving 458 citations, resulting in extremely high citation averages (C/P = C/CP = 458.00). Throughout this formative period, the annual h-index values ranged

between 1 and 2, indicating that impact was concentrated in a small number of highly cited contributions.

The field's research activity increased significantly beginning in 2019. The number of publications increased from three in 2019 to six in 2020, four in 2021, eight in 2022, five in 2023, and six in 2024. The number of citations varied, with 131 citations in 2019, 60 in 2020, 101 in 2021, 110 in 2022, 69 in 2023, and 32 in 2024. During this period, citation averages were substantial; for example, 2019 recorded 43.67 citations per paper (C/P = 43.67; C/CP = 43.67), while 2021 recorded 25.25 citations per paper (C/P = C/CP = 25.25). The indices for these years (e.g., h = 5 and g = 6 in 2020; h = 7 and g = 8 in 2022) suggest the emergence of a sizeable body of influential publications, with certain years dominated by clusters of highly cited work.

According to the most recent data, publication output has increased even further. In 2025, there are 13 publications, the highest annual volume over the entire period. However, these papers have only received three citations in total (C/P = 0.23; C/CP = 1.50), which is typical of newly published work that has not yet had enough time to be widely cited. A similar recency effect is evident in 2023 and 2024, where citation averages (C/P = 13.80 and 5.33, respectively) are lower than those of earlier impactful years but are expected to grow over time. Across the full 2008–2025 window, the cumulative indices (h = 16, g = 37, m = 0.889) confirm the presence of a reasonably large and influential core of publications that underpin the field.

Collectively, the annual publication and citation trends indicate a research area that has expanded in both scope and complexity over nearly two decades. Early highly cited papers laid a strong intellectual foundation, while the marked rise in publication numbers from 2019 onwards reflects a broadening research community and increasing scholarly interest. Although citation averages in the most recent years have been dampened by the limited time available for new work to be cited, the overall trajectory suggests that the field is both active and evolving, with ongoing contributions that continue to shape its academic development.

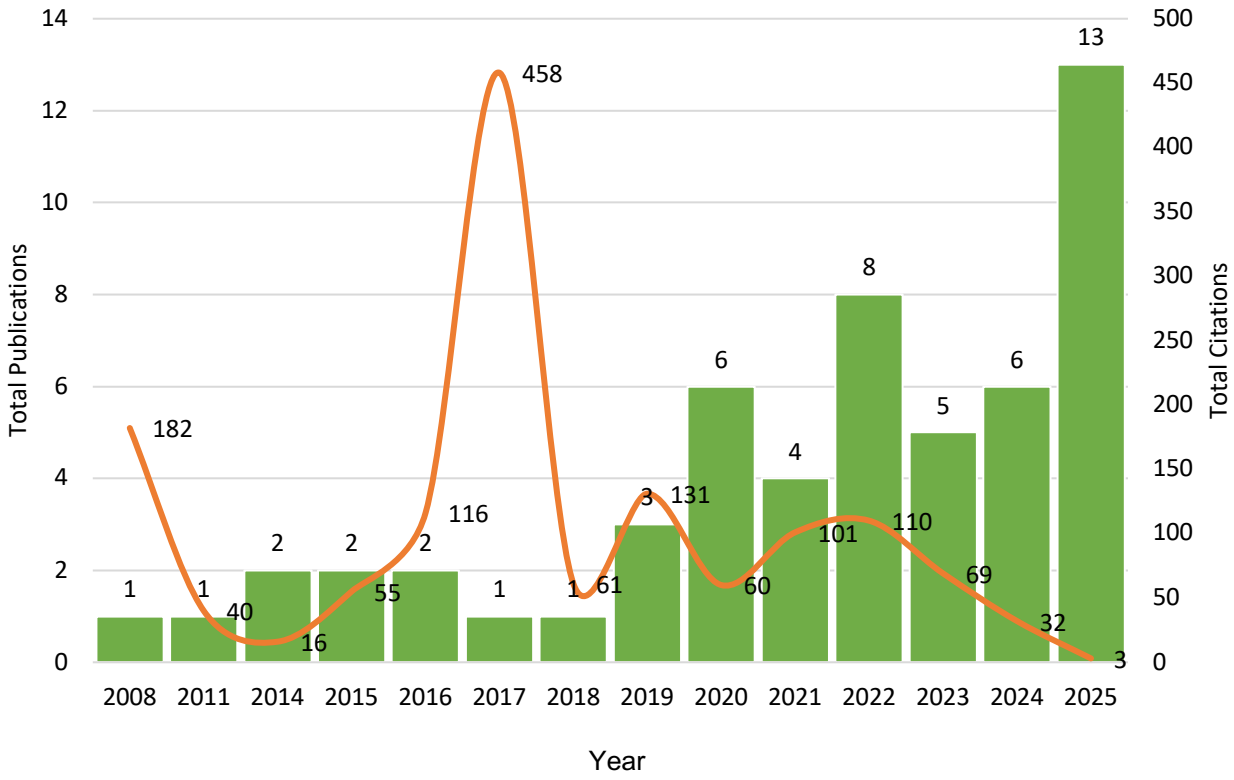

Fig. 2. Total publications and citations by year (data are only available up to 9 December 2025)

Table 3
Publications by year

Year	TP	NCA	NCP	TC	C/P	C/CP	*h*	*g*	*m*
2008	1	2	1	182	182.00	182.00	1	1	0.053
2011	1	3	1	40	40.00	40.00	1	1	0.063
2014	2	7	2	16	8.00	8.00	2	2	0.154
2015	2	3	2	55	27.50	27.50	2	2	0.167
2016	2	8	1	116	58.00	116.00	1	2	0.091
2017	1	3	1	458	458.00	458.00	1	1	0.100
2018	1	4	1	61	61.00	61.00	1	1	0.111
2019	3	12	3	131	43.67	43.67	2	3	0.250
2020	6	21	6	60	10.00	10.00	5	6	0.714
2021	4	14	4	101	25.25	25.25	3	4	0.500
2022	8	27	8	110	13.75	13.75	7	8	1.400
2023	5	13	5	69	13.80	13.80	4	5	1.000
2024	6	19	5	32	5.33	6.40	4	5	1.333
2025	13	34	2	3	0.23	1.50	1	1	0.500
Total	55	170	42	1434	26.07	34.14	16	37	0.842

3.3 Most Productive Title

Figure 3 and Table 4 present the distribution of the most productive and active source titles in this research field. These sources represent key publication venues that have contributed to the dissemination of scholarly work in this area. The results highlight both the diversity of the journals involved and their relative influence based on publication volume and citation performance.

The two most productive source titles are Education and Information Technologies and the Journal of Engineering Education Transformations, each contributing three publications to the dataset. Education and Information Technologies has the highest citation count among these leading outlets, with 36 total citations and a citation average of 12.00 citations per paper and per cited paper (C/P = C/CP = 12.00). Its impact indices (h = 3, g = 3, m = 0.50) show a consistently cited core of articles that have become important references in the field. Although the Journal of Engineering Education Transformations has the same publication volume as this journal (TP = 3), it has only six citations (C/P = 2.00; C/CP = 6.00), with h = 1, g = 2, and m = 0.50, indicating that its influence is concentrated in a smaller number of highly cited contributions.

The next tier of active sources consists of Digital, the International Journal of Emerging Technologies in Learning, and Frontiers in Education, each of which has two papers published. Digital accounts for five citations (C/P = 2.50; C/CP = 5.00), with h = 1, g = 2 and m = 0.33, indicating emerging but still limited impact. The International Journal of Emerging Technologies in Learning has seven citations (C/P = C/CP = 3.50), supported by h = 2 and g = 2 (m = 0.17), pointing to a small but influential set of contributions at the intersection of technology and pedagogy. Frontiers in Education also makes a significant contribution, with six citations (C/P = C/CP = 3.00) and indices h = 2, g = 2, and m = 1.00, indicating strong average performance despite its relatively short publishing history in this topic.

Overall, the analysis of Figure 3 and Table 4 shows that research outputs are distributed across a broad set of international journals, with a small number of core outlets, particularly Education and Information Technologies, emerging as especially productive and influential. These leading sources

combine high publication counts with strong citation performance, underscoring their role as important platforms for advancing scholarship in educational technology and related domains.

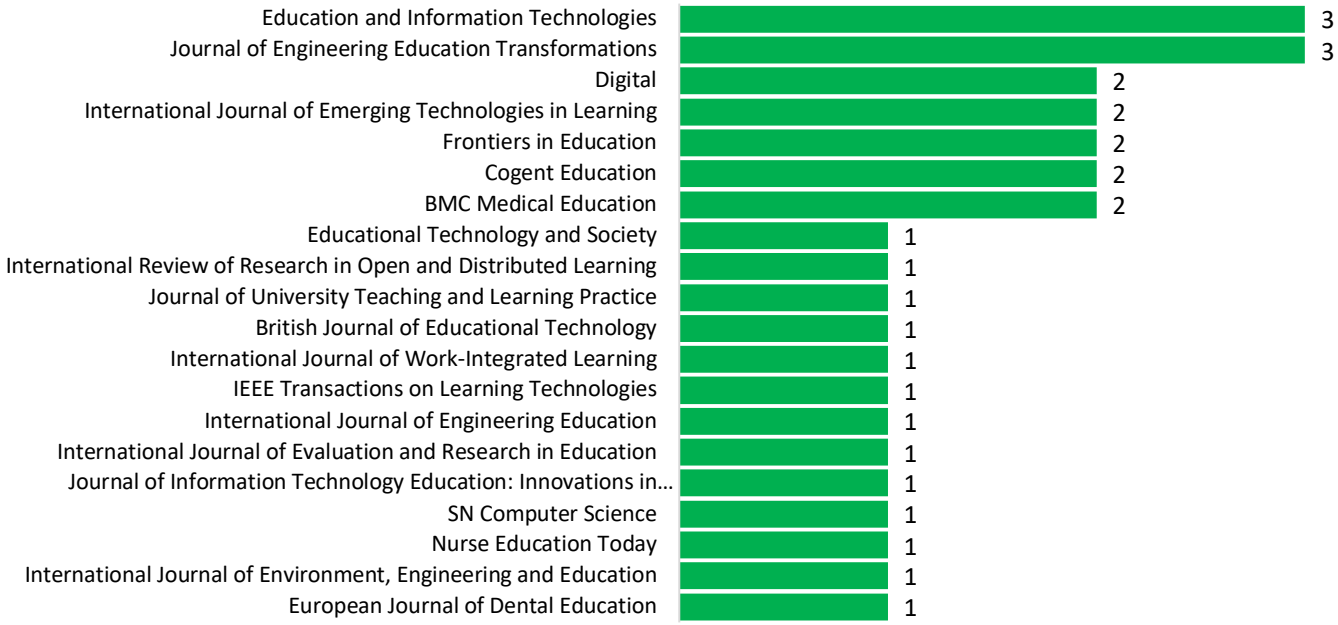

Fig. 3. Top 20 most productive source titles

Table 4
Top 5 most active source titles

Source Title	TP	NCA	NCP	TC	C/P	C/CP	*h*	*g*	*m*
Education and Information Technologies	3	9	3	36	12.00	12.00	3	3	0.429
Journal of Engineering Education Transformations	3	10	1	6	2.00	6.00	1	2	0.333
Digital	2	5	1	5	2.50	5.00	1	2	0.250
International Journal of Emerging Technologies in Learning	2	5	2	7	3.50	3.50	2	2	0.154
Frontiers in Education	2	8	2	6	3.00	3.00	2	2	0.667

3.4 Highly Cited Documents

Table 5 displays the ten most highly cited articles in response to the fifth research question (RQ5), which seeks to identify the most influential publications in the field. Collectively, these works form a core body of scholarship on blended and technology-enhanced learning, and their citation counts indicate substantial academic interest and long-term influence on research and practice.

Kintu, Zhu, and Kagambe [20] published the most highly cited article, “Blended learning effectiveness: the relationship between student characteristics, design features, and outcomes,” in the *International Journal of Educational Technology in Higher Education*. With 458 citations and 50.89 citations per year, this study is a key reference for understanding how learner attributes and instructional design interact to shape outcomes in blended learning environments. The second most cited work is Akkoyunlu and Yılmaz Soylu [21], whose article “A study of students' perceptions in a blended learning environment based on different learning styles” in *Educational Technology and Society* has 182 citations (C/Y = 10.11), providing foundational insights into students’ experiences and preferences in blended settings. Morton *et al*., [22] follow closely with “Blended learning: How can we optimize undergraduate student engagement?” in BMC Medical Education, which has accrued

116 citations (C/Y = 11.60) and is widely cited for demonstrating strategies to improve engagement in higher education.

Several other articles also have a significant impact. Morris, Swinnerton, and Coop [23] examine "Lecture recordings to support learning: A contested space between students and teachers" in *Computers and Education*, receiving 73 citations (C/Y = 10.43) and highlighting tensions and opportunities associated with recorded lectures. Dooley et al. [24] and Røe *et al*., [25], published in the *Journal of Veterinary Medical Education* and *BMC Medical Education*, respectively, investigate flipped classroom models in veterinary and physiotherapy education, with 61 and 57 citations (C/Y = 7.63 and 8.14) that underscore the growing use of active, technology-supported pedagogies in health-related disciplines.

The remaining highly cited works expand the thematic scope to include online assessment, lifelong learning, and digital engagement. Chen, Jiao, and Hu [26] examine "Formative assessment as an online instruction intervention" in the International Journal of Distance Education Technologies (51 citations, C/Y = 10.20), highlighting the role of assessment in maintaining engagement and learning outcomes. Lock *et al*., [27], in the British Journal of Educational Technology, introduce "Creating technology-enabled lifelong learning: A heutagogical approach," with 43 citations (C/Y = 8.60), emphasizing learner autonomy and self-directed learning. Stewart, Stott, and Nuttall [28] analyze long-term "Student engagement patterns" in geography modules in the Journal of Geography in Higher Education (40 citations, C/Y = 2.67). Meanwhile, Shafiq and Parveen [29] investigate "Social media usage: Analyzing its effect on the academic performance and engagement of higher education students in the International Journal of Educational Development, which has already accumulated 36 citations with a high annual rate (C/Y = 12.00), indicating rapid growth in research on social media and academic outcomes.

When combined, the articles in Table 5 form a robust intellectual foundation for the field of blended and technology-enhanced learning. Their high citation counts and strong yearly citation rates demonstrate the centrality of themes such as learner engagement, flipped and blended pedagogies, online assessment, and social media use in contemporary educational research. These contributions continue to guide theoretical development, inform methodological choices, and shape practical innovations across diverse educational contexts and disciplines.

Table 5
Top 10 highly cited articles

No.	Author(s)	Title	Source Title	TC	C/Y
1	Kintu, M.J.; Zhu, C.; Kagambe, E. [20]	Blended learning effectiveness: the relationship between student characteristics, design features and outcomes	International Journal of Educational Technology in Higher Education	458	50.89
2	Akkoyunlu, B.; Yilmaz Soylu, M.Y. [21]	A study of students' perceptions in a blended learning environment based on different learning styles	Educational Technology and Society	182	10.11
3	Morton, C.E.; Saleh, S.N.; Smith, S.F.; Hemani, A.; Ameen, A.; Bennie, T.D.; Toro-Troconis, M. [22]	Blended learning: How can we optimise undergraduate student engagement?	BMC Medical Education	116	11.60

4	Morris, N.P.; Swinnerton, B.; Coop, T. [23]	Lecture recordings to support learning: A contested space between students and teachers	Computers and Education	73	10.43
5	Dooley, L.M.; Frankland, S.; Boller, E.; Tudor, E. [24]	Implementing the flipped classroom in a veterinary pre-clinical science course: Student engagement, performance, and satisfaction	Journal of Veterinary Medical Education	61	7.63
6	Røe, Y.; Rowe, M.; Ødegaard, N.B.; Sylliaas, H.; Dahl-Michelsen, T. [25]	Learning with technology in physiotherapy education: Design, implementation and evaluation of a flipped classroom teaching approach	BMC Medical Education	57	8.14
7	Chen, Z.; Jiao, J.; Hu, K. [26]	Formative assessment as an online instruction intervention: Student engagement, outcomes, and perceptions	International Journal of Distance Education Technologies	51	10.20
8	Lock, J.; Lakhal, S.; Cleveland-Innes, M.; Arancibia, P.; Dell, D.; de Silva, N. [27]	Creating technology-enabled lifelong learning: A heutagogical approach	British Journal of Educational Technology	43	8.60
9	Stewart, M.; Stott, T.; Nuttall, A.-M. [28]	Student engagement patterns over the duration of level 1 and level 3 geography modules: Influences on student attendance, performance and use of online resources	Journal of Geography in Higher Education	40	2.67
10	Shafiq, M.; Parveen, K. [29]	Social media use: Analyzing its impact on higher education students' academic performance and engagement	International Journal of Educational Development	36	12.00

4. Conclusions

This bibliometric analysis of hybrid and technology-enhanced learning research in education shows a clear shift from a relatively small, scattered body of work to a more visible, growing knowledge base, especially since 2019. The dataset highlights strong growth in publications and citations, with scholarly attention increasingly focused on a few highly influential studies. This pattern indicates that hybrid learning has transitioned from a minor instructional option to a more established research field, aligning with broader bibliometric evidence of sustained growth in technology-enhanced higher education research and related areas such as online learning, learning analytics, and digital assessments [11]. The growth trend over time also closely aligns with the COVID-19 period and subsequent institutional efforts to enhance teaching resilience, during which hybrid formats gained prominence as a way to maintain face-to-face interaction while allowing remote participation when necessary [13].

However, the rise in publications does not equate to uniform success in implementation. The literature consistently highlights challenges such as increased workload, divided attention, interactional complexity, and ongoing concerns about social presence and pedagogical quality in synchronous hybrid environments [13-15]. Consequently, the field's core focus increasingly emphasizes pedagogical design, engagement strategies, learning assessment, and institutional support systems rather than just access to technology. Additionally, the dissemination pattern shows that hybrid learning research is spread across multiple outlets. However, a recurring set of education and educational technology journals remains key publication venues, indicating a consolidation around core journals alongside ongoing interdisciplinary dissemination [9,10].

Regarding contributors, the dataset shows an internationally distributed and collaborative authorship profile characterized by frequent co-authorship and multi-institutional participation. While this spread highlights the cross-context applicability of hybrid learning, previous bibliometric evidence suggests the need for stronger cross-regional partnerships and more consistent methodological approaches to enhance cumulative knowledge building [9,10]. Additionally, the most highly cited studies confirm that learning effectiveness relies on intentional design features and ongoing learner interaction rather than just modality combination [20,22], and that earlier work on learner perspectives and implementation processes remains relevant for understanding adoption and experience [21].

Overall, these findings directly address the study's goal of mapping the evolution, influence, and thematic development of hybrid learning research by outlining its growth path, key publication venues, collaboration patterns, and main pedagogical issues. For researchers, this mapped landscape emphasizes the importance of more in-depth exploration of educator experiences, institutional readiness, and cross-context comparisons. For educators and institutional leaders, the evidence indicates that sustainable hybrid learning practices require well-coordinated learning activities, focused staff development, and strong support systems. This study provides a structured foundation to guide future research and to strengthen evidence-based hybrid practices that are pedagogically rigorous and practically sustainable.

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