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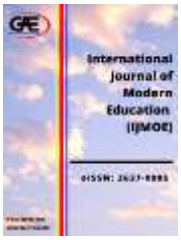

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RESEARCH TRENDS IN ARTIFICIAL INTELLIGENCE FOR LEARNING ANALYTICS: A BIBLIOMETRIC MAPPING

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Abstract:

Artificial Intelligence (AI) has progressively been integrated into learning analytics, thereby enhancing data-driven decision-making processes within educational settings. Despite the rapid growth of this interdisciplinary field, a comprehensive understanding of its publication productivity, citation impact, and thematic evolution remains limited. To address this gap, this study presents a Scopus-based bibliometric mapping that integrates productivity indicators, citation impact analysis, and longitudinal thematic clustering to provide a structural overview of AI-driven learning analytics research. This study aims to map the research landscape of AI in learning analytics through a bibliometric analysis. Bibliographic data were sourced from the Scopus database, spanning publications from 2010 to 2025. A comprehensive analysis of 1,401 documents was conducted using VOSviewer to examine publication trends, research productivity and impact across countries, authors, and publications, as well as dominant research themes. The results show a significant increase in publications over the past few years, suggesting growing scholarly interest in AI-driven learning analytics. The United States, Australia, and China emerged as the most productive and influential countries, while a small group of highly cited authors and journals also demonstrated high research impact based on citation indicators. Keyword co-occurrence analysis revealed significant research themes, encompassing AI-driven educational analytics, predictive analytics modelling, adaptive learning systems, generative AI-driven learning analytics, immersive technologies, multimodal analytics, and natural language processing-based applications. In conclusion, this study provides a systematic

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mapping of research trends and the intellectual structure of AI-driven learning analytics. The findings offer strategic insights for researchers, educators, and policymakers by highlighting emerging methodological innovations, expanding application domains, and opportunities for interdisciplinary collaboration.

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Keyword:

Artificial Intelligence, Bibliometric, Educational Data Mining, Learning Analytics, Research Trends

Introduction

Learning analytics, a rapidly growing research area, uses advanced data-driven methods to identify complex learning patterns and improve educational outcomes (Ali et al., 2025). In the modern education approach, learning analytics employs analytical methods to collect, analyse, and interpret data generated by students and learning environments to support evidence-based decision-making and enhance educational performance (Timmi et al., 2022).

Recent studies have highlighted the significant integration of learning analytics into educational settings, which aims to enhance learning outcomes and optimize educational environments. For instance, an experimental study demonstrated that employing learning analytics platform significantly improved students' academic performance and learning motivation, highlighting the effectiveness of data-driven educational interventions (Li, 2025). Learning analytics play a significant role in higher education decision-making, providing insights that ultimately improve student success and enhance educational quality (Nartgün & Kennedy, 2025).

The rapid digitalization of education, driven by the widespread use of learning management systems, online courses, and blended learning environments, has generated large volumes and heterogeneous educational data (Moreno-Marcos et al., 2025). By leveraging these educational datasets, researchers and educators gain significant insights into student behaviour, engagement, and academic performance (Oyedotun et al., 2025). However, the increasing complexity and massive of educational data pose challenges beyond the existing traditional statistical and descriptive analytical techniques (Ampadu, 2023; Veldkamp et al., 2021).

To overcome this challenge, Artificial Intelligence (AI) has increasingly been integrated into learning analytics research and practice, primarily due to its ability to manage high-dimensional data and learn complex patterns from a wide range of data sources (Ikegwu et al., 2024). AI

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techniques, particularly machine learning, deep learning, multimodal learning, Natural Language Processing (NLP), and Educational Data Mining (EDM), have significantly enhanced the analytical capabilities of learning analytics systems. For instance, studies conducted by Shaik et al., (2022) and Guerrero-Sosa et al., (2025) show the application of NLP and multimodal learning analytics to derive valuable insights from a diverse of data sources.

Numerous studies have utilized AI-powered algorithms for predictive analytics, facilitating educators in identifying students at risk and implementing targeted interventions (Alalawi et al., 2025). Furthermore, previous research has demonstrated the efficacy of AI-powered learning analytics in various domains, such as student performance prediction (Ouyang et al., 2023), adaptive learning systems (Afolabi et al., 2025), and personalized feedback mechanisms (Agarwal et al., 2023). Thus, AI has become a core methodological foundation in contemporary learning analytics research, reshaping pedagogical practices and enabling adaptive, learner-centred educational environments.

Despite the extensive adoption of AI in educational contexts, its application within learning analytics has evolved into a rapidly expanding body of scholarly literature across multiple disciplines. Recent studies have explored a wide range of themes, such as algorithm development, feature selection, ethical AI, learning behaviour modelling, and system implementation. For example, Imran et al., (2025) employs advanced machine learning and deep learning techniques in system development to transform education into a more effective, personalised, and supportive experience for institutional stakeholders. A study conducted by Siddiqui et al., (2025) highlighted the significance of combining learning analytics-based behavioural data with psychological constructs to improve the predictive accuracy of early warning systems and facilitate ethical, timely interventions for student retention.

Due to the rapid expansion of AI-driven learning analytics research has produced a complex and disseminated body of knowledge, making it difficult to synthesize using traditional narrative reviews. As this research area grows rapidly and interdisciplinarily, it has become crucial to systematically examine its development, key contributors, and dominant research themes. Bibliometric analysis offers a robust and objective methodology for assessing extensive academic literature by quantitatively analyzes publication trends, citation influence, collaborative networks, and thematic structures (Gan et al., 2022). Despite the existence of several review studies on AI applications in education, a comprehensive bibliometric mapping solely focussing on AI in learning analytics is still relatively limited in providing insights into the thematic and longitudinal evolution of AI-driven learning analytics over time.

Building on these considerations, this study aims to conduct a comprehensive bibliometric analysis to map research trends in AI for learning analytics. The study addresses the following research questions (RQ):
RQ1: What are the publication trends in AI research within learning analytics?
RQ2: Which countries, authors, and publications have demonstrated the highest research productivity and impact in AI for learning analytics?
RQ3: What are the most dominant research themes on AI in learning analytics?

By addressing these research questions, the study seeks to provide a comprehensive overview of the intellectual landscape of AI-driven learning analytics and to identify emerging directions including methodologies, applications, and interdisciplinary integration, for future research in this field. These empirical findings offer valuable for researchers planning future studies,

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educators understanding the foundations of AI-enabled learning systems, and policymakers seeking evidence-based educational innovation.

Methodology

The present study employs a bibliometric analysis method to examine research trends in the field of AI within the domain of learning analytics. Bibliometric analysis is a content analysis method that has been widely adopted for exploring extensive bodies of scientific literature (Donthu et al., 2021). In addition, the bibliometric analysis method facilitates the identification and visualization of relationships among publications, countries, authors, and cited authors through mapping techniques (Su et al., 2021). Recent studies further emphasize the growing adoption of bibliometric methods to illustrate the evolution of academic research across diverse domains (Amiruddin et al., 2025; Lazarides et al., 2025). The methodology of the study is structured into two primary phases: data collection and data analysis.

Data Collection

In this phase, the bibliometric study was conducted at the end of December 2025. The Scopus database was used as the data source due to its wide disciplinary coverage and consistent indexing of AI and learning analytics publications. The study conducted a data search across the Scopus database, spanning from 2010 to 2025, using combined terms and keywords related to AI and learning analytics. This search query was applied to the article titles, abstracts, and keywords, with English as the language of filtering, as shown in Table 1 and Table 2. This phase resulted in the final refined search, comprising 1,401 records from diverse fields of study, which were subsequently utilized for bibliometric analysis.

Table 1: Search String

Scopus	TITLE-ABS-KEY ((AI OR "artificial intelligence") AND ("learning analytic*")) AND PUBYEAR > 2011 AND PUBYEAR < 2026 AND (LIMIT-TO (LANGUAGE , "English"))

Table 2: Selection Criterion in Searching

Criterion	Inclusion	Exclusion
Timeline	2010 - 2025	< 2009
Language	English	Non-English

Data Analysis

During this phase, the study exported metadata records in plain text format, which were retrieved from the Scopus database covering publications from 2010 to December 2025. The final dataset contained 1,401 records with bibliometric information such as publication year, title, author, journal, citation, and keywords. The study conducted a bibliometric analysis using both performance analysis and science mapping techniques. Performance analysis was used to assess annual publication trends, citation impact, and research productivity. In addition, science mapping techniques, particularly keyword co-occurrence analysis and thematic clustering, were utilized to construct thematic clusters and reveal the conceptual structure and longitudinal evolution of AI-driven learning analytics research. The study employed three tools, including Microsoft Excel 2016, for calculating the frequency and percentage of publications and

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generating appropriate graphical representations. Vosviewer (version 1.6.19) was utilized to create and visualize bibliometric networks, while Harzing's Publish and Perish tool was used to compute citation metrics.

Results and Discussion

This section presents the findings derived from bibliometric analysis of AI research within the field of learning analytics. The analysis of 1,401 records provides insight into mapping research productivity, impact, and thematic evolution in the field of AI for learning analytics. By analyzing publication trends, citation patterns, and keyword co-occurrence, the results provide a comprehensive overview of the intellectual structure and development of AI-driven learning analytics research. The findings are organized according to the study's research questions to facilitate coherent discussion and interpretation.

RQ1: What Are the Publication Trends in AI Research Within Learning Analytics?

To address RQ1, this study examines publication trends over time to highlight the growth of AI research in learning analytics. The study analyzed publication trends using four indicators: annual output, source types, sources, and subject areas. This analysis offers insights into the field's growth in publication patterns and structural characteristics, revealing its evolution in response to AI advances and the growing demand for data-driven educational decision-making.

Annual Publication Growth

The Figure 1 illustrates the annual publication trends in AI research within learning analytics from 2010 to 2025. The results show a clear upward trend, indicating the increasing interest in the field. Initially, publication output remained relatively low, with only 15 recorded between 2012 and 2014. Notably, there were no publications between 2010 and 2011. However, a noticeable steady growth was observed between 2015 and 2018. The annual publication output increased from 25 publications in 2015 to 52 publications in 2018, indicating the beginning of a post-2018 surge in research activity.

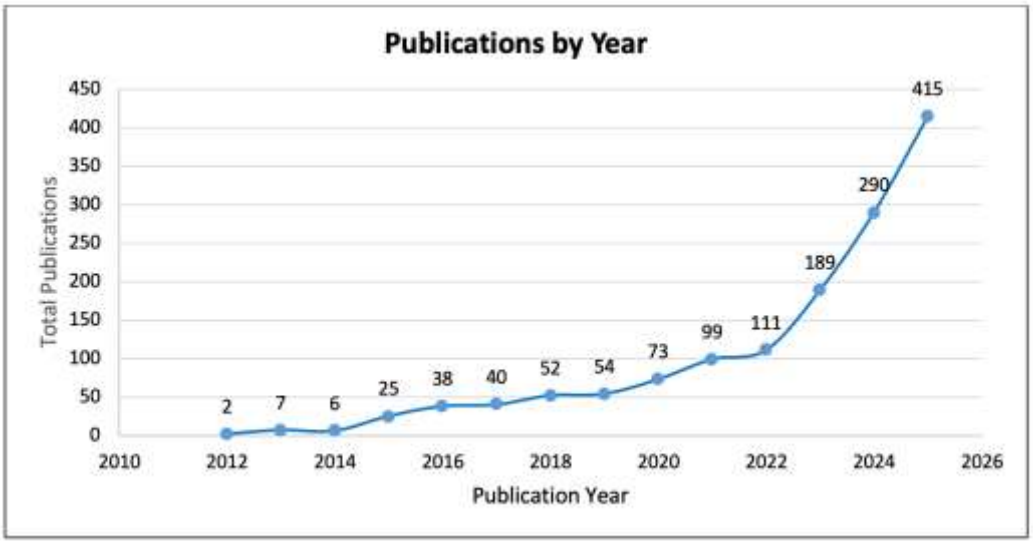

Figure 1: Annual Publication by Year

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From 2019 onward, scholarly interest in this topic has markedly increased, with the annual publication count rising from 54 publications in 2019 to 99 publications in 2021, 111 publications in 2022, and continuing to expand rapidly, reaching 415 publications by 2025. This rapid growth indicates that AI for learning analytics has matured into a highly active research area, driven by advancements in AI technologies and the increasing adoption of data-driven approaches in education. In addition, the publication's growth trend also aligns with the global shift towards data-driven educational decision-making and the integration of educational technologies into teaching and learning methodologies.

Source Types Distribution

Figure 2 illustrates the distribution of publications on AI in learning analytics by source type. The results show that journal articles dominate the publication landscape, with 547 publications, followed by conference proceedings with 454 publications. This publication distribution indicates that the field has attained a level of maturity where research is increasingly disseminated through peer-reviewed journals, which generally emphasize methodological rigour, theoretical grounding, and empirical validation. Concurrently, the substantial number of conference publications reflects the rapid pace of innovation in AI-driven learning analytics, where emerging methodologies and experimental applications are frequently introduced at academic conferences.

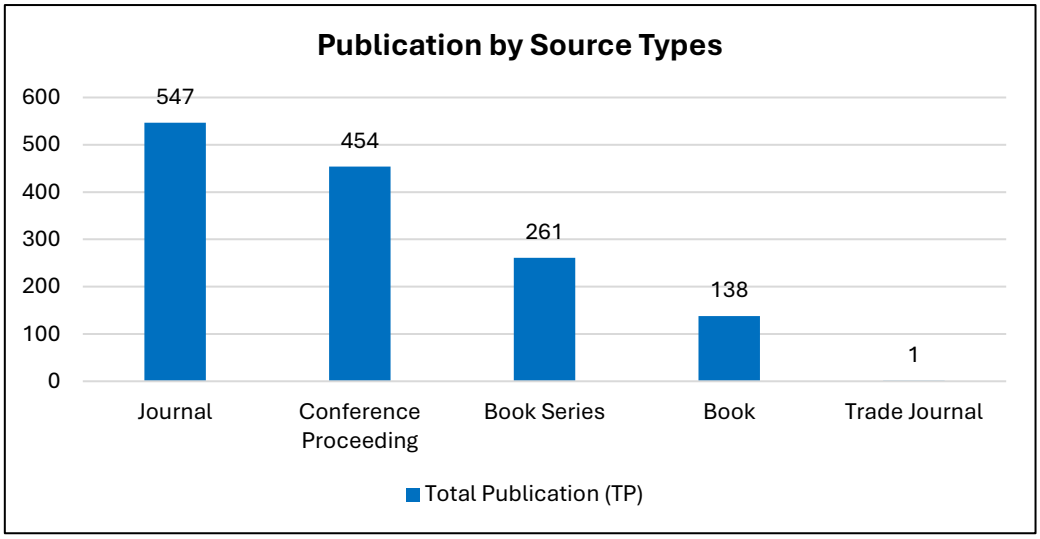

Figure 2: Source Types Distribution

Furthermore, book series (261 publications) and books (138 publications) contribute to the establishment of knowledge by offering comprehensive discussions of frameworks, methodologies, and educational applications. These source types play a crucial role in synthesizing research findings and fostering interdisciplinary understanding. In contrast, the limited presence of trade journals suggests that research in this domain predominantly remains academic, with a focus on practitioner-oriented dissemination rather than dissemination to the general public. Overall, the distribution of source types across the research landscape reveals a mature scholarly community that continues to innovate in methodological approaches, supported by a wide range of academic publication platforms.

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Leading Publication Sources

Table 3 presents the ten most leading publication sources in AI research related to learning analytics, based on the number of publications, along with their respective h-index and SJR values for 2024.The results indicate that both conference proceedings and scholarly journals contribute substantially to the dissemination of research within this field. Notably, Lecture Notes in Computer Science (LNCS) stand out as the most productive source, with 93 publications, reflecting the strong emphasis on conference-oriented dissemination in the research landscape of this area. Subsequently, followed by the CEUR Workshop Proceedings (73 publications) and the ACM International Conference Proceedings Series (54 publications), further emphasising the importance of conference venues for sharing emerging AI methodologies and experimental applications in learning analytics.

Table 3: Top 10 Leading Publication Sources

Publication Source	Total Publications	h-Index	SJR2024
Lecture Notes in Computer Science (including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)	93	499	0.352
Ceur Workshop Proceedings	73	69	0.166
ACM International Conference Proceeding Series	54	164	0.191
Communications in Computer and Information Science	48	75	0.182
British Journal of Educational Technology	34	127	2.690
Lecture Notes in Networks and Systems	33	48	0.166
Computers and Education: Artificial Intelligence	26	51	5.217
Journal of Learning Analytics	25	26	0.997
IEEE Access	18	290	0.849
International Journal of Artificial Intelligence in Education	17	68	1.960

In contrast, several high-impact journals demonstrate comparatively lower publication volumes but substantially higher influence. For instance, Computers and Education: Artificial Intelligence and the British Journal of Educational Technology exhibit high SJR values of 5.217 and 2.690, respectively, indicating strong journal prestige and citation impact. Similarly, the International Journal of Artificial Intelligence in Education is a specialized and high-quality publication that focusses on theory-driven and empirical AI research within educational settings.

In summary, the distribution of publication sources exhibits a dual publication pattern: conference series predominate in terms of research output, while established journals contribute fewer but more impactful publications. This pattern reflects both the rapid

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innovation cycle of AI research and the growing convergence of established findings in high-impact learning analytics and educational technology journals.

Subject Area Distribution

The distribution of publications on AI in learning analytics across source areas is presented in Figure 3. The results show that Computer Science dominates the field, with the largest number of publications (1,095). These areas contribute to core developments in machine learning algorithms, data mining techniques, system design, and analytical frameworks. Subsequently, followed by Engineering (309) and Decision Sciences (268), indicating the robust methodological and technical underpinnings of AI-driven learning analytics research.

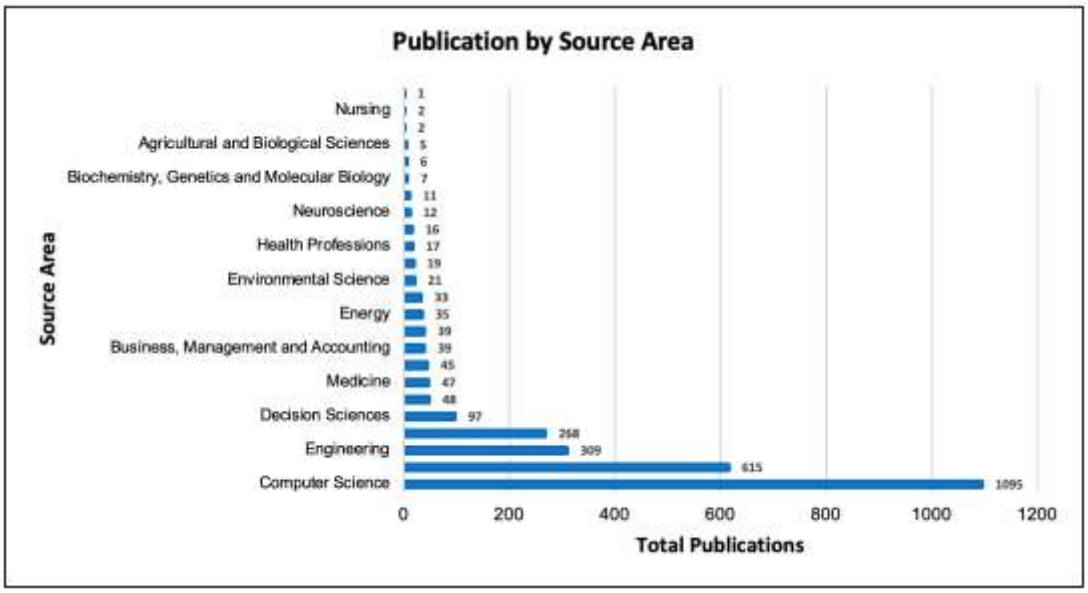

Figure 3: Publication by Source Area

Beyond the technical disciplines, significant contributions also arise from the Social Sciences, Business, Management, and Accounting, and Medicine, reflecting the interdisciplinary expansion of learning analytics into applied and domain-specific contexts. The presence of publications in Health Professions, Neuroscience, and Environmental Science, although less numerous, suggests growing interest in applying learning analytics and AI methods to specialized educational and training environments. In contrast, source areas such as Agricultural and Biological Sciences, Nursing, and Energy show minimal representation, indicating limited integration of learning analytics research within these domains.

Collectively, the distribution of publications on AI in learning analytics shows that it is primarily rooted in computational and engineering disciplines. However, it is gradually expanding into educational, social, and applied sciences. This pattern highlights the field's evolution from a technically driven research area to a broader interdisciplinary landscape that integrates methodological innovation with domain-specific educational applications.

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RQ2: Which Countries, Authors, And Publications Have Demonstrated the Highest Research Productivity and Impact in AI For Learning Analytics?

As outlined in RQ2, the study analyzes research productivity and scholarly impact within the field of AI for learning analytics across countries, authors, and publications. The study uses three bibliometric indicators: publication counts, citation counts, and citation impact to identify influential research publications, authors, and their geographical distributions. These findings provide insight into the global research landscape and collaborative patterns shaping AI for learning analytics.

Leading Contributing Countries

Table 4 highlights the top ten leading countries contributing to research on AI in learning analytics, along with their total publications and citation counts. The results show that the United States is the most influential contributor, with the highest number of publications (235) and citations (3,776), underscoring its central role in advancing both the volume and impact of research in this domain. Australia ranks second in publication output (140) but demonstrates a comparable citation count (3,535), indicating strong research influence and high-quality contributions despite a smaller volume of publications.

Table 4: Top 10 Leading Contributing Countries

No.	Country	Total Publications	Total Citations	Continent
1	United States	235	3776	North America
2	Australia	140	3535	Oceania
3	China	117	1790	Asia
4	India	115	1340	Asia
5	Germany	114	2141	Europe
6	United Kingdom	102	3434	Europe
7	Spain	99	856	Europe
8	Finland	79	1087	Europe
9	Japan	47	488	Asia
10	Norway	47	739	Europe

European countries collectively demonstrate substantial engagement in the field of learning analytics and educational technology research. The United Kingdom and Germany stand out with high citation counts compared to their publication numbers, demonstrating strong research visibility and impact. Other European countries, such as Spain, Finland, and Norway, also contribute steadily, reflecting the region's active involvement in this area.

While Asian countries like China, India, and Japan are showing growing research productivity, their citation impact remains comparatively lower. The result suggests that research from these regions is still gaining international visibility. In summary, the global distribution of AI-driven learning analytics research across countries indicates a strong leadership from North America and Oceania, sustained contributions from Europe, and rapidly expanding participation from Asia. This distribution pattern reflects both established research ecosystems and emerging centres of innovation in the field.

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Most Productive and Influential Authors

The study further determined the most productive and influential authors in AI research focussing on learning analytics by analyzing three key metrics: total publications, total citations, and average citations per publication, as presented in Table 5. The results show that Gašević, D. (Australia) is the most productive author, with 33 publications and 990 citations, reflecting a sustained and influential contribution to the field. Several other Australian authors, including Martinez-Maldonado, R., Echeverría, V., Yan, L., and Khosravi, H., also rank highly, highlighting Australia's prominent research leadership in the domain of learning analytics.

Table 5: Top 10 Productive and Influential Authors

No.	Author	Country	Total Publications	Total Citations	Average Citations
1	Gašević, D.	Australia	33	990	30.00
2	López-Pernas, S.	Finland	27	136	5.03
3	Saqr, M.	Finland	27	130	4.81
4	Martinez-Maldonado, R.	Australia	23	507	22.04
5	Cukurova, M.	United Kingdom	18	892	49.55
6	Echeverria, V.	Australia	16	262	16.37
7	Yan, L.	Australia	16	305	19.06
8	Khalil, M.	Norway	15	150	10.00
9	Khosravi, H.	Australia	15	265	17.66
10	Nguyen, A.	Finland	15	342	22.80

In terms of citation impact, Cukurova, M. (United Kingdom) stands out with the highest average citations per publication (49.55), despite a lower publication count, which suggests high-quality and highly influential research. Authors from Finland, including López-Pernas, S., Saqr, M., and Nguyen, A., demonstrate consistent productivity but comparatively lower average citations. This observation suggests their active engagement in research and their potential for significant impact.

Overall, the distribution pattern indicates a concentration of influential authors in Australia and Northern Europe, reflecting robust institutional ecosystems and collaborative networks. The variation between publication volume and citation impact further demonstrates that influence in AI-driven learning analytics is not solely determined by productivity but also by research quality and thematic relevance.

Most Cited Publications

To explore the scholarly impact of AI for learning analytics research, the study analyzed citation patterns of the most influential publications. The analysis uses publication counts, citation counts, and citation impact as key indicators to identify highly cited works. Table 6 presents the top ten most cited publications, showcasing their scholarly impact through their total citations and citations per year.

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Table 6: Top 10 Cited Publications

No.	Publication Title	Author	Publication Source	Total Citations	Citation/Year
1	Should robots replace teachers? Mobilisation of AI and learning analytics in education	(Alam, 2021)	2021 International Conference on Advances in Computing, Communication, and Control (ICAC3)	711	142.2
2	Learning analytics for investigating the mind map-guided AI chatbot approach in an EFL flipped speaking classroom	(Lin & Mubarok, 2021)	Educational Technology & Society	262	52.4
3	Human-centred learning analytics and AI in education: A systematic literature review	(Alfredo et al., 2024)	Computers and Education: Artificial Intelligence	218	109
4	Learning analytics and AI: Politics, pedagogy and practices	(Shum & Luckin, 2019)	British journal of educational technology	205	29.29
5	Automated machine learning: AI-driven decision making in business analytics	(Schmitt, 2023)	Intelligent Systems with Applications	197	65.67
6	Incorporating AI and learning analytics to build trustworthy peer assessment systems	(Darvishi et al., 2022)	British Journal of Educational Technology	140	35
7	AI-driven learning analytics for personalized feedback and assessment in higher education	(Vashishth et al., 2024)	Book: Using traditional design methods to enhance AI-driven decision making (pp. 206-230).	128	64

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8	Prompt Aloud!: Incorporating image-generative AI into STEAM class with learning analytics using prompt data	(Lee et al., 2024)	Education and Information Technologies	104	52
9	Empowering teachers with AI: Co-designing a learning analytics tool for personalized instruction in the science classroom	(Nazaretsky et al., 2022)	LAK22: 12th International Learning Analytics and Knowledge Conference	101	25.25
10	AI-driven predictive analytics for autonomous systems: A machine learning approach	(Goriparthi, 2024)	Revista de Inteligencia Artificial en Medicina	100	50

The results show that the most influential publication is "Should Robots Replace Teachers? Mobilisation of AI and Learning Analytics in Education" by Alam (2021). This work has received 711 citations and the highest citation rate (142.2 citations per year). It has strongly influenced academic discourse by critically examining the role of AI and learning analytics in education, particularly in relation to pedagogical change and ethical considerations.

Several other highly cited studies concentrate on the pedagogical integration of artificial in AI and learning analytics. For instance, Lin and Mubarok (2021) investigate AI chatbot-supported learning analytics in language education, while Shum and Luckin (2019) offer a foundational perspective on the political, pedagogical, and practical implications of AI in learning analytics. These studies have significantly contributed to both conceptual understanding and classroom-level applications.

A number of recent publications with high citation rates, such as Alfredo et al. (2024) and Vashishth et al. (2024), demonstrate growing interest in human-centred, trustworthy, and personalized AI-driven learning analytics. The growing presence of studies related to generative AI (Lee et al., 2024), automated machine learning (Goriparthi, 2024), and teacher empowerment (Nazaretsky et al., 2022) further underscores the field's evolution towards responsible and practice-oriented AI adoption. In summary, the citation distribution results indicate that the most influential publications in AI-driven learning analytics research cover conceptual debates, empirical classroom studies, and system-level innovations. This observation highlights the multidisciplinary and rapidly evolving nature of the field.

RQ3: What Are the Most Dominant Research Themes on AI In Learning Analytics?

Extending the productivity and impact analysis in RQ2, the study further shifts its focus to identifying the conceptual and thematic structure of AI research in learning analytics domain, as defined in RQ3. The present study employs keyword-based bibliometric techniques, particularly co-occurrence analysis and thematic clustering, to investigate both established

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research themes and emerging directions within the field. This thematic map analysis offers insight into the intellectual structure of AI-driven learning analytics, highlighting the aspects of AI that are most extensively explored.

Keyword Co-occurrence Network

To explore the conceptual framework and dominant research themes within the field of AI in learning analytics, a software tool, Vosviewer was used to generate and visualize a bibliometric network map depicting the co-occurrence of keywords across the authors' publications. Figure 4 presents a network visualization map of the author's keywords, generated using Vosviewer with a minimum of five keyword occurrences and the fractional counting method. Each node in Figure 4 represents a keyword extracted from the dataset. The colour, node size, font size, and thickness of connecting lines indicate a relationship between keywords. Larger node sizes suggest more frequent keyword occurrences, and these keywords often serve as the leading keywords in the research topic.

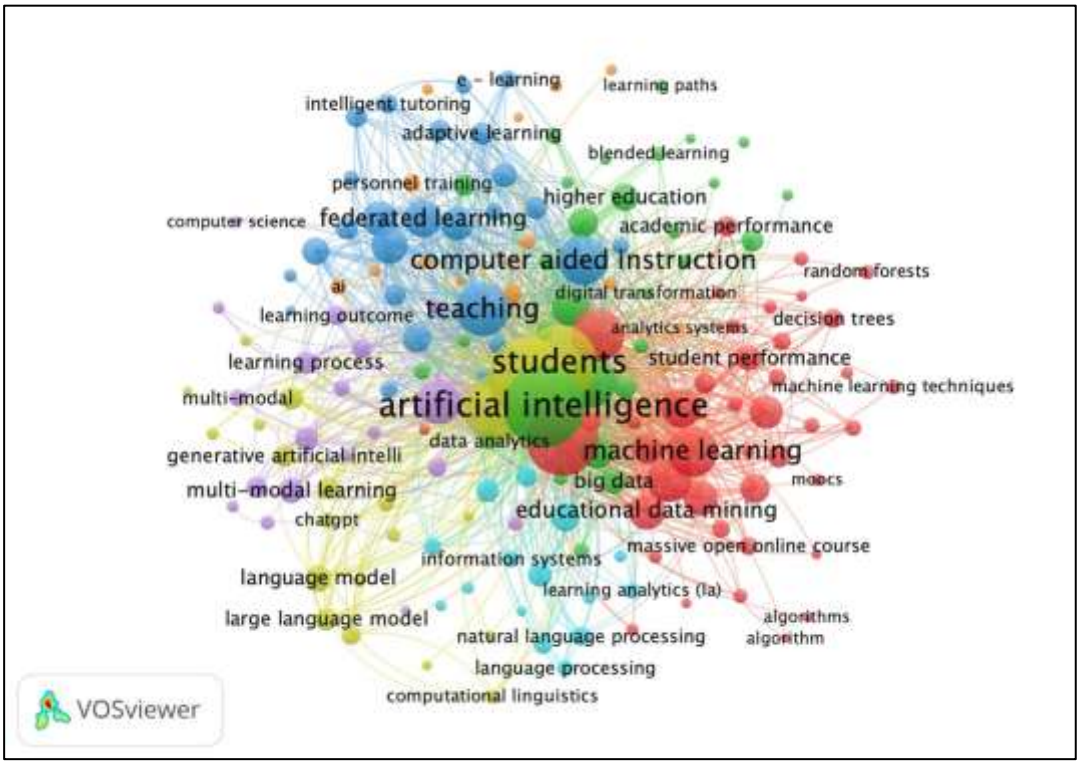

Figure 4: Keyword Co-Occurrence Network

The visualized nodes in Figure 4 demonstrate a densely connected and multidisciplinary structure, suggesting strong conceptual integration across AI-related research in learning analytics. The results highlight core keywords, including artificial intelligence, machine learning, students, and educational data mining, are prominently displayed as highly significant nodes, underscoring their foundational role in the field.

The default clustering algorithm employed in VOSviewer visualized 84 keywords and grouped them into seven different colour clusters as shown in Figure 4. These different colour clusters represent distinct thematic clusters, aiding in identifying the research focus areas. The clusters highlight interdisciplinary connections, particularly the overlap between educational data mining, AI methodologies, and learning analytics applications. Notably, emerging topics such

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as generative AI, large language models, and multimodal learning analytics are positioned as interconnected hubs, indicating their growing influence on the research landscape. These cluster visualisations offer a comprehensive overview of the current state of AI for learning analytics research, as well as emerging trends within the field.

Dominant Research Themes

The previous keyword co-occurrence analysis identified seven thematic clusters, thereby highlighting the prominent and emerging research areas within the field of AI dedicated to learning analytics. The study further categorized these seven thematic clusters through interpretative analysis of the representative keywords. Table 7 presents the intepretative results of the keyword co-occurrence analysis, underscoring the primary thematic clusters and their respective representative keywords.

Table 7: Thematic Clusters and Representative Keywords

Cluster	Theme	Representative Keywords
1	Predictive Analytics and Educational Data Mining	education computing, data mining, educational data mining, machine learning, learning algorithms, predictive analytics, learning systems
2	AI-Driven Learning Analytics Platforms	artificial intelligence, advanced analytics, big data, data analytics, e-learning, learning management system, teaching and learning
3	Adaptive and Intelligent Learning Systems	computer aided instruction, federated learning, contrastive learning, adaptive learning, educational technology, tutoring system, student engagement
4	Generative AI in Learning Analytics	learning analytics, large language model, language model, generative artificial intelligence, collaborative learning
5	Multimodal and Self-Regulated Learning Analytics	multi-modal learning, multimodal analysis, multimodal learning analytics, multimodal data, self-regulated learning
6	Natural Language Processing for Learning Analytics	natural language processing, language processing, behavioral research, deep learning, natural language, data science, data analytics, information system, human computer interaction
7	Immersive Technologies in Learning	virtual reality, augmented reality, learning behaviour, educational innovation, emerging technology, technology enhanced learning

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The results reveal seven dominant research themes that have significantly evolved the research landscape in AI for learning analytics. Based on the representative keywords, the study classified Cluster 1 as Predictive Analytics and Educational Data Mining. This cluster emphasizes machine learning, predictive modelling, and educational data mining techniques, which are employed in learning systems and reflect the methodological impact of analyzing learning behaviours. The second cluster, AI-Driven Learning Analytics Platforms, explores the integration of AI into educational platforms, particularly within e-learning environments and learning management systems.

Cluster 3, which concentrates on Adaptive and Intelligent Learning Systems, emphasizes the educational pedagogical application of AI technology, particularly in enhancing student engagement through adaptive instructional support. Notably, Cluster 4 reflects emerging research directions in Generative AI in Learning Analytics, highlighting the growing adoption of generative AI and large language models in this field. This cluster emphasizes collaborative learning, intelligent feedback, and the utilization of generative AI models to facilitate interactive and human-centric learning analytics.

Cluster 5 reflects growing attention to Multimodal and Self-Regulated Learning Analytics with dedicated on analyzing multimodal data sources, encompassing behavioural, interaction, and contextual data, to gain insights into learning processes. This cluster frequently addresses self-regulated learning and the integration of multiple data modalities to comprehensively capture complex learner behaviours. In contrast to Cluster 6, this cluster emphasizes Natural Language Processing for Learning Analytics. It highlights the significance of employing NLP and deep learning techniques to analyse discourse, behaviour, and interaction data in learning analytics.

Cluster 7 finally captures Immersive Technologies in Learning, representing exploratory but expanding research on immersive learning environments, such as virtual and augmented reality within educational settings and technology-enhanced learning environments. The overall thematic findings demonstrate a distinct evolutionary progression in AI-driven learning analytics. Established research themes, grounded in predictive analytics, student performance modelling, and educational data mining, form the foundational analytical core of the field.

In contrast, recent research developments indicate a shift towards explainable AI, adaptive and personalized learning systems, and multimodal analytics. Notably, generative AI-driven learning analytics has emerged as a rapidly expanding research frontier, supported by the significant growth in publications since 2020, the high frequency of keywords related to the topic, thematic evolution mapping, and its representation among the top 10 cited publications in Table 6 (e.g., Lee et al., 2024). This transition signifies a shift from conventional predictive approaches towards more integrated, adaptive, and AI-powered learning ecosystems.

This evolutionary progression underscores both methodological advancement and technological innovation within the discipline. It suggests that future research will increasingly integrate generative AI and intelligent systems into scalable, context-sensitive, and data-rich educational environments. Consequently, this transition is likely to redefine the next generation of AI-driven learning analytics research.

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Conclusion

The study presents a bibliometric mapping of research on AI in learning analytics from 2010 to 2025, encompassing publication productivity, citation impact, and thematic evolution within this field. This bibliometric study employs performance analysis and science mapping techniques to analyze bibliographic data, thereby contributing to a comprehensive understanding of the evolution of AI-driven learning analytics over time. The findings show a steady increase in research publication output, primarily disseminated through journals and conference proceedings. Computer science and engineering remain the primary disciplinary foundations of research, alongside growing contributions from education, social sciences, and applied domains. These trends indicate that AI-driven learning analytics is a mature field supported by interdisciplinary research activity.

In terms of research productivity and scholarly impact across countries, the United States stands as the leading contributor, ranking first in both publication output and citation impact. Australia closely follows, exhibiting significant influence relative to its research volume. European nations, notably the United Kingdom and Germany, maintain consistent research visibility, whereas Asian countries, including China and India, demonstrate increasing productivity. Although the term of the author and publication impacts are significant, the findings indicate that a relatively small group of highly influential scholars and widely cited works play a pivotal role in shaping the field.

The study further examined the dominant research themes by analyzing keyword co-occurrence and thematic clustering. The findings revealed seven core themes, including AI-driven educational analytics, predictive analytics modelling, adaptive learning systems, generative AI-driven learning analytics, immersive technologies, multimodal analytics, and NLP-based applications. These derived themes illustrate a recent shift towards more intelligent, adaptive, and integrated educational ecosystems, with the increasing prominence of generative AI-enhanced learning analytics and explainable learning analytics.

The bibliometric study presents a comprehensive overview of the AI landscape in learning analytics, establishing a foundation for future research on emerging methodologies, applications, and interdisciplinary integration. In addition, the study serves as a valuable resource for researchers, educators, and policymakers, thereby offering insights into current research priorities and potential future opportunities in these disciplines.

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