

REVIEW

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# A bibliometric analysis of research trends in the application of artificial intelligence by college students in research writing

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## Abstract

AI has emerged as a transformative force across a wide range of sectors, including education. Tools like ChatGPT, Grammarly, and Quillbot are increasingly integrated into college students' writing processes, providing real-time support for grammar correction, content paraphrasing, citation formatting, and even literature review synthesis. However, the mounting acceptance of AI tools among students reflects a broader shift toward digital academic ecosystems. In response, the incorporation of artificial intelligence (AI) tools into research writing has led to a surge in scholarly publications, highlighting the need for a bibliometric analysis to systematically examine emerging trends and identify future directions in this rapidly evolving and interdisciplinary field. Bibliometric data were sourced from the Scopus database, covering 10 years from January 2015 to June 2025. The analysis was conducted using Bibliometrix and VOSviewer, complemented by Microsoft Excel and RStudio for data retrieval and visualization. Results revealed a yearly growth rate of 32.75% in the field's publications. Countries such as China and the United States are at the forefront of research output production, indicating their substantial investment in the application of AI among college students to research writing procedures. Keyword co-occurrence analysis revealed thematic clusters centered on AI tools, including artificial intelligence, ChatGPT, students, academic writing, and higher education. There is also a growing presence of multiple countries where college students utilize AI in research writing, as indicated by keyword co-occurrence networks. The findings indicate an increasing global demand, participation, collaboration, and interest among college students in applying AI to research writing standards and procedures.

**Keywords** Artificial intelligence (AI), College students, ChatGPT, Grammarly, Research writing

## 1 Introduction

Artificial Intelligence (AI) is redefining the landscape of higher education, particularly in how students engage in academic and research writing. As intelligent systems capable of processing human language, learning from data, and generating coherent text, AI applications such as ChatGPT, Grammarly, Quillbot, Elicit, and Scite are transforming the



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way students plan, draft, and refine scholarly work [2, 7]. These technologies offer immediate feedback on grammar, structure, and style, assist in paraphrasing and summarizing content, and even support literature synthesis and citation management [16, 25]. Among college students, these tools are now frequently employed in research writing for various purposes, ranging from conducting literature reviews and generating ideas to refining grammar and managing citations, thereby streamlining the writing process and expanding access to scholarly content. AlSamhori and Alnaimat [4] explain that, beyond streamlining the technical aspects of writing, AI has the potential to significantly enhance the effectiveness, creativity, and accessibility of scholarly work. By mechanizing repetitive tasks such as grammar correction, citation formatting, and summarization, AI allows students to focus more on critical thinking and idea development [12, 23]. Furthermore, tools like language models can help non-native English speakers articulate complex ideas with greater fluency, thereby democratizing academic expression.

However, excessive dependence on AI-generated outputs may compromise originality, critical reasoning, and writing independence [1]. These risks underscore the need for AI literacy and ethical governance in academic settings, ensuring that both students and educators understand the potential and limitations of generative systems. Empirical evidence shows that AI has quickly permeated academic life worldwide. Surveys reveal that most university students now regularly use AI tools, with ChatGPT and Grammarly being the most familiar and frequently applied in research-related tasks [22]. In the United States, the rate of student adoption exceeds that of faculty use, reflecting a generational shift in how students approach scholarly communication [14]. Roy [24]. This surge in utilization illustrates a pedagogical transformation in which AI-assisted writing is becoming an integral dimension of academic literacy and research competence. These technologies offer immediate feedback on grammar, structure, and style, assist in paraphrasing and summarizing content, and even support literature synthesis and citation management [9, 10]. AI tools are becoming indispensable companions in the research writing process, providing students with greater confidence, accessibility, and efficiency in communicating academic ideas [5, 8, 13].

Despite its benefits, the increasing reliance on AI tools by college students raises several critical concerns. Academic integrity is a foremost issue, as students may use generative AI to produce large portions of assignments without proper attribution, blurring the lines between assistance and authorship. Another pressing challenge is skill erosion; excessive dependence on AI for tasks such as grammar correction, paraphrasing, or ideation may hinder students' development of core competencies, including critical thinking, analytical writing, and original synthesis [15, 20, 28]. Additionally, many AI tools operate as "black boxes". They may produce outputs containing biased perspectives, factual inaccuracies, or hallucinated references, which can mislead students lacking the expertise to critically evaluate such content [3, 26]. Compounding these risks is the widespread lack of AI literacy among both students and educators, which leads to inappropriate use, overtrust in AI outputs, and insufficient ethical guidance in academic settings. When harnessed thoughtfully, AI tools offer immense opportunities to elevate academic learning. They can facilitate modified learning understandings by becoming accustomed to individual student requirements, pacing, and proficiency levels [21]. For multilingual learners, AI-powered translation and grammar correction tools enhance language accessibility, enabling more inclusive participation in scholarly discourse [18].

Furthermore, AI's capacity to analyze large datasets, generate insights, and automate literature reviews can fuel research innovation, allowing students to engage with complex problems more creatively and efficiently [17]. However, these benefits necessitate the establishment of robust ethical frameworks and digital literacy programs. Such initiatives are essential to ensure students and educators use AI tools responsibly, critically evaluate outputs, and uphold academic standards in an increasingly automated educational landscape.

To capture the scope and trajectory of this emerging field, bibliometric analysis is conducted to provide a methodological framework for mapping scholarly activity and thematic development over time. It enables the systematic examination of publication growth, citation impact, keyword networks, and patterns of collaboration across countries and disciplines. Through this lens, it discerns how research on AI and college student writing has evolved conceptually, from previous studies to contemporary explorations of generative AI applications in research writing among college students. By situating AI within the intersecting contexts of technology, pedagogy, and academic integrity, this study contributes to a deeper understanding of how intelligent systems are reshaping research writing practices, redefining scholarly research writing among college students.

## 2 Methodology

A bibliometric analysis was conducted using the Scopus database, chosen for its comprehensive coverage of peer-reviewed scholarly sources. The search employed the provided Boolean string, covering publications from January 2015 to June 2025. The dataset included document types such as journal articles, conference papers, books, and reviews, all limited to the English language and at the final publication stage. Data cleaning was performed using OpenRefine (v3.7) and Microsoft Excel to ensure the integrity and accuracy of the bibliometric dataset. Duplicate records (e.g., repeated DOIs, identical titles, or overlapping metadata) were automatically flagged in OpenRefine and manually reviewed. Duplicates were identified by matching author names, publication year, and title strings, and only one version of each record was retained. Publications with missing bibliographic information (e.g., incomplete titles, authors, or missing publication years) were excluded if the missing data affected analysis reliability. After cleaning, 169 documents remained in the final dataset. The annual publication growth rate was computed using the Compound Annual Growth Rate (CAGR) formula to determine the average yearly increase in publications over the study period. The calculation followed the standard expression:  $CAGR = (N_t / N_0)^{1/t} - 1$ , where  $N_t$  denotes the total number of publications in 2025 (169 documents), and  $N_0$  represents the number of publications in the base year 2015 (3 documents) and  $t$  is the number of years between 2015 and 2025 (10 years). Substituting these values yielded a Compound Annual Growth Rate (CAGR) of 32.75%, reflecting the average annual rate at which the number of publications increased during the decade. This calculation assumes a consistent rate of growth and treats the 2025 data (collected in June) as a representative estimate of the year's publication trend.

Keyword harmonization was implemented to merge terms with identical meanings (e.g., "AI," "artificial intelligence," "machine learning") to prevent fragmentation of themes. Decisions on synonym grouping were made jointly by two reviewers (the

first and second authors). Disagreements were resolved through discussion until consensus was reached. Inter-rater reliability for these subjective judgments was assessed using Cohen's Kappa, which yielded a value of 0.87, indicating strong agreement. For the keyword co-occurrence analysis, the dataset was imported into VOSviewer. A minimum occurrence threshold of 5 was applied, meaning that only keywords appearing at least five times across the dataset were included in the final visualization. This threshold was determined to strike a balance between network clarity and the inclusion of significant terms. All subjective coding decisions, including keyword merging, exclusion of irrelevant entries, and thematic cluster naming, were independently cross-verified by the authors. Cohen's Kappa coefficient ( $\kappa=0.87$ ) confirmed a high level of consistency between raters, minimizing bias in qualitative judgments.

After the initial retrieval, duplicate and non-relevant records ( $n=14$ ) were removed. These included conference abstracts, editorial notes, and non-scholarly materials that did not meet the inclusion criteria of peer-reviewed, citable works. The final dataset, comprising 169 publications, formed the basis for all analyses. Quantitative and network analyses were conducted using Biblioshiny, a web-based interface of the Bibliometrix R package, and VOSviewer for visualization. Biblioshiny was utilized to compute descriptive indicators such as publication trends, citation impact, and co-authorship statistics. At the same time, VOSviewer facilitated the mapping of co-authorship networks, keyword co-occurrences, and thematic evolution patterns. Output tables were exported to Microsoft Excel for tabulation, and graphical visualizations were retained in their original format to preserve analytic transparency.

A bibliometric analysis was conducted, which began by collecting data on publications listed in Scopus. It is a bibliographic database that details a comprehensive synopsis of worldwide interdisciplinary logical evidence and brought about by Elsevier. The search in the database was achieved with the advanced keywords TITLE-ABS-KEY.

((“artificial intelligence” OR “AI” OR “generative AI” OR “ChatGPT” OR “machine learning” OR “natural language processing” OR “language model” OR “automated writing tools”) AND (“academic writing” OR “research writing” OR “student writing” OR “thesis writing” OR “writing skills” OR “academic literacy”) AND (“college students” OR “university students” OR “undergraduate students” OR “higher education”) AND (“challenges” OR “issues” OR “barriers” OR “difficulties” OR “opportunities” OR “benefits” OR “trends” OR “developments”)) AND PUBYEAR>2015 AND PUBYEAR<2025 AND (LIMIT-TO ( DOCTYPE, “ar”) OR LIMIT-TO ( DOCTYPE, “cp”) OR LIMIT-TO ( DOCTYPE, “cr”) OR LIMIT-TO ( DOCTYPE, “re”) OR LIMIT-TO ( DOCTYPE, “bk”)) AND (LIMIT-TO (SUBJAREA, “SOCI”) OR LIMIT-TO (SUBJAREA, “COMP”) OR LIMIT-TO (SUBJAREA, “ARTS”) OR LIMIT-TO (SUBJAREA, “ENGI”) OR LIMIT-TO (SUBJAREA, “MULT”) OR LIMIT-TO (SUBJAREA, “BUSI”) OR LIMIT-TO (SUBJAREA, “HEAL”) OR LIMIT-TO (SUBJAREA, “AGRI”) OR LIMIT-TO (SUBJAREA, “MATH”) OR LIMIT-TO (SUBJAREA, “PSYC”) OR LIMIT-TO (SUBJAREA, “DECI”) OR LIMIT-TO (SUBJAREA, “ECON”) OR LIMIT-TO (SUBJAREA, “NURS”) OR LIMIT-TO (SUBJAREA, “MEDI”) OR LIMIT-TO (SUBJAREA, “ENVI”) OR LIMIT-TO (SUBJAREA, “ENER”) OR LIMIT-TO (SUBJAREA, “MATE”) OR LIMIT-TO (SUBJAREA, “CHEM”) OR LIMIT-TO (SUBJAREA, “BIOC”)) AND (LIMIT-TO ( PUBSTAGE, “final”)) AND (LIMIT-TO (SRCTYPE, “j”) OR LIMIT-TO (SRCTYPE, “p”) OR LIMIT-TO (SRCTYPE, “b”) OR LIMIT-TO (SRCTYPE, “k”)).

These keywords indicate that the analysis covered publications from 2015 to 2025. The included document types were peer-reviewed scholarly works (journal articles, books, conference papers, and reviews) in their final stage of publication. The Transformer architecture, which underpins modern large language models, was introduced by Vaswani et al. in [27]. The search began in 2015 to capture earlier foundational work in NLP and machine learning, such as sequence-to-sequence models, attention mechanisms, and early neural language models, which set the stage for later Transformer-based advances. This allowed for a full decade-scale view of how the field evolved prior to and after the Transformer breakthrough. Key subsequent milestones include the publication of BERT and GPT-style models (from 2018 onward) and the rapid public and educational uptake of generative AI between 2020 and 2024. Extending the dataset through June 2025 allows for the inclusion of in-press and early-indexed outputs, while clearly noting partial-year coverage for 2025. Subject areas were limited to Social Sciences, Computer Science, Arts and Humanities, Engineering, Multidisciplinary and others such as Business, Health, Agriculture, Psychology, Education, because these capture the interdisciplinary core coverage relevant to education, technology, and society. The bibliometric analysis is limited only to Scopus database in English language publications, with document types such as articles, books, conference papers and reviews on its final publication within the time frame between 2015 and 2025 to ensure high-quality, peer-reviewed, and citable sources, which form the foundation of scientific discourse and citation-based impact analysis. This also ensures that the bibliometric scope only reflects the full range of the most relevant and impactful studies. The bibliometric data were generated on June 2025, thereby not reflecting the total publications of the entire year.

The extracted data from the Scopus database were managed using Microsoft Excel and OpenRefine, with the settings configured to merge synonymous keywords, including both individual words and phrases. Subsequently, the bibliometric data were analyzed in RStudio using Biblioshiny, a web-based graphical interface built on the Bibliometrix R package, after being exported from the database. Output tables from the analysis were downloaded in Microsoft Excel format, while selected graphical outputs from Biblioshiny were used in their original form without further modification. Finally, the co-occurrence analysis was conducted using VOSviewer to envision the associations among keywords within the dataset. A minimum occurrence threshold was applied to determine which keywords were included in the final analysis.

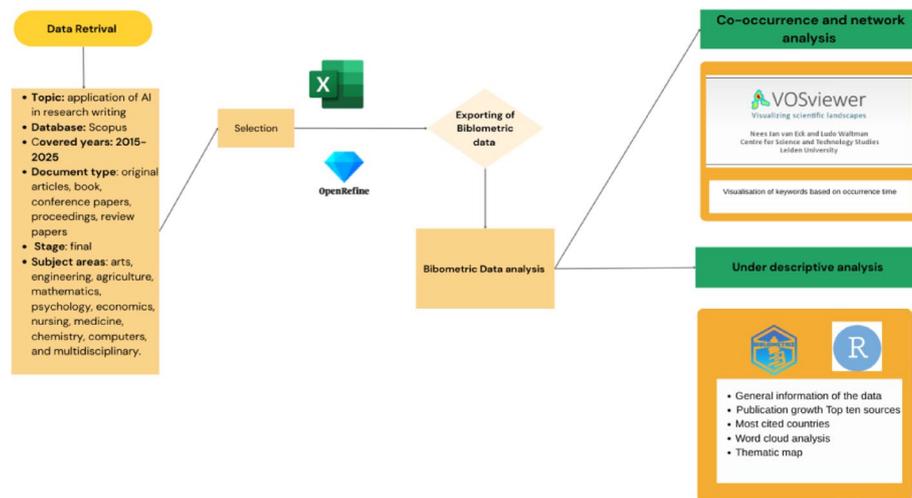
### 3 Analysis and calculation

Annual Growth Rate Calculation (CAGR) was done based on the following formula.

$$\text{CAGR} = \left( \frac{\text{Final Value}}{\text{Initial Value}} \right)^{\frac{1}{n}} - 1$$

### 4 Results and discussion

Table 1 presents a summary of information regarding studies conducted on the application of artificial intelligence by college students in research writing since 2015 until the present. A total of 169 documents are indexed in Scopus and authored by 509 individuals revealing high researcher engagement; only 36 documents or 21% of documents were single-authored, suggesting a strong trend toward collaborative research (79%). Annual



**Fig. 1** Illustrates the sequential steps followed in the bibliometric analysis, including database selection, search strategy formulation, data screening, data extraction, and bibliometric mapping and analysis. Flow chart of bibliometric analysis sequences

**Table 1** General information on the application of artificial intelligence by college students in research writing

Variables	Result
Data set	
Timespan	2015:2025
Sources (journals, books, etc.)	132
Documents	169
Annual growth rate (%)	32.75
Document average year of publication (years)	1.36
Average citations per document	12.05
Document contents	
Index keywords of all documents	554
Author's keywords of all documents	555
Authors	
Authors	509
Authors of single-authored documents	36
Authors collaboration	
Single-authored documents	37
Co-Authors per document	3.22
International co-authorships (%)	26.04
Document types	
Article	111
Article	1
Book	4
Conference paper	46
Conference review	2
Review	5

growth rate is 32.75% which measures how fast the number of publications increased each year over the timespan (2015–2025), which represents the number of documents on June 2025, the number of documents from January 2015, and the number of years between 2015 and 2025, equivalent to 10 years. This is a very high growth rate, suggesting rapidly expanding research interest. The total documents are 169; therefore, there are fewer documents from 2015 to 169 in 2025. In the document, the average year of

**Table 2** Publication growth and average citation per year from 2015 to 2025 on the application of artificial intelligence by college students in research writing

Year	Articles	MeanTCperArt	N	MeanTCperYear	Citable years
2015	3	3.00	3	0.27	11
2016	2	15.00	2	1.50	10
2017	2	0.50	2	0.06	9
2018	1	1.00	1	0.12	8
2019	1	3.00	1	0.43	7
2021	4	51.50	4	10.30	5
2022	7	7.00	7	1.75	4
2023	17	58.47	17	19.49	3
2024	81	8.17	81	4.08	2
2025	51	1.59	51	1.59	1

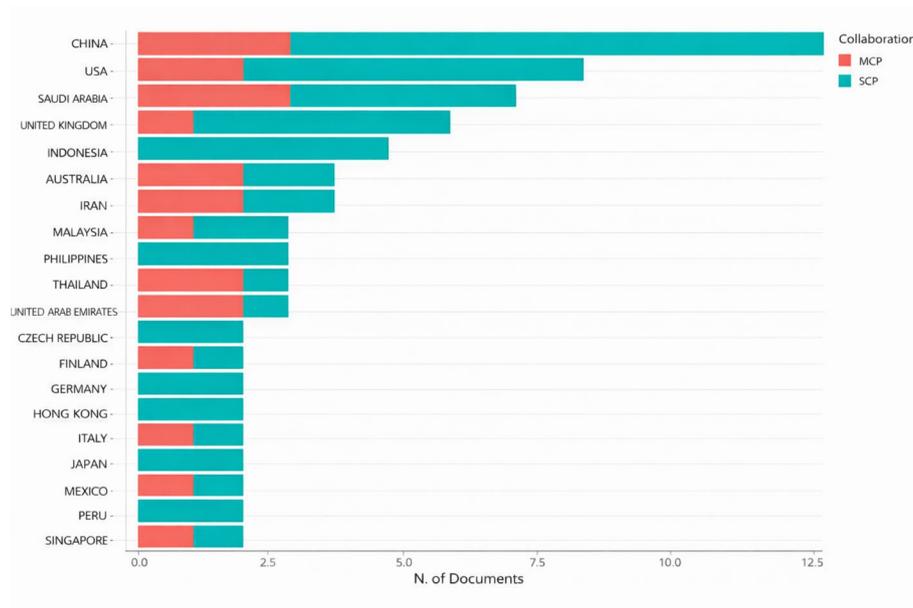
publication represents the average recency or age of publications, indicating how recent the documents are on average relative to the latest year analyzed in June 2025. The average document year is 1.36 years; most of the documents in the dataset are very recent (within the last 1–2 years). This indicates a strong and current research interest in the topic.

On average, each publication received 12 citations, indicating a moderate level of academic influence. The documents were published across 132 unique sources, indicating broad scholarly interest across journals, books, and proceedings. On average, each document involved about 3–4 (3.22) domestic co-authors, indicating healthy collaboration. International co-authorship document of 26.04, which significantly illustrated that 1 in 4 papers involved international collaboration, suggesting a global academic engagement with the topic. The majority of the works are journal articles of 111 and conference papers of 46, likely peer-reviewed on both theoretical and applied research. Many contributions come from conferences common in fast-evolving fields like AI. The data gathered covered publications from January 2015 to June 2025. It is important to note that the 2025 data are incomplete, as only documents indexed through June were available at the time of data extraction. Consequently, the total number of publications for 2025 does not represent the whole year. This partial-year coverage may lead to a slight underestimation of both the total publication count and the computed Compound Annual Growth Rate (CAGR) of 32.75%. While the calculation provides a reliable estimate of the decade-long trend, readers should interpret the 2025 values as provisional indicators rather than final figures. This clarification is provided to ensure methodological transparency and allow future researchers to accurately reproduce or update the analysis when full-year data become available. The data implied that the topic shows accelerating interest among scholars, indicating that this is an emerging and dynamically evolving field. This growth suggests a responsive academic community to recent technological innovations using AI as writing tools. These timely publications are especially relevant for understanding research trends in the application of artificial intelligence by college students in research writing.

The growth in publications and average citations per year from January 2015 through June 2025 in this field highlights a steady increase in article production. Evident rise in 2024 with 81 articles and 2025 with 51 articles, indicating surging academic interest in the topic in recent years, and there could be more to publish in 2025 because we are still in the middle of the year. In terms of citation impact over time, between 2015 and

2019, there were low publication numbers and low to moderate citations; for example, 2016 had the highest impact, with 15 citations/article, or 1.5 citations per year. The lack of publications in 2020 likely reflects a combination of external disruptions, such as the lockdowns brought on by the COVID-19 pandemic, keyword relevance/timing, and database limitations, rather than a complete absence of scholarly activity. In 2020, it was confirmed that no eligible records met the inclusion criteria, thereby validating the observed data gap. This absence likely reflects delays in database indexing and the timing of topic emergence rather than a total research hiatus. The 2020 period coincided with global pandemic disruptions and shifting research priorities, explaining the minimal relevant output. Additionally, it coincided with the peak of the global pandemic, which led to widespread disruptions in academic operations. Many colleges and universities suspended or delayed research activities, particularly those that required close supervision, collaboration, or institutional access. During the early phase of the pandemic, global research attention shifted toward health, public policy, and the adaptation of online learning. The specific focus on AI in research writing may not have been a priority area at the time, resulting in an absence of relevant publications. The integration of artificial intelligence tools, such as AI-assisted writing, plagiarism detection, and automated feedback systems, into research writing gained widespread traction only after 2021. Thus, 2020 could represent a transition phase when the topic had not yet become a recognized research trend and fewer research outputs, particularly student-led studies, were completed or published during that year. The peak impact years occurred between 2021 and 2023, with citations per year of 10.3, 1.75, and 19.49, respectively. These years likely saw foundational work on hot topics like generative AI, ChatGPT, and student writing, which led to rapid citations and represent the core period of academic engagement. In 2024, with 81 articles and an average of 4.08 citations per year, there is a strong interest, but the citation impact is moderate due to the recency of the articles. The year 2025, with 51 articles and an average of 1.59 citations per year, is a newly published work. It is expected not to gain wide citations yet, as they are too recent for high citations. These articles are relatively new and have not yet accumulated significant academic traction, but their volume reflects continued momentum in the field. This field is relatively young but is experiencing rapid growth, with notable expansion since 2021. Citation performance peaks occur 1–3 years post-publication, highlighting the typical citation lifecycle. Recent publications (2024–2025) may become influential in the near future, primarily if they address pressing or novel issues in AI and academic writing. Researchers should consider focusing on reviewing and synthesizing literature published after 2021, as this period has yielded the most impactful contributions.

Figure 2 maps the distribution of documents on the application of artificial intelligence by college students in research writing, with color intensity indicating the number of documents published per country in terms of domestic authorship and international co-authorship. China has the highest publication output, dominated by domestic authorship, with relatively low international collaboration. Seconded by the USA, with a moderate balance indicating both domestic strength and global partnerships. Saudi Arabia, the UK, and Indonesia have a notable presence. The UK shows a higher MCP, implying strong international collaboration. Saudi Arabia and Indonesia lean more toward SCPs, reflecting regional or internal collaboration. Countries with high international collaboration include the United Kingdom, Saudi Arabia, the Philippines, Germany, Italy



**Fig. 2** Top ten sources of documents (by countries) on the application of artificial intelligence by college students in research writing. MCP -Multiple Country Publications - research articles co-authored by researchers from two or more different countries; SCP - Single Country Publications - research articles authored by researchers all from the same country

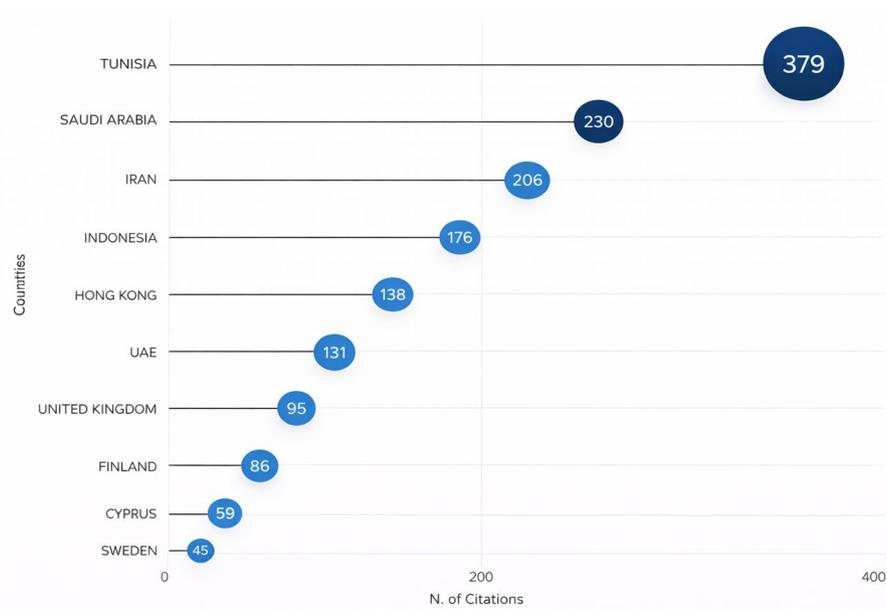
**Table 3** Country publication collaboration showing SCP, MCP and %MCP

Country	SCP	MCP	%MCP
China	12	2	14.3%
USA	10	2	16.7%
Saudi Arabia	7	2	22.2%
United Kingdom	5	3	37.5%
Indonesia	5	1	16.7%
Australia	4	2	33.3%
Iran	4	1	20.0%
Malaysia	3	1	25.0%
Philippines	3	2	40.0%
Thailand	3	1	25.0%
United Arab Emirates	2	1	33.3%
Czech Republic	2	1	33.3%
Finland	2	1	33.3%
Germany	2	1	33.3%
Hong Kong	2	1	33.3%
Italy	2	1	33.3%
Japan	2	1	33.3%
Mexico	1	1	50.0%
Peru	1	1	50.0%
Singapore	1	1	50.0%

and Singapore. These countries engage frequently in cross-border academic collaboration, suggesting they are well-integrated into international research networks. Countries like the Czech Republic, Finland, Mexico, Peru and Singapore contribute a small number of documents, but several show a clear presence of international collaboration, a sign of early-stage or niche participation in the research topic with global links. The result in Table 3 shows that China and the USA dominate the scholarly landscape in terms of

volume, but with differing collaboration styles. Countries with higher MCP percentages, such as the UK, Philippines and Germany, are strategically engaging in global academic networks, which may enhance visibility, citation impact, and research quality. Countries with mostly SCPs (e.g., China, Iran, Indonesia) may benefit from expanding international collaboration to enhance research diversity and citation potential. The rise of smaller or emerging countries such as Peru, Singapore, and Mexico indicates a broadening global interest in the research area (Fig. 3).

Top-cited countries are presented in deductive order, starting from Tunisia (379), the highest citation count despite likely lower publication volume. Suggests high-impact publications, possibly review papers or highly relevant studies. Saudi Arabia (230) has a strong citation performance, reflecting regional leadership and likely engagement in high-interest topics such as AI and education. Iran (206), a high citation count points to growing influence in international scholarly discourse. Indonesia (176) indicates a solid citation impact, possibly due to both local and internationally collaborative publications. Hong Kong (138) reflects consistent academic visibility and quality, likely driven by institutional strength and international collaboration. UAE (137) strong performance, especially for a smaller research base, is indicative of strategic, high-impact publications. The result highlights that High-impact countries are not always the most prolific. For example, Tunisia leads in citations despite not appearing as a top publishing country in your earlier chart, indicating high citation efficiency. Middle Eastern and Asian countries (Saudi Arabia, Iran, UAE, Indonesia) are showing strong citation performance, reflecting their rising influence in research on emerging topics like AI, education, and writing technologies. Smaller European countries such as Finland, Cyprus, and Sweden, while less cited, demonstrate growing participation, suggesting the international diffusion of the research theme. Hong Kong and the UK, with traditionally strong academic systems, continue to contribute impactful work, though their citation counts here are modest relative to their global stature, perhaps due to a narrower topical focus. This citation map highlights non-traditional research leaders like Tunisia, Saudi Arabia, and Iran rising



**Fig. 3** Most cited countries on the application of artificial intelligence by college students in research writing

to prominence in this domain, often with highly cited, impactful work. It also signals a shifting global research landscape, where impactful contributions are no longer dominated solely by Western countries but are increasingly coming from diverse regions. The citation map underscores two key observations: first, high-impact countries are not necessarily the most prolific; for instance,

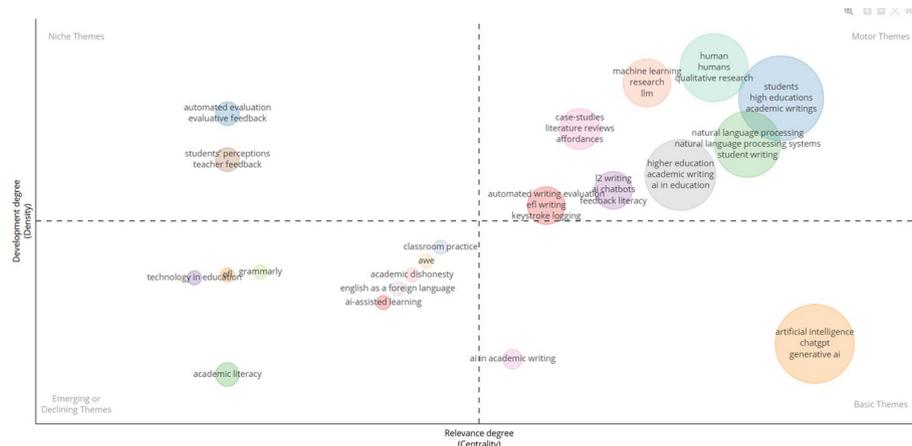
Tunisia exemplifies how focused, high-quality contributions can yield significant scholarly influence; second, the global research landscape is shifting. Traditional Western dominance in research impact is increasingly complemented and, in some cases, challenged by contributions from Middle Eastern and Asian countries. These emerging leaders, through strategic research investment and international collaboration, are reshaping the dynamics of high-impact scholarly publishing. This analysis highlights a more diversified and decentralized global research ecosystem, where quality, collaboration, and strategic focus are redefining scholarly influence across regions.

Table shows that Tunisia produced three (3) publications in total. Despite the small number, these papers accumulated 379 total citations, giving an exceptionally high average of 126.3 citations per publication. This indicates that Tunisia's contribution is limited in quantity but remarkable in scholarly influence. Given their unusually high citation rate, Tunisia's publications were most likely peer-reviewed journal articles or review papers. Review papers often receive more citations because they summarize and synthesize existing research. Highly collaborative journal articles especially in international projects can also attract significant citations. Hence, Tunisia's outputs were review articles or high-impact journal studies published in reputable international journals. This pattern clearly reflects 1–2 highly cited papers, not several moderately cited ones. With 3 publications generating 379 citations, each paper averaged over 126 citations far exceeding the field's usual range. Such a high ratio implies a few landmark studies that have been extensively cited by other researchers. Tunisia's small number of publications but very high citation rate indicates that even a few well-executed, high-quality studies can make a significant global impact. This underscores the value of prioritizing research quality over quantity in academic productivity metrics. The high citation concentration suggests that Tunisian researchers may be leading in a specialized or emerging niche area within the field. Their work likely serves as a key reference point for subsequent studies, highlighting the country's potential to influence international research directions.

While impact is strong, Tunisia's low publication volume also points to limited research continuity or institutional capacity. In Tunisia's case, the total citations stem from only three publications, resulting in an unusually high citation-per-paper ratio (126.3). This indicates that the country's impact is driven by a few highly influential studies rather than a broad base of consistent research output. Encouraging more consistent publication output could help sustain and expand its academic visibility and global collaboration network. The results imply that strategic investment in targeted, high-impact studies supported by collaboration, funding, and visibility can yield substantial citation returns, even for smaller research systems.

The word cloud represents the key themes and dominant research trends of the study, the strongest parts of the analysis are depicted in Fig. 4 as "Artificial Intelligence" and "Students" appear as the largest words, signifying that these are the central research focus. This means most studies explore how students use or are affected by AI tools in academic or research contexts. "ChatGPT" also stands out prominently, reflecting the

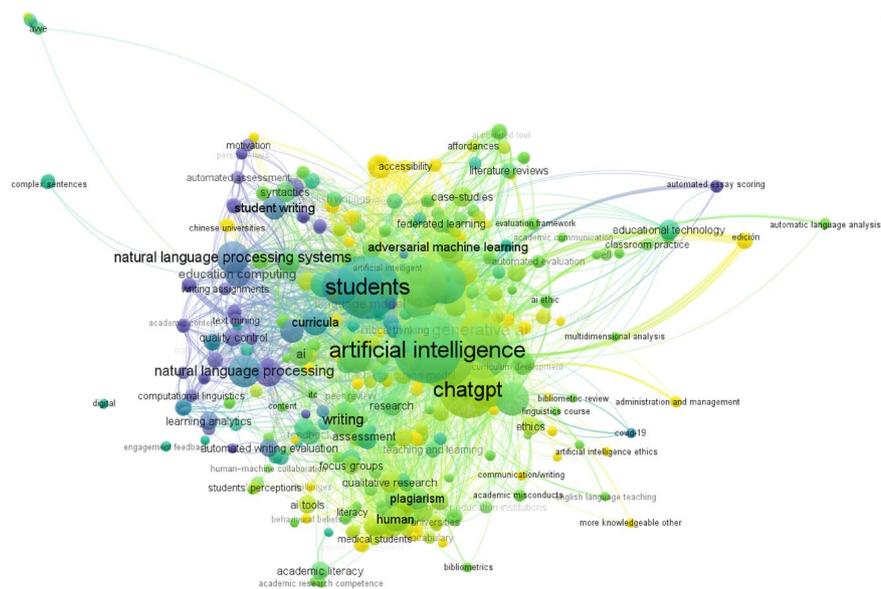




**Fig. 5** Thematic map on the application of artificial intelligence by college students in research writing. Source: [6].

and crucial themes driving current research trends corresponding to key clusters such as students, academic writings, higher education, natural language processing systems, qualitative research, machine learning, human writing. These themes show that the strongest research areas focus on students' use of AI tools in academic writing and the integration of natural language processing and machine learning in higher education. Studies emphasize how AI transforms writing processes, research methodologies, and qualitative data handling when used in writing research agendas. Second, the thematic map also represents foundational topics that are essential but still developing with words like artificial intelligence, ChatGPT, generative AI. These are the core building blocks of research in this area. They form the conceptual base, highlighting how ChatGPT and generative AI serve as fundamental innovations shaping modern research writing practices among college students. Third, it represents specialized areas studied in depth but not yet broadly influential such as automated evaluation, evaluative feedback, teacher feedback, students' perceptions. These topics represent focused investigations into feedback mechanisms and automated assessment tools, suggesting potential applications of AI in enhancing writing evaluation of students in college, but with limited mainstream adoption. Fourth, it represents topics that are new areas gaining traction or older ones losing relevance such as academic literacy, technology in education, Grammarly, AI-assisted learning. These words represent transitional phases in research, older focuses (like Grammarly) being replaced by advanced generative AI tools or new directions, such as AI-enhanced academic literacy development, being used as an avenue to aid college students in writing research.

The co-occurrence network visualization of the study highlights the strongest research connections and thematic clusters showing how frequently key terms appear together in the literature, revealing dominant and emerging research areas that represent and interpret the strongest parts of the analysis shown in Fig. 6 with the largest and most interconnected nodes "artificial intelligence," "ChatGPT," "students," "writing," and "higher education" represent the core research relationship indicating that the most influential studies revolve around how college students use AI tools such as ChatGPT to assist in research writing, emphasizing both educational and technological perspectives making AI a central topic of interests in academic writing, learning support, and ethical use in research circumstances among students in college education. Meanwhile, surrounding



**Fig. 6** Visualization of keywords based on occurrence time (VOSViewer)

clusters include “natural language processing,” “machine learning,” “automated writing evaluation,” “plagiarism,” “ethics,” and “educational technology,” which are supporting concepts that explain how AI functions among college students during their research writing endeavors such as NLP, automation and address its pedagogical and ethical implications towards responsible use. Strong links among “AI ethics,” “plagiarism,” and “academic integrity” indicate that college students writing research are increasingly concerned about responsible AI use in writing. Noticeably, newer and smaller nodes such as “adversarial machine learning,” “federated learning,” “literature reviews,” and “automated essay scoring” are evident, indicating growing subfields related to the technical and evaluative aspects of AI in college education research writing. The visualization reveals that research on AI in student writing among college students is dominated by ChatGPT-centered studies that focus on AI integration, natural language processing, and ethics in writing. The strong interconnections among these themes underscore a growing interdisciplinary trend in which technology, pedagogy, and academic integrity converge in a college education in which students thrive and grow towards the completion of their degrees, with research writing part and parcel of the educational process. The network also suggests a rapid expansion of interest among college students in writing research, moving away from traditional AI-assisted tools toward generative and interactive AI systems that redefine how students engage in a purposely and productive academic writing endeavors.

## 5 Conclusion

This bibliometric analysis confirms a substantial and accelerating growth of research on the application of artificial intelligence in college research writing, reflected in an annual publication growth rate of 32.75%. Over the past decade, this field has evolved into a dynamic and interdisciplinary area marked by strong global collaboration, particularly among countries such as China, the United States, Saudi Arabia, the United Kingdom, and Indonesia. High citation rates in Tunisia, Saudi Arabia, and Iran further indicate these nations’ active engagement in AI-driven academic research writing among college

students. The absence of data in 2020 reflects pandemic-related disruptions and database delays rather than a halt in scholarly activity. Keyword mapping and co-occurrence analyses identified artificial intelligence, ChatGPT, students, academic writing, and higher education as the most influential and frequently studied themes, demonstrating the central role of generative AI tools in shaping contemporary academic writing practices and procedures. The findings highlight the need for colleges and universities to develop clear policies and guidelines for the ethical and responsible use of AI tools in research writing. Universities may integrate AI literacy and critical evaluation skills into academic curricula to ensure students can effectively use these technologies without compromising academic integrity. International collaboration and resource-sharing frameworks may be strengthened to promote fair and equitable access to AI technologies and to foster inclusive participation in global research development. Future studies may explore the pedagogical, ethical, and cognitive impacts of AI-assisted research writing on students' learning outcomes and scholarly independence. Comparative and longitudinal analyses may also be conducted to assess the sustainability and practicality of relying on generative AI tools such as ChatGPT in authentic academic contexts across different educational systems.

## 6 Limitations

The study is limited to publications in the Scopus database published in English from 2015 to 2025, extracted in June 2025, reflecting partial data for the year. Words searched in the data base include “artificial intelligence” OR “AI” OR “generative AI” OR “ChatGPT” OR “machine learning” OR “natural language processing” OR “language model” OR “automated writing tools” AND (“academic writing” OR “research writing” OR “student writing” OR “thesis writing” OR “writing skills” OR “academic literacy” AND (“college students” OR “university students” OR “undergraduate students” OR “higher education” AND “challenges” OR “issues” OR “barriers” OR “difficulties” OR “opportunities” OR “benefits” OR “trends” OR “developments” to comprehensively capture the needed data for the bibliometric analysis. Another limitation of the study is that the bibliometric analysis conducted did not assess the quality, validity, and/ or actual impact of the interventions studied. Also, due to a comprehensive Boolean search string, keyword co-occurrence may not reflect the actual challenges and issues, or just research interests. Citation counts may favor recent publications, as the use of AI in all fields of education is increasing.

### Author contributions

First drafted the manuscript, made substantial contributions to the conception and design of the work, and participated in the acquisition, analysis, and interpretation of data. Second author revised and reviewed the manuscript critically for important intellectual content, assisted in the writing process, and contributed to improving the clarity and quality of the paper.

### Dual publication

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### Data availability

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## Declarations

### Ethics approval and consent to participate

Not applicable.

**Consent for publication**

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**Competing interests**

The authors declare no competing interests.

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