

Scientific Trends of Large Language Model Assisted Pedagogy in Higher Education: A Bibliometric Analysis

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ABSTRACT This research work presents a bibliometric analysis of Large Language Model (LLM)-assisted pedagogy in higher education to study its global research trends and identify key themes, collaboration patterns, and research gaps. Lens (Lens.org) was used to retrieve the dataset by incorporating a logical and expanded structure from December 2015 to December 2025. A total of 17,089 relevant records were retrieved and analysed. VOSviewer was used for keyword co-occurrence, author collaboration, and journal-source network analyses. The results showed that LLM-assisted pedagogy research surged between 2020 and 2022. Journal articles were the main source of literature on LLM-assisted Pedagogy research. Computer science and artificial intelligence were the major disciplines in this field. Curriculum, education, digital learning, and assessment were the outcomes of the keyword co-occurrence analysis. It can be concluded that the findings may play a pivotal role in policy framing in LLM-assisted pedagogy development in higher education.

INTRODUCTION

The Large Language Model (LLM) is an Artificial Intelligence (AI) application for generating and summarising human-like content, mostly text, for writing and inference purposes. The LLM is widely used in higher education pedagogy. Higher education is a complex idea and its studies (Filippakou 2022) are meant to measure the “quality” of education (Hansen and Torgersen 2021). Students’ understanding of higher education could be developed by connecting educational development with quality assurance (Gosling and D’Andrea 2001), although reforms in teaching were often more concerned with quality assurance (Patfield et al. 2025). Accordingly, higher education institutions framed their quality assurance mechanism to match national and international levels (Alzafari and Ursin 2019) through the technology integration (Stukalo and Lytvyn 2021) of new technology, likely LLM for now. The LLM got attention with its abilities in natural language generation and understanding as well as harnessing multiple types of data, such as images, texts,

audios and videos (Claman and Sezgin 2024). AI-powered chatbots created a substantial quantity of conversation (Chan et al. 2024), personalised learning experiences (Yigci et al. 2025) automated grading, intelligent tutoring systems and administrative efficiency (Nuong Deri et al. 2024). Ultimately, it created opportunities for changing higher education (Zhang 2025) through problem-solving (Sudrajat 2025), developing curricula and course materials (Yigci et al. 2025). Even feedback created through large language models (LLMs) show the ability for enhancing students’ learning outcomes (Jacobsen and Weber 2025). Large language models (LLMs) like Gemini, ChatGPT-4, Megatron-Turing NLG, PaLM, Jurassic-1 Jumbo, etc. provided to the researchers’ understanding (Kumar 2024) in pedagogy. Eventually it assisted academic institutions extensively utilise electronic learning context to ensure improved teaching and learning experiences in congruence by educational activities (Fu et al. 2021) and also played a foundational role in shaping students for the demands of knowledge-based societies and underwriting to the proliferation of a more innovative and adaptive education system (Leffia et al. 2024).

In brief, quality assurance in higher education is evolving through technology integration,

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particularly LLMs, as of now. The LLM enhances teaching, learning, assessment, and administration by enabling personalised learning, intelligent tutoring, and feedback systems, thereby improving educational quality and preparing students for knowledge-based and innovative societies.

Rationale of the Study

There has been a remarkable transformation in the field of higher education in terms of curriculum design, digital learning environments, and personalised learning due to the significant evolution of the LLM. This exceptional growth has created vast opportunities for scholarly work in multidisciplinary fields. Although there are many publications in this area, there is limited bibliometric analysis or mapping on collaboration patterns, thematic clusters, and major areas of study co-occurrence of work. Hence the outcome of this study will provide understanding of existing knowledge and future research directions.

Objectives of the Study

Objective 1: Global Research Trends and Intellectual Structure

To examine the growth trajectory, publication patterns, leading disciplines, influential journals, and the overall intellectual structure of research on LLM-assisted pedagogy in higher education.

Objective 2: Themes, Collaboration, and Research Areas

To identify major thematic clusters, emerging research directions, author and institutional collaboration networks, and existing research areas within the field of LLM-assisted pedagogy in higher education.

MATERIAL AND METHODS

Methodology

The systematic bibliometric technique was followed in this research to examine the scientific trends of Large Language Model (LLM)-as-

sisted pedagogy in higher education. Necessary data was obtained from the Lens (<https://www.lens.org/>). It is an inclusive scholarly database that includes metadata stored from the multiple sources, that is, publishers, indexing services and also broad coverage of peer-reviewed research outputs. The key search string “Large Language Model Assisted Pedagogy in Higher Education” was placed in lens.org. To capture relevant variations and ensure comprehensive retrieval, the query was logically expanded as follows:

Large AND (Language AND (Model AND (Assisted AND (Pedagogy AND (Higher AND Education))))))

While searching through the Lens, the screening option was opted for with the provision of the data range of the scholarly works between 1 December 2015 and 24 December 2025 and the search yielded 17,089 scholarly records. Additional filters options were author, institution, journal, identifier type (DoI, Microsoft Academic, OpenAlex, PubMed, PubMed Central, Core), Open Access (Open Access coloured, Open Access License). The data was exported as a CSV file from the Lens for data cleaning and for the keywords co-occurrence and author collaboration network analysis through the VOSviewer (www.vosviewer.com). The analysis option of the Lens was opted for to obtain a CSV file for getting data for the analysis of scholarly works over the time, publications type, most active author, top fields of study and top journals.

The scholarly works relevant to higher education in LLM Pedagogy were retained. To ensure consistency in textual analysis, English written publications were included. Data cleaning done based on titles, abstracts, and keywords and non-relevant items were screened out during data cleaning. For maintaining data integrity duplicate records were discarded. Bibliometric technique was used to analyse journal sources, authorship pattern, document types, citation performance and country-wise contributions. The bibliometric and text-mining tools compatible with the Lens metadata helped in conducting data extraction and data processing. The bibliometric and text-mining tools compatible with the Lens metadata helped in conducting data extraction and data processing. The standard bibliometric and machine learning li-

barities, which provide reproducibility and analytical rigour, generated the network visualisation, and topic modelling outputs were used to ensure highly sophisticated analytical and methodological practice. The comprehensive methodological framework used in this study to understand the implications of the LLM-assisted pedagogy in higher education (Fig.1). The framework will incorporate workflow from the Lens for data collection, data cleaning, and three streams of analyses for bibliometrics, analysis of word and n-grams, and Latent Dirichlet Allocation (LDA) and Bidirectional Encoder Representations from Transformers (BERT) topic modelling. The framework's combination of trends from different analyses allow for a more robust

study, measuring both the qualitative and quantitative dimensions of data publications. While bibliometric analysis captures the volume of research produced and the pattern of collaboration, the other two streams will shed light on the more subtle themes of pedagogy. The framework is optimised to give a more inclusive analysis of the structure and flow of research in the LLM pedagogy.

RESULTS

The findings showed that there was a steady increase in the publications from 2016 with considerable increase in 2020 (14.10%), 2021 (19.41%), 2022 (17.58%) and followed by a de-

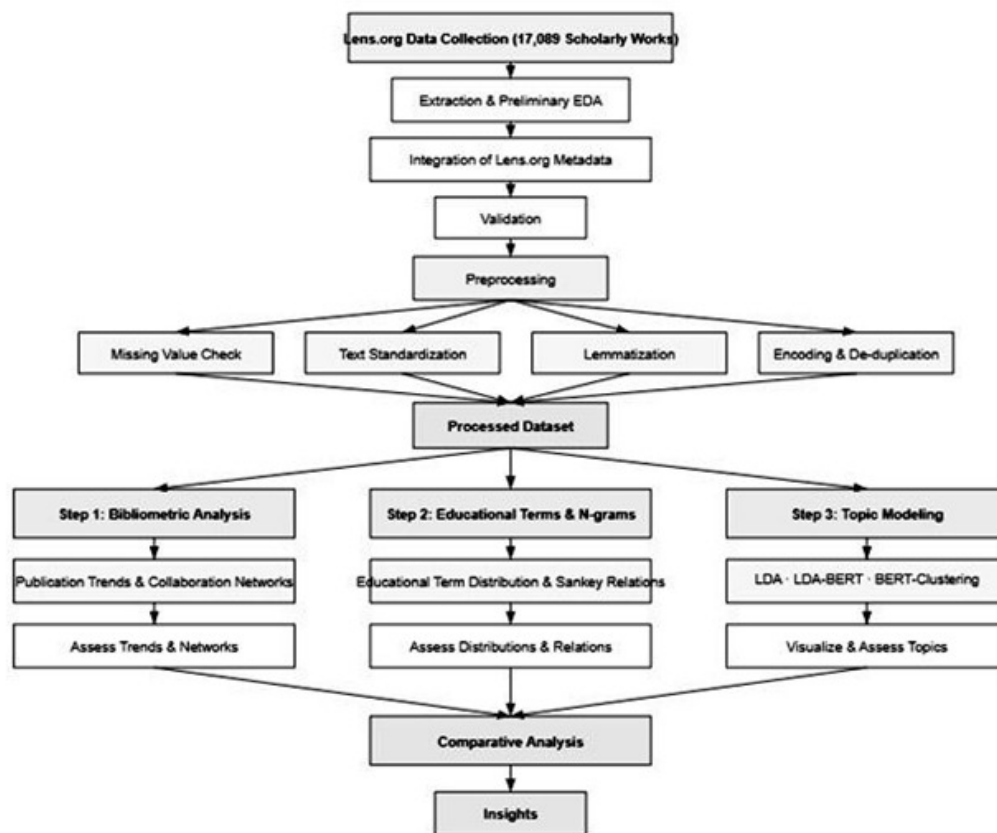


Fig. 1. Workflow of scientific trends analysis in Large Language Model(LLM)-assisted pedagogy in higher education

cline after 2023 (5.76%) in the LLM-assisted pedagogy in higher education (Table 1) research. It was noted that journal articles (74.81%) constitute the majority of documents in total and over the years while books (7.71%), dissertations (6.36%), book chapters (4.48%) and preprints (2.80%) contribute comparatively smaller shares (Fig. 2).

Recent year's reviews showed the LLMs as architects of self-paced learning, reasoning ability, and problem-solving skills (Martínez-Peláez et al. 2025) and learning objectives across disciplines (Nikolovski et al. 2025). This decade illustrated a growing scholarly consensus that LLMs can significantly reshape pedagogy in scalable teaching in higher education and expand personalised learning (Macneil et al. 2022; Correia et al. 2025).

Arthur Tash and Zhongpeng Yu were the prolific authors who published 24 and 20 scholarly articles respectively, having made the most contribution in the year of the LLM assisted pedagogy in higher education followed by Athanasios Drigas (12), Lawrence Jin Zhang (11) and Melor Md Yunus (8). However, the second tier of authors showed moderate productivity in this domain, although several authors contribute a smaller but consistent number of publications (Table 2).

This matches with notable patterns where a leading group of authors demonstrate high productivity, while a second group showed modest engagement, and many other authors continue consistent, notwithstanding smaller, contributions to this the LLM research domain (Eager and Brunton 2023; Laato et al. 2023). Such groupings among authors echo an evolving and dynamic research community around the LLM-assisted pedagogy in higher education.

Computer Science (5,081) was the most leading subject, followed by Sociology (4,702), Pedagogy (4,057) and Political Science (3,946) in LLM-assisted pedagogy in higher education. Other evident subject areas were Medicine (2,686), Law (2,539), Philosophy (2,087), Higher Education (1,481) and Artificial Intelligence (1,342) showing varied disciplinary coverage (Fig.3). The representation of these diverse fields showed the significant impact in reshaping pedagogical of AI and LLM technologies in higher education for developing AI-augmented teaching tools and personalised learning through

Table 1: Scholarly publications over time (2015-2025) in the LLM-assisted pedagogy in higher education

Years	Publication types						Total publications		
	Journal articles	Books	Book chapters	Conference papers*	Dissertations	Preprints		Reports	Others**
2015	99	8	12	1	1	0	0	0	121 (0.71%)
2016	766	108	85	7	50	7	12	5	1040 (6.09%)
2017	1,081	140	84	14	44	20	9	5	1,397 (8.17%)
2018	1,203	180	87	15	66	33	11	12	1,607 (9.40%)
2019	1,407	179	107	29	113	62	10	18	1,925 (11.26%)
2020	1,696	223	153	57	121	101	42	16	2,409 (14.10%)
2021	2,305	250	135	41	386	125	46	29	3,317 (19.41%)
2022	2,256	163	77	34	262	89	81	43	3,005 (17.58%)
2023	800	47	19	16	39	29	8	26	984 (5.76%)
2024	440	8	3	61	5	6	0	2	525 (3.07%)
2025	731	12	4	2	0	6	0	4	759 (4.44%)
Total	12,784 (74.81%)	1318 (7.71%)	766 (4.48%)	277 (1.62%)	1087 (6.36%)	478 (2.80%)	219 (1.28%)	160 (0.94%)	17,089

Source: Analysis of data

* Conference Papers include "Conference Proceedings Article" and similar entries.

** Others include Editorials, News, Journal Issues, Components, Datasets, Letters, Reviews and Reference Entries.

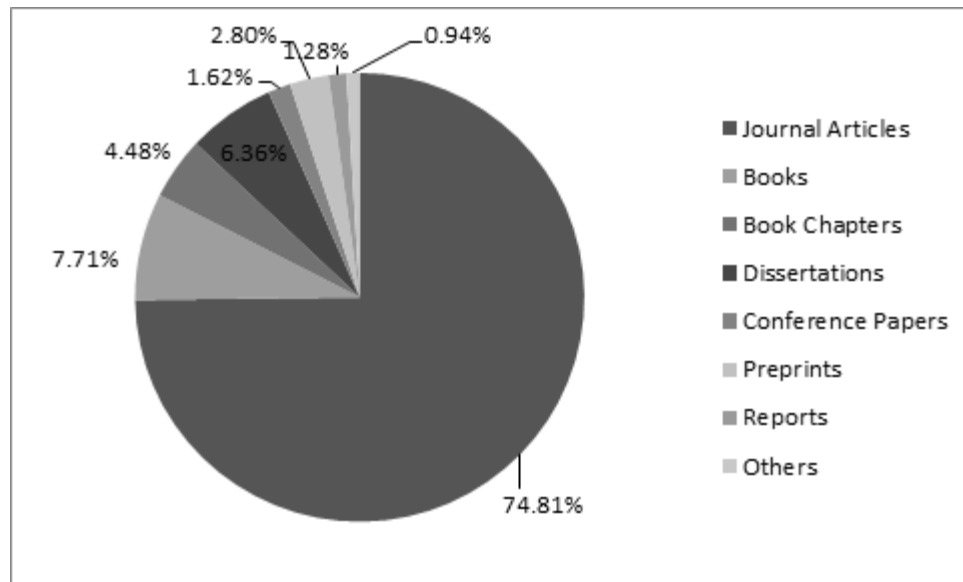


Fig. 2. Types of scholarly publications in LLM-assisted pedagogy in higher education

Source: Analysis of data

Table 2: Most active authors in the LLM-assisted pedagogy in higher education

S. No.	Author name	Publication count
1	Arthur Tatnall	24
2	Zhongyuan Yu	20
3	Athanasions Drigas	12
4	Lawrence Jun Zhang	11
5	Melior Md Yunus	8
6	Abu Bakar Razali	6
7	Curtis J Bonk	6
8	Denis Vladlenov	6
9	Ines Gik- Jaurena	6
10	Victoria I. Matic	6
11	Abdel Syahid	5
12	Adeline Asmawi	5
13	Agnese Kukulska-Hulme	5
14	Bjorn C.A. Vinholt	5
15	Nitza Davidovitch	5
16	Abdulkadir Karadeniz	4
17	Abdullah Rajab Alfalagg	4
18	Adnan Abid	4
19	Afsheen Rezai	4
20	Ahmed Tlili	4

Source: Analysis of data

AI (Brown and Kauchak 2013; Azukas and Gibson 2025), in social sciences like sociology and political science, research may examine ethical considerations of AI integration (Eager and Brunton 2023).

In the distribution of publications in the LLM assisted pedagogy amongst the different journal sources, it was noted major sources were depicted by *Frontiers in Psychology* (396), *Zenodo* (364) followed by and *Sustainability* (270). Other noticeable sources were *Education Sciences* (204), *PLOS ONE* (152) and *BMC Medical Education* (136) demonstrating a broad distribution over education, psychology, and interdisciplinary journals (Table 3). It is also noted that these twenty journals published 20.44 percent of total journal article publication in different journals (Tables 1 and 3). The multidisciplinary journals distribution, namely, *Frontiers in Psychology*, *Education Sciences*, *Sustainability* and platforms like *Zenodo*, reflect the manifold interest and high interconnectivity in publishing of the LLM-assisted pedagogy (Aina et al. 2018; Triansyah et al. 2025; Ballance and Coxhead 2025).

The Vosviewer (<https://www.vosviewer.com>) was used for developing the keywords co-occurrence network of LLM-assisted pedagogy in higher education. ‘All keywords’ was the unit of analysis to obtain both indexed and authored-supplied keywords. To ensure each keyword occurrence was paved equally to the analysis, ‘full counting’ techniques were administered.



Fig. 3. Subject-wise distribution of publications across disciplines in the LLM-assisted pedagogy in higher education

Source: Adapted from data retrieved from Lens.org, 2026

The keyword co-occurrence network depicted multi-cluster intellectual structure, dense underlying research on the LLM-assisted pedagogy in higher education. Multi-cluster intellectual structure was derived through the keyword co-occurrence network. The keyword co-occurrence network map showed strong digital learning modalities, assessment practices, educational foundation, human-centric learning outcome and disciplinary applications. The prominent node 'humans' is closely associated with 'education', 'child', 'curriculum', which indicated 'Learner-Centric' LLM-Oriented pedagogy. This depict-

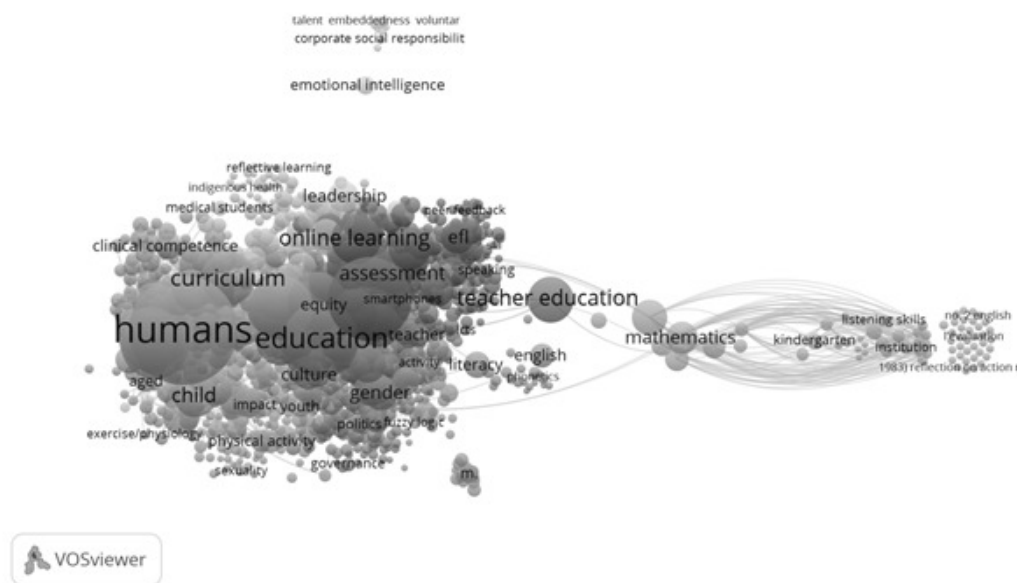
ed that major thrust of the research were human learning techniques, cognitive development, and teaching efficiency (Fig.4). Maps of keyword co-occurrence highlighted discrete clusters showing assessment practices, prevailing modalities, human-centric learning outcomes, basic educational theories, which noted with the existing research outcome in digital and AI-driven higher educational research domains (Judijanto et al. 2024; Young et al. 2023; Ramli et al. 2025).

The author-level collaboration network presented a varied and thematically associated research landscape, depicted by several concen-

Table 3: Top source research journal titles by number of publications in LLM-assisted pedagogy in higher education

<i>S.No.</i>	<i>Top source research journal titles</i>	<i>No. of research articles published</i>
1.	Frontiers in Psychology	396
2.	Zenodo (CERN European Organisation for Nuclear Research)	364
3.	Sustainability	270
4.	Education Sciences	204
5.	PloS One	152
6.	BMC Medical Education	136
7.	Frontiers in Education	134
8.	Heliyon	128
9.	Education and Information Technologies	104
10.	International Journal of Environmental Research and Public Health	9
11.	Online Learning	81
12.	English Language Teaching	79
13.	Cogent Education	73
14.	Scientific Reports	72
15.	Australasian Journal of Educational Technology	62
16.	Deep Blue (University of Michigan)	59
17.	International Journal of Learning, Teaching and Educational Research	56
18.	International Journal of Instruction	52
19.	Behavioural Sciences (Basel, Switzerland)	49
20.	International Journal of Emerging Technologies in Learning (iJET)	49
	Total	2613

Source: Analysis of data

**Fig.4. Keywords co-occurrence in LLM-assisted pedagogy in higher education**

Source: Adapted from data retrieved from Lens.org and developed through VOSviewer (<https://www.vosviewer.com/>), 2026

trated collaboration clusters. The cluster linkages structure reflected the existence of special-

ised research groups backing independently to the field. Recognisable author clusters appear,

with scholars such as Victoria I. Marín, Ahmed Tlili, Zhonggen Yu, and Daniel Burgos positioning relatively central positions, showing higher publication volume and collaborative link strength. Other authors, namely, Karsten Lundqvist, Athanásios Drigas and Nikolaos Pellas, appeared as smaller, lightly connected nodes, representing focused or independent research paths. Overall, the light density of links suggested modest collaboration strength across the field (Fig.5). The author-level collaboration network observed in this study reflected broader bibliometric patterns in the LLM-assisted pedagogy and educational technology that highlighted intellectual foundations leading to scholarly interests (Polat et al. 2024) although scholars tend to centralise the research networks, but it was across broader regions remains uneven, with limited cross-cluster association (Rodriguez and Aclao 2025; Tamilmani et al. 2025).

DISCUSSION

The sharp increase in scholarly works and publications on LLM-assisted pedagogy in higher education between 2019 and 2022 shows the rising academic importance and appreciation of the field's prominence. This increase aligns with wider trends of growing the LLM applications

across diverse fields, including medical science, where research outcomes have expanded rapidly as the technology matured and adoption increased (Gencer and Gencer 2025; Hassan et al. 2025) and rapidly progressing beyond theoretical core to applied sciences (Uysal 2025) however advocates for critical insights to pedagogical design and policy development in AI in LLM (Huang and Liu 2026). The supremacy of journal articles over dissertations, books, and book chapters within this span likely stems from journals' higher citation potential, broader visibility, more rigorous peer review processes, better recognition, and academic impact (Gray 2024). Furthermore, the skewed authorship distribution observed in the LLM-assisted pedagogy research can be credited to the small number of scholars with profound expertise in this innovative interdisciplinary field, resulting in a main group of leading authorities driving seminal advancements in this area. This proposition is sustained by an increasing network of collaborators backing evolving or specialised visions, an outline consistent with findings in other emergent fields where proficiency concentration balances broader community involvement (Köseoglu et al. 2017).

Subject-wise distribution of computer science depicted technological orientated research land-

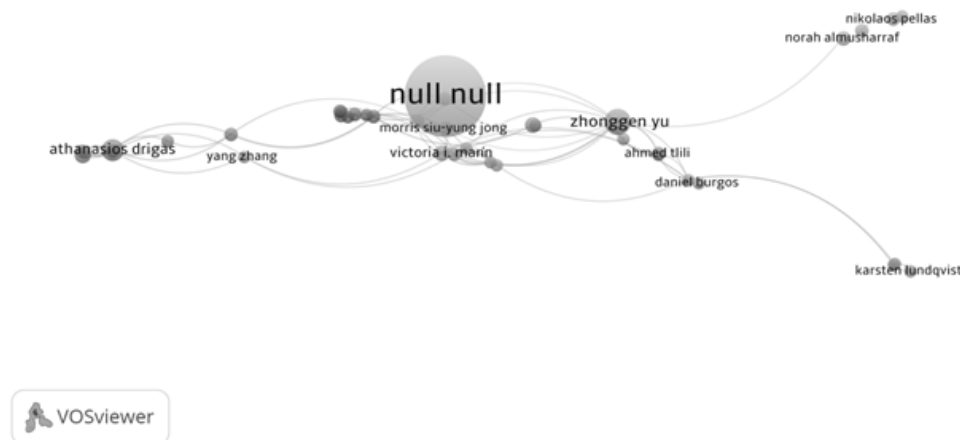


Fig. 5. Author collaboration network in LLM-assisted pedagogy research in higher education

Source: Adapted from data retrieved from Lens.org and developed through VOSviewer (<https://www.vosviewer.com/>), 2026

scape in the LLM assisted pedagogy. The presence of pedagogy, sociology, and political science showed the multidisciplinary convergence of educational, social, and policy standpoints. The findings support that the LLM-assisted pedagogy is shaped by both technical innovation and social-humanistic inquiry. Enormous existence of education and psychology centred journals in documents spreading depicted the robust pedagogical and behavioural orientation of the research in the LLM assisted pedagogy. Contemporary scholarly discourse and empirical studies validate that the LLM-assisted pedagogy is a vibrant multidisciplinary field, enriched by robust contributions from computer science, education, psychology, sociology, and political science, as reflected in multidisciplinary journals such as PLOS ONE, Sustainability, and Heliyon (Liu et al. 2023; Bolger 2021).

The diverse thematic clusters of Keyword Co-Occurrence Network showed that the LLM-assisted pedagogy was continuously evolving. The main cluster focused on curriculum, education and assessment and this is increasingly improved by the dimensions of equity, cultural and ethical inclusiveness. The online learning system presented the LLM-assisted pedagogy, providing personalised learning, feedback and instruction systems at varying scales. These ultimately paved for the competencies building in emotional intelligence, leadership, and other professionalism and ethically aligned integration of AI. Recent studies stress that the application of LLM in educational sets must highlight ethical concerns (Mondal 2025; Mariyono and Abror 2024), greatly augmenting the effectiveness of remote and hybrid education models (Mahmoud and Sørensen 2024). Leaders in education must instrument inclusive ethical guidelines, data protection protocols, bias detection and to ensure fairness and inclusivity in AI-guided educational breakthroughs (Igbokwe 2024) and concerns associated with these are disparities in access to AI-enhanced education and economic barriers to adopting AI tools (Gavira Durón and Jiménez-Preciado 2025).

It appears that the LLM and digital pedagogy associations are still emerging and displaying signs of localised research teams instead of wide global research partnerships. Central authors play as knowledge links among several

clusters, moving along thematic strands in psychology, education tech, and AI learning. The occurrence of some isolated cluster and poorly linked authors suggested that there was the possibility for more interdisciplinary and global collaboration. The “null null” node characterises the need for improved bibliometric data concerning the authors, as the incomplete attribution gaps, that data can impact the real collaboration patterns. More cross-cluster collaborations should advance the theoretical and methodological integration in this developing area of research. Similar findings in Science, Technology, Engineering, and Mathematics (STEM) research recommend that as these fields mature, increasing international cooperation and interdisciplinary collaborations emerge, leading to more cohesive knowledge networks. However, the initial phases are marked by knowledge silos and disparities in research connectivity, which calls for concerted efforts to integrate isolated clusters (Zhan et al. 2022; Youngblood and Lahiti 2018; Ullah et al. 2022).

Bibliometric studies provide a quantitative information on the evolution on LLM-assisted pedagogy inside a rapidly evolving research ecosystem that still needs deeper multidisciplinary engagement to fully leverage AI’s educational potential (Abnoulgid et al. 2024; Delen et al. 2024). LLMs support pedagogy more closely with real-world demands and promoting educational equity and workforce readiness (Eager and Brunton 2023; Solorzano et al. 2024). However, alongside these, issues such as data privacy, algorithmic bias, misinformation risks, and threats to academic integrity are recurrent themes (Salam et al. 2025).

CONCLUSION

The bibliometric analysis of Large Language Model (LLM)-assisted pedagogy in higher education from 2015 to 2025 provided a comprehensive outline of the publications trend, active authors, publications across disciplines, journal-level source network and author-level collaboration. This is being pushed by speedy advancements in artificial intelligence (AI) and educational technologies (ET). The prevalence of more number of journal articles echoed the dynamic and rapid-evolving nature of this re-

search field. The discipline or subject-wise distribution showed the prominent existence of artificial intelligence and computer science, while the notable existence of sociology, pedagogy and allied disciplines emphasised the plurality of disciplinary perspectives of the LLM-assisted pedagogy. The analysis of keyword co-occurrence showed a learner-centric approach, with reasonable emphasis on curriculum framing and designing, personalised digital learning, self and mentor assessment practices, and human-centric educational outcomes. Author collaboration networks showed the existence of core researchers and thematic clusters of Sociology, Pedagogy, Political Science and others Medicine, Law, Philosophy, Artificial Intelligence and Higher Education. The LLM-assisted pedagogy is still evolving as overall collaboration density modest, suggesting scope for broader international and interdisciplinary partnerships for doing more research. The study concluded that LLM-assisted pedagogy emerged as a new domain after introduction of Artificial Intelligence, however transformative and rapidly maturing research areas with significant roles for teaching-learning process, and policy formulation in higher education.

RECOMMENDATIONS

For the broader application of the LLM-assisted pedagogy in higher education, multidisciplinary collaboration among AI specialists, computer scientists, educators, psychologists, social scientists, and planners is imperative. To strengthen global research, multi-institutional associations should be strengthened to enhance the exchange of knowledge, methodological diversity, and global utility of research findings. Future research on the LLM-assisted pedagogy should emphasise ethical considerations, data privacy, inclusivity, and bias mitigation to confirm the responsible and equitable use of the LLMs in higher education.

While framing guidelines and adopting best practices for the adoption of the LLM-assisted pedagogy, educational administrators and policymakers should consider evidence from bibliometric and empirical studies. Metadata standardisation should be emphasised through precise author identification and prospective bibliometric analyses.

LIMITATIONS OF THE STUDY

Although a comprehensive approach was adopted, the study has certain limitations. First, the analysis is based on the data retrieved from [Lens.org](https://lens.org), hence there may be possibilities of excluding pertinent scholarly publications indexed in other databases, namely, Scopus, Web of Science, PubMed/MEDLINE, Google Scholar, etc. Second, publications from other languages were excluded, potentially overlooking significant ones. Third, bibliometric/thematic analysis above all provides quantitative trends and structural patterns, but does not reflect real world content of effectiveness of the LLM-assisted teaching practices. Lastly, the analysis of collaboration networks may be affected by the unprocessed author data (for example, “null null”).

These limitations may be overcome in upcoming studies by the use of multiple databases, literature in several languages, and a mixed methods model which integrates bibliometric studies with qualitative and empirical approaches.

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COMPETING INTERESTS

The author hereby declares that there are no competing interests.

CONFLICT OF INTEREST

The author hereby declares that there is no conflict of interest regarding this manuscript.

ETHICS STATEMENT

The author hereby declares that the ethical obligation was followed and research was conducted by abiding ethical research principles.

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