IAES International Journal of Artificial Intelligence (IJ-AI)
Vol. 15, No. 1, February 2026, pp. 66~75
ISSN: 2252-8938, DOI: 10.11591/ijai.v15.i1.pp66-75

Artificial intelligence in writing: unveiling a research landscape

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Article Info

Article history:

Received Dec 23, 2024
Revised Nov 15, 2025
Accepted Dec 15, 2025

Keywords:

Artificial intelligence
Bibliometrics
Data analysis
Generative artificial intelligence
Writing

ABSTRACT

This study examines the expanding research landscape of artificial intelligence (AI) in writing, a field that continues to reshape the way ideas are produced, refined, and communicated. While AI has been widely examined in education and technology, limited research has mapped its thematic evolution and ethical dimensions in writing. To address this gap, 1,596 publications indexed in Scopus between 2021 and 2024 were analyzed using bibliometric mapping tools such as Scopus analyzer and VOSviewer. The analysis covers publication patterns, collaboration networks, and keyword relationships to trace the intellectual structure of the field. The results indicate a sharp increase in scholarly output over the past four years, supported by contributions from multiple disciplines including computer science, social sciences, and education. Several thematic clusters were identified, centering on AI-assisted creative writing, authorship ethics, educational use, and cross-sector innovation. Despite these advances, ethical frameworks and responsible AI applications in writing remain underexplored. This paper offers a comprehensive overview of current trends and presents a foundation for future research on how AI can be integrated into writing practices responsibly and in ways that uphold human creativity and academic integrity.

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1. INTRODUCTION

Artificial intelligence (AI) has revolutionized various aspects of human life and writing is no exception. The advent of AI-powered writing tools has transformed the way we approach the writing process, from drafting to editing and beyond. These tools leverage natural language generation to produce human-quality text in seconds, raising important questions about the future of writing and its teaching. For instance, AI has been integrated into educational settings, where it assists in teaching writing by providing real-time feedback and suggestions, thereby enhancing the learning experience for students [1]. In different fields, AI has been utilized to address specific writing needs. In the realm of English as a foreign language (EFL), AI-powered writing assistants like Wordtune help non-native speakers articulate their thoughts more clearly and effectively. These tools offer various rewriting options, adjusting tone and length to suit different contexts, which aids EFL writers in maintaining a continuous flow and learning new ways to express their ideas [2]. Similarly, in the literary world, AI has been employed to generate stories, demonstrating both the potential and limitations of machine-generated narratives. While AI can

produce coherent and contextually relevant stories, it often lacks the emotional depth and creativity inherent in human writing [3].

Beyond education and literature, AI's impact on writing extends to specialized fields such as healthcare and pharmaceuticals [4], [5]. In these domains, AI is used to analyze complex data and generate reports, aiding in drug discovery, clinical trials, and disease diagnosis [6]–[8]. The ability of AI to process vast amounts of information quickly and accurately makes it an invaluable tool for researchers and professionals, streamlining the documentation process and enhancing the quality of written reports [9]. As AI continues to evolve, its role in writing across various fields is likely to expand, offering new opportunities and challenges for writers and educators alike.

2. LITERATURE REVIEW

AI is increasingly influencing writing across educational, academic, and professional domains [10]. Its integration offers clear benefits, improving productivity, supporting feedback, and aiding learners. It also introduces ethical, technical, and pedagogical challenges [9]. In education, AI-powered tools like ChatGPT significantly reduce writing time and improve quality [11]. These technologies enhance grammar, coherence, and vocabulary for EFL learners while supporting writing development through real-time, interactive feedback [12]–[14]. Positive impacts are reported across academic levels [15], [16] and writing stages such as literature review, argumentation, and result analysis [17], [18]. Scientific domains also benefit from AI's efficiency, although concerns remain over authorship and fairness [19].

The ethical implications of AI use in writing are increasingly discussed, with growing attention from both international and institutional bodies. Notably, ethical guidelines on generative AI have been issued by organizations such as the European Commission [20], UNESCO [21], and Saudi Arabia [22], alongside institutional policies introduced by universities to promote responsible AI integration in academic writing. The collective benefit, authority to control, responsibility, and ethics (CARE) framework [23] advances ethical guidance through critical and pedagogical lenses, emphasizing collective benefit, accountability, and respect for human authorship while countering over-reliance on surveillance and plagiarism detection mechanisms. Similarly, the European Commission's 2024 guidelines on the responsible use of generative AI [20], embed these principles within research governance, highlighting transparency, human oversight, and institutional responsibility. These frameworks collectively strengthen the ethical foundation of AI in writing, situating the study within a broader global movement towards responsible and human-centered AI in writing. Nonetheless, significant challenges remain the ranging from misinformation, academic dishonesty, and demographic bias [24] to technological limitations such as inconsistency, lack of adaptability, and minimal emotional responsiveness [25], [26]. These persistent issues underline the need for more comprehensive and context-sensitive ethical frameworks to guide the evolving role of AI in writing.

Despite growing interest, the literature reveals critical research gaps. Few studies explore the intersection between AI ethics and authorship accountability in collaborative writing environments, and limited work addresses culturally and linguistically diverse contexts [27], [28]. Studies also highlight transparency and factual accuracy as ongoing challenges [29], [30], little attention has been paid to how disciplinary norms shape AI-writing adoption across fields such as education, journalism, and healthcare. Addressing these omissions requires cross-disciplinary collaboration, inclusive design, and longitudinal inquiry into the long-term cognitive and ethical consequences of AI use in writing. AI holds strong potential in transforming writing, but careful, responsible integration is essential. Building on the CARE framework and current insights, this study applies bibliometric analysis to map the research landscape on AI and writing from 2021 to 2024.

Previous bibliometric studies on AI have primarily focused on broad technological or educational domains, with limited emphasis on the writing context. This study advances the discussion by critically synthesizing findings from related bibliometric analyses [31]–[35], revealing methodological variations and emerging areas of inquiry. Ethical frameworks such as CARE, UNESCO's AI ethics, and responsible AI guidelines were compared to reveal overlaps and gaps concerning authorship, integrity, and creativity. The literature remains fragmented technological studies emphasize efficiency, while ethical works address integrity in isolation. Thus, an integrated approach combining bibliometric and ethical perspectives is essential to capture the full complexity of AI-writing research.

3. METHOD

Bibliometrics involves collecting and analyzing bibliographic data from scientific publications [36]–[38], using both descriptive statistics (e.g., publishing journals, publication years, and main authors) [39] and advanced techniques like document co-citation analysis. A thorough literature review requires iterative keyword selection, literature searching and in-depth manual screening to ensure a robust bibliography and reliable findings [40]. This study focused on high-impact publications to capture critical

theoretical insights, relying on the Scopus database for dependable data [41], [42]. Only rigorously peer-reviewed journal articles were included, excluding books and lecture notes [43]. Scopus's extensive coverage enabled the collection of publications from January 2021 to November 2024, establishing a relevant timeframe to analyze recent developments in the field. By narrowing the dataset to this period, the study ensured that only contemporary contributions reflecting the latest trends and discussions were considered. The research questions guide this study to provide a comprehensive understanding of the research landscape surrounding AI in writing. These questions aim to uncover key trends, document types, prominent keywords, and global collaboration patterns within the field. Through the consideration of these aspects, the study offers insights into the evolution of AI applications in writing and highlights areas for future exploration. Table 1 presents the research questions.

Table 1. Research questions

No.	Research questions
Q1	What are the research trends in AI and writing according to the year of publication?
Q2	What are the subject domains contribute to AI in writing research?
Q3	What are the most popular keywords related to the AI-writing study?
Q4	What are the patterns of international collaboration among authors in AI-writing research?

3.1. Data search strategy

The study employed a systematic and transparent approach to retrieve relevant articles using the Scopus database. The initial query focused on the TITLE-ABS-KEY field, incorporating the terms ("writing" AND "artificial intelligence") and refining the results to include only articles published between 2021 and 2024. Further filters were applied to include only final-stage publications written in English, ensuring that the articles selected were complete and accessible for analysis. The document type was restricted to "ar" (articles) and "cp" (conference papers). Before finalizing the search, a pilot search was conducted to test different keyword combinations, and slight adjustments were made to maximize relevance and minimize noise.

The final search string yielded a comprehensive dataset of articles, which formed the basis for the bibliometric analysis. As of November 2024, all relevant articles from the Scopus database were included to ensure a thorough exploration of the topic. The final search string, TITLE-ABS-KEY (("writing" AND "artificial intelligence")) AND (LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2022) OR LIMIT-TO (PUBYEAR, 2023) OR LIMIT-TO (PUBYEAR, 2024)) AND (LIMIT-TO (PUBSTAGE, "final")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "cp")). The refinement included 1,596 articles which were used for bibliometric analysis. The explicit reporting of the query string and filtering parameters allows other researchers to replicate the search and validate the study.

3.2. Data analysis

VOSviewer was used as a co-occurrence network mapper to create a bibliometric map to visualize the relationship between keywords in each publication within the bibliometric network for future examination [44], [45]. VOSviewer, developed by Eck and Waltman [2] at Leiden University, is a widely used bibliometric tool for visualizing and analyzing scientific literature [46]. Renowned for its intuitive interface, clustering features, and density maps, it excels at mapping co-authorship, co-citation, and keyword networks. Its compatibility with various data sources and ability to generate interactive visualizations make it invaluable for exploring complex research landscapes [47]. A key strength of VOSviewer is its transformation of bibliometric datasets into accessible visual maps, highlighting keyword co-occurrence patterns and thematically related clusters. Regular updates ensure its relevance, offering customizable metrics and visualizations for both new and experienced users.

This study analyzed datasets from the Scopus database (January 2021 to November 2024) in PlainText format. The exported data included key metadata such as publication year, title, author names, journal, citations and keywords. Using VOSviewer version 1.6.19, clustering and mapping techniques generated visual representations of the data. VOSviewer also employs association strength for normalizing co-occurrence frequencies, ensuring accurate reflections of item relatedness and similarity [43], [48].

$$AS_{ij} = \frac{c_{ij}}{w_i w_j} \quad (1)$$

Which is "proportional to the ratio between on the one hand, the observed number of co-occurrences of 'i' and 'j' and on the other hand the expected number of co-occurrences of 'i' and 'j' under the assumption that co-occurrences of 'i' and 'j' are statistically independent" [48]. To ensure robustness and transparency, this

study documented all software settings and threshold values for co-occurrence and clustering resolution parameters, enabling reproducibility by other scholars.

3.3. Theoretical grounding

Bibliometric analysis was adopted as the primary method due to its ability to quantitatively and theoretically explore knowledge structures within emerging research domains [49], [50]. Grounded in scientific mapping theory and knowledge domain visualization, this approach identifies intellectual, conceptual, and social patterns across a body of AI-writing studies [51]. By integrating descriptive bibliometrics with network visualization via VOSviewer, it not only tracks publication trends but also uncovers underlying research paradigms and ethical orientations shaping the field [52]. This methodology offers a robust framework for systematically mapping the intellectual landscape of AI in writing, enabling deeper insights into its evolving dynamics [53], [54]. Furthermore, bibliometric techniques such as author co-citation and co-word analysis, combined with strategic diagrams, provide an understanding of conceptual shifts and thematic developments within the AI-writing domain [55].

However, this study acknowledges several methodological limitations. The reliance on the Scopus database may lead to coverage bias, while the inclusion of English-only articles restricts linguistic diversity and may overlook regional perspectives. The selected timeframe (2021 to 2024) focuses on recent developments but excludes earlier foundational works. In addition, use of VOSviewer's clustering algorithms may influence keyword visualization and interpretation. Despite these constraints, the study remains transparent, replicable, and theoretically grounded in mapping evolving research landscape of AI in writing.

4. RESULTS AND DISCUSSION

This section presents the findings and interpretation of the bibliometric network analysis on AI in writing. The analysis addresses four key research questions: i) research trends in AI and writing according to the year of publication, ii) subject domains contributing to AI in writing research, iii) the most popular keywords related to AI-writing studies, and iv) patterns of international collaboration among authors in this field. Each result is examined in detail, offering insights into the current state of AI-writing research and revealing emerging trends, dominant themes, and cross-national partnerships that shape the evolution of this domain. These findings collectively provide a comprehensive overview of the research landscape.

4.1. What are the research trends in AI and writing according to the year of publication?

Figure 1 illustrates a significant upward trend in the number of publications related to AI in writing between January 2021 and November 2024. Starting with approximately 200 documents in 2021, the volume remained relatively stable in 2022, reflecting modest early interest in this field. However, 2023 witnessed a sharp rise, with the number of publications exceeding 400, highlighting a growing recognition of AI's potential in writing tasks. By 2024, the upward momentum continued, reaching nearly 700 documents. This surge suggests an escalating focus on AI applications in writing, likely driven by advancements in generative AI technologies and their adoption across various domains such as education, research, and professional communication. This rapid growth aligns with the increasing accessibility and capabilities of AI tools like ChatGPT, which have reshaped the writing landscape. The rising number of studies reflects growing interdisciplinary interest, covering areas such as linguistic assistance, ethical considerations and pedagogical applications. The steep increase from 2023 onward indicates a pivotal point where research interest accelerated, possibly in response to global attention on generative AI and its integration into mainstream writing practices. This trend underscores the importance of further exploration into ethical guidelines, pedagogical frameworks and practical applications to balance innovation with responsible use.

The upward trend in publications between 2021 and 2024 indicates more than just quantitative growth; it reflects a conceptual shift in how AI is perceived within the writing domain. Early studies in 2021 to 2022 mainly explored AI-assisted grammar correction and text generation, while post 2023 research shows a surge in discussions on generative AI ethics, authorship legitimacy, and pedagogical integration. This temporal evolution coincides with the release of ChatGPT in late 2022, which catalyzed global scholarly attention and debates on the balance between automation and human creativity. The rapid expansion of publications thus mirrors the growing tension between innovation and integrity in writing practices, suggesting that future studies must navigate this dual imperative.

4.2. What are the subject domains contribute to AI in writing research?

The pie chart in Figure 2 illustrates the distribution of research on AI in writing across various subject areas. Computer science and social sciences dominate, indicating both technical and interdisciplinary research interest. Table 2 shows the percentage based on Figure 2. Computer science leads with 27.3% of the documents, reflecting its foundational role in developing AI technologies, algorithms, and applications in writing. This dominance highlights the critical importance of technical advancements in areas such as natural

language processing (NLP) and machine learning, which underpin AI-driven writing tools and systems. Social sciences account for 17.3% of the documents, indicating significant interest in examining the societal, ethical, and educational dimensions of AI in writing. This share suggests that researchers are exploring the broader implications of AI, such as its impact on communication, creativity, and human interaction within social and cultural contexts. The prominence of this field demonstrates an interdisciplinary focus on understanding AI's role beyond its technical applications.

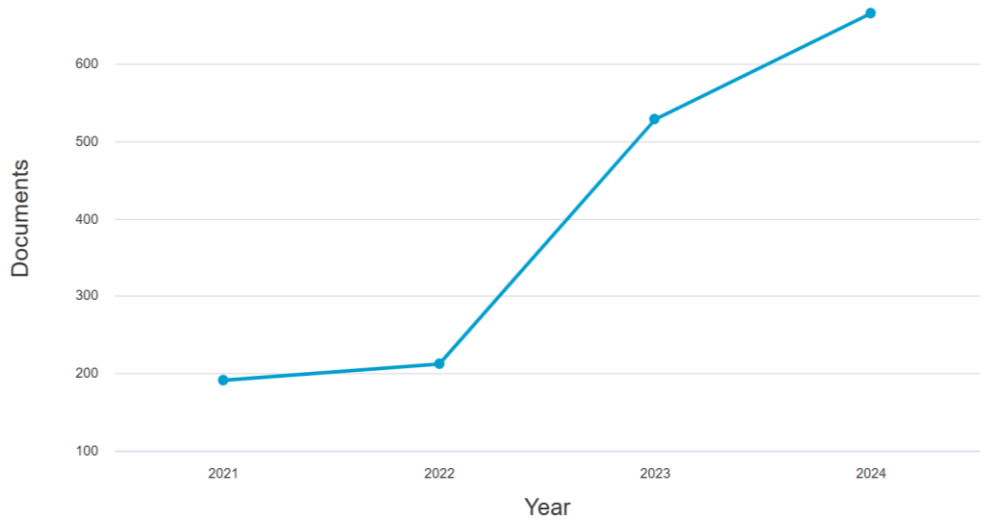

Figure 1. Annual growth of publications on AI in writing from 2021 to 2024

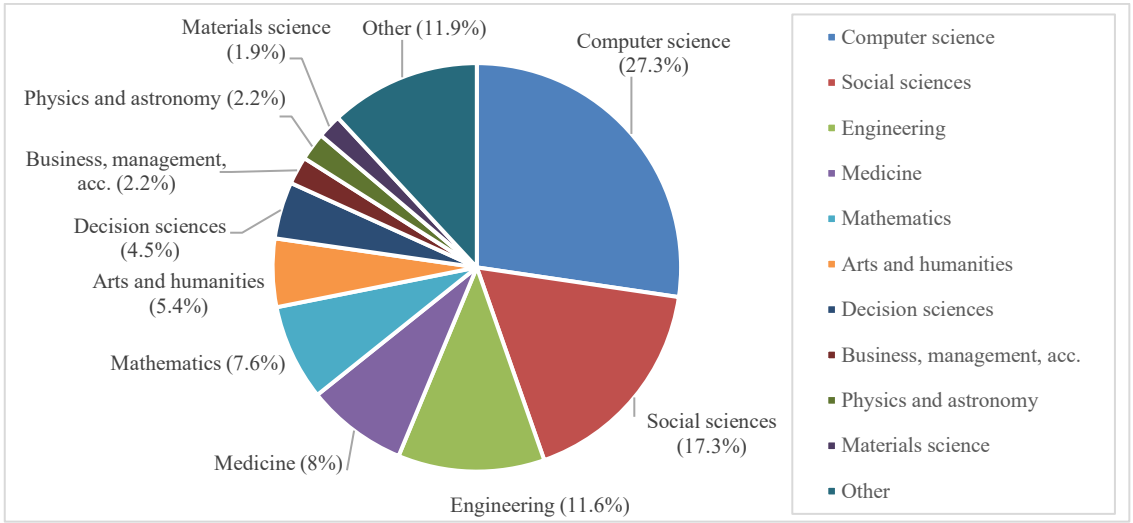

Figure 2. Distribution of documents on AI in writing by subject area

Table 2. Distribution of documents on AI in writing by subject area

Subject area	Percentage (%)
Computer science	27.3
Social sciences	17.3
Engineering	11.6
Medicine	8
Mathematics	7.6
Arts and humanities	5.4
Decision sciences	4.5
Business, management, acc.	2.2
Physics and astronomy	2.2
Materials science	1.9
Other	11.9

Other noteworthy contributions include engineering (11.6%), medicine (8.0%), and mathematics (7.6%), underscoring the interdisciplinary applications of AI in writing. Engineering likely focuses on hardware and system design, while medicine explores AI's role in clinical documentation and patient communication. Mathematics provides the theoretical foundation for algorithm development and optimization. Fields like arts and humanities (5.4%) also contribute, highlighting AI's influence on creative writing and content creation. This distribution reflects the diverse research areas exploring AI's potential in writing.

The dominance of computer science (27.3%) and social sciences (17.3%) reveals that AI in writing is no longer confined to technical innovation but extends into humanistic inquiry. Computer science research focuses on improving natural language models and generative systems, while social sciences emphasize their ethical and pedagogical consequences. The substantial share of engineering, medicine, and arts and humanities highlights AI's diffusion across disciplines, from automated documentation to creative authorship. Yet, the relative underrepresentation of arts and humanities (5.4%) exposes a research gap: the philosophical and cultural dimensions of AI-assisted writing remain insufficiently examined. This imbalance calls for more interdisciplinary work that connects algorithmic development with cultural and ethical critique.

4.3. What are the most popular keywords related to the AI-writing study?

Figure 3 shows the VOSviewer network mapping, which is based on keyword occurrences and total link strength, offers important insights about the state of writing AI research. Larger nodes indicate higher keyword frequency, while colors represent clusters of related research themes such as language models and education (red), human factors and medical ethics (green), and machine learning techniques (blue). The keyword 'artificial intelligence' dominates with 992 occurrences and the highest total link strength of 5,309, reflecting its central role in the field. Closely related terms like 'AI' (70 occurrences, 481 link strength), 'ChatGPT' (315 occurrences, 2,212 link strength), and 'generative AI' (69 occurrences, 365 link strength) emphasize the growing prominence of generative AI technologies and their applications. These keywords demonstrate that discussions around AI's transformative capabilities are expanding, particularly with tools like ChatGPT influencing academic writing, creative processes, and teaching methodologies.

Other frequently occurring terms highlight specific applications and implications of AI in writing. Keywords like 'academic writing' (43 occurrences and 292 link strength) and 'plagiarism' (39 occurrences and 393 link strength) indicate the field's focus on ethical and practical challenges, including integrity concerns in academic contexts. Terms such as 'natural language processing' (89 occurrences and 815 link strength) and 'machine learning' (147 occurrences and 1,162 link strength) illustrate the reliance on advanced AI models for text generation and analysis. Additionally, 'human' (235 occurrences and 2,800 link strength) and 'students' (197 occurrences and 1,286 link strength) underscore the intersection of AI technologies with human-centric applications, particularly in education and authorship. This network mapping reveals the broad and interdisciplinary nature of AI in writing, encompassing technological advancements, ethical considerations and its transformative impact on education and publishing.

The prominence of keywords such as "ChatGPT," "academic writing," and "plagiarism" suggests that the discourse has shifted from technical efficiency to ethical accountability. The rise of ChatGPT-related terms after 2023 implies growing scholarly attention to the implications of AI authorship, originality, and intellectual ownership. The frequent pairing of "students" and "human" with "AI" underscores a strong educational focus, particularly in academic integrity and learning ethics. Meanwhile, the coexistence of technical terms ("machine learning," "NLP") with moral ones ("ethics," "authorship") illustrates the dual nature of AI-writing research, balancing innovation with responsibility. However, the relative absence of keywords related to cultural diversity, multilingualism, and accessibility points to neglected areas deserving future exploration.

4.4. What are the patterns of international collaboration among authors in AI-writing research?

Figure 4 shows the co-authorship network based on international collaboration, which emphasizes important international contributions to the subject of "artificial intelligence in writing" study. Larger nodes indicate a higher number of publications, while colors represent clusters of highly collaborative countries. Thicker lines between countries signify stronger collaborative relationships. The United States leads with 372 documents, 4,160 citations, and a total link strength of 198, reflecting its dominant role in driving research and fostering international collaborations. Similarly, the United Kingdom follows with 101 documents, 2,105 citations, and a high link strength of 123, indicating its prominence in contributing to and collaborating on impactful AI research. China, with 287 documents and 1,830 citations, also stands out as a major contributor, but its total link strength of 74 suggests a relatively moderate level of international collaboration compared to the United States and United Kingdom.

Other countries like Germany (65 documents, 519 citations, and link strength of 78), Canada (53 documents, 310 citations, and link strength of 92), and Italy (55 documents, 1,313 citations, and link strength of 87) also play pivotal roles in advancing AI-related research. Notably, Belgium, with only

12 documents, has an exceptionally high citation count of 866, indicating significant academic impact despite fewer publications. Regional contributors such as India (144 documents, 1,189 citations, and link strength of 52) and Saudi Arabia (43 documents, 231 citations, and link strength of 26) emphasize the growing interest in AI research in Asia and the Middle East. The network reflects a well-distributed effort globally, with developed nations leading collaborations and emerging economies increasingly participating in the AI research landscape.

The co-authorship network shows that AI-writing research is dominated by the United States, United Kingdom, and China, with emerging contributions from India and Saudi Arabia. This concentration among high-income nations highlights disparities in research capacity and access to AI resources. Developing regions remain underrepresented, with lower citation impact and network visibility. Strengthening South–South collaborations, multilingual research, and cross-cultural exchange is crucial to broaden the epistemological base beyond Western-centric perspectives.

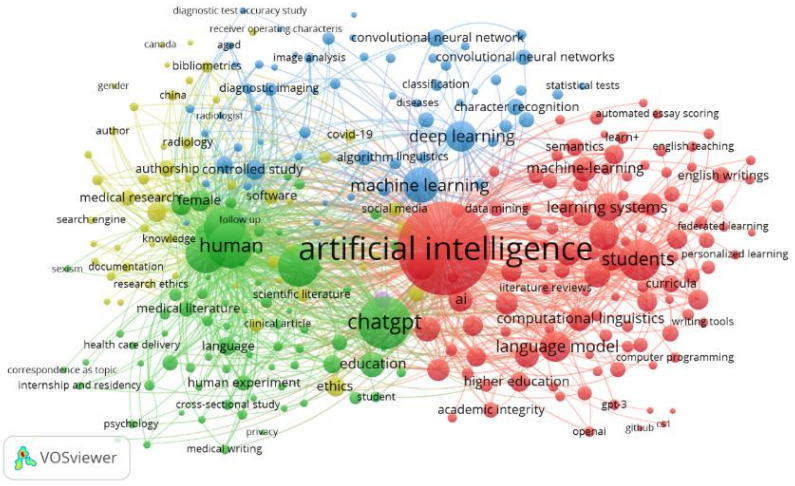

Figure 3. Keyword co-occurrence network of publications on AI in writing

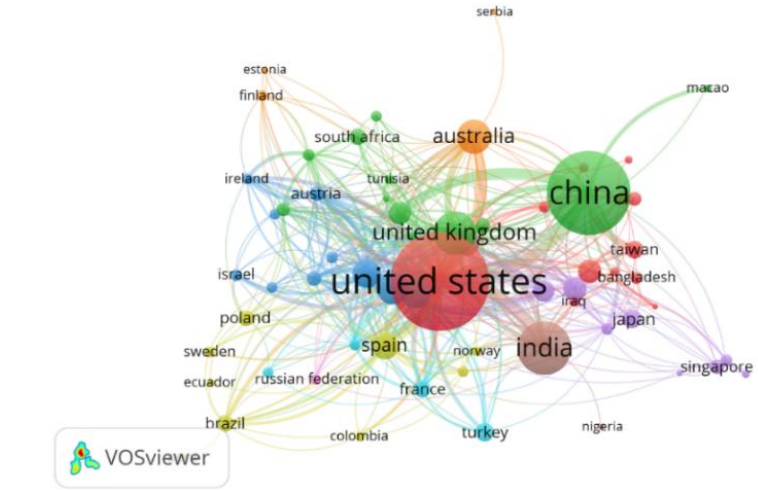

Figure 4. Country co-authorship network of publications on AI in writing

5. CONCLUSION

Overall, the results reveal a rapidly expanding yet unevenly distributed research landscape. Technological progress continues to outpace ethical reflection, and global participation remains uneven, concentrated in technologically advanced regions. From 2021 to 2024, research on AI in writing underwent a marked transformation, with publications rising from about 200 in 2021 to 2022 to over 400 in 2023 and nearly 700 in 2024. This surge illustrates the growing influence of generative technologies such as ChatGPT,

which have reshaped writing practices and scholarly discussions in education, professional communication, and creative fields. The expansion also underscores the need to address ethical and pedagogical challenges, including plagiarism, authorship, and intellectual responsibility. The interdisciplinary character of this research is evident: computer science leads with innovations in NLP and machine learning, while the social sciences examine social and educational implications. Contributions from engineering, medicine, and the arts and humanities extend the conversation to clinical documentation, media, and creative writing. Internationally, collaborations are led by the United States, the United Kingdom, and China, with emerging economies such as India and Saudi Arabia showing growing engagement. Nations like Belgium, despite fewer papers, demonstrate high citation impact, indicating strong qualitative contributions. Collectively, these patterns highlight three key imperatives: integrating ethical and cultural perspectives into technical inquiry, developing pedagogically grounded frameworks for AI in writing, and strengthening inclusive global collaboration toward a balanced and responsible understanding of AI in writing.

FUNDING INFORMATION

The authors state no funding was involved.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [WRS], upon reasonable request.

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