Online Journal of Communication and Media Technologies, 2024, **14**(1), e202405
e-ISSN: 1986-3497

OPEN ACCESS

Review Article

A bibliometric analysis of publications on ChatGPT in education: Research patterns and topics

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Citation: Zheltukhina, M. R., Sergeeva, O. V., Masalimova, A. R., Budkevich, R. L., Kosarenko, N. N., & Nesterov, G. V. (2024). A bibliometric analysis of publications on ChatGPT in education: Research patterns and topics. *Online Journal of Communication and Media Technologies, 14*(1), e202405. https://doi.org/10.30935/ojcmt/14103

ARTICLE INFO

Received: 2 Sep 2023
Accepted: 5 Dec 2023

ABSTRACT

This paper aims to conduct a bibliometric analysis and a comprehensive overview of publications on ChatGPT in educational research. This research also aimed to present the bibliometric results to interpret the research patterns and themes of the application of ChatGPT in educational research. The researchers used the VOSviewer program to conduct a bibliometric analysis and identify research patterns and topics in publications indexed in the Scopus database. For this purpose, the researchers used the Scopus database to find related publications. After applying inclusion and exclusion criteria, they found 82 publications and analyzed them using the bibliometric method. This study showed that researchers from 42 countries examined various topics, including academic writing, artificial intelligence's (AI) potential, and benefits, using ChatGPT in research, exploring best practices, and reviewing AI. The keyword analysis results showed that five clusters emerged from the current studies on ChatGPT in education research. These results showed that researchers focused on understanding the use of ChatGPT in medical and nursing education, generative AI's ethical dimensions, the effects of ChatGPT on educational outcomes, large language models and medical education, and ChatGPT and AI. In general, the use of ChatGPT in educational contexts and research is frequently discussed in the publications analyzed in this study. In addition, medical and nursing education was the most studied of the many research studies. Based on the obtained results, recommendations for further studies are drawn.

Keywords: artificial intelligence, ChatGPT, bibliometric, ethics

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INTRODUCTION

ChatGPT is an artificial intelligence (AI)-powered chatbot that generates text based on user input (Halaweh, 2023). It provides intelligent responses to user inquiries (OpenAI, 2022). This chatbot can transform various educational tasks such as finding information, answering questions, researching any subject, participating in discussions, editing and writing essays and reports, coding software, explaining coding for tutoring purposes, providing data samples for analysis and databases, performing mathematical and statistical calculations, and translating text (Mhlanga, 2023). This tool can generate text, summarize information, and create outlines, providing a helpful resource for improving writing quality and saving time in educational settings (Jarrah et al., 2023). This platform, representing a revolutionary technology, can enhance research skills by offering pertinent information and resources on particular subjects and presenting research topics for improved comprehension and evaluation (Kasneci et al., 2023).

Researchers have indicated several benefits of ChatGPT, including its ability to generate human-like conversations, speed, and efficiency (Baidoo-Anu & Owusu Ansah, 2023; Sok & Heng, 2023). It provides many benefits that can significantly enhance the learning experience beyond the classroom (Alneyadi & Wardat, 2023a; Wardat et al., 2023). It facilitates independent learning by giving students a virtual mentor available 24 hours daily to answer their questions. Furthermore, AI platforms can provide instant feedback, identify areas for improvement, and promote continuous learning for students (Alneyadi et al., 2023b). With this aspect, including ChatGPT in education can lead to significant discussions, promoting the development of critical thinking, problem-solving, and communication abilities among students (Deng & Lin, 2023).

It promotes online learning by allowing students to explore perspectives and engage in informed discourse. ChatGPT can streamline administrative chores for instructors, such as addressing frequently asked questions and disseminating course content, resulting in time and resource savings. In particular, it is a valuable resource for research projects, as it assists students in gathering pertinent information, conducting literature reviews, and generating ideas for further study. To promote self-directed learning and academic development, ChatGPT's personalization capability enables students to receive customized recommendations for additional study materials, online resources, and extracurricular opportunities. In summary, ChatGPT is a revolutionary advancement in educational technology that meets the evolving needs of students and teachers. By utilizing AI, this highly intelligent chatbot possesses the capacity to enhance learning results, help in teaching, and revolutionize the educational environment (Uddin et al., 2023; Wu & Yu, 2023).

Due to ChatGPT's novelty, researchers have demonstrated great interest in its use in education for learning and teaching. Many publications on the use of ChatGPT have appeared in peer-reviewed journals. On the other hand, ChatGPT's AI-based nature and educational application raise concerns regarding its use. People at schools and universities are worried about losing their jobs, being unable to think creatively and critically, and the problem of inaccuracies and plagiarism (Mhlanga, 2023; van Dis et al., 2023) are among some concerns raised since its emergence. Although there is an increased number of these publications, there is little research in peer-reviewed journals on its use in education. For example, only one study by Lo (2023) conducted a literature review about understanding ChatGPT's capabilities in various disciplines. For the content analysis, he reviewed fifty articles. After analyzing ChatGPT's performance, his results showed that it varies depending on the subject area. ChatGPT is proficient in economics and performs satisfactorily in programming but lacks proficiency in mathematics. Although it has the potential to serve as an instructor's assistant by creating course materials and providing suggestions and as a student's virtual tutor by answering questions and facilitating collaboration, there are also challenges associated with its use. These challenges include generating false or fake information and evading plagiarism detectors.

In another research, Mhlanga (2023) reviewed the ethical use of ChatGPT in education. He analyzed 23 publications on ChatGPT in education and concluded that incorporating it in education necessitated guaranteeing privacy, impartiality, and non-discriminatory practices. In light of these studies given above, we can conclude that, to our knowledge, no bibliometric research analyzed the publications on ChatGPT in educational research. Hence, this paper aims to perform a bibliometric analysis and an overview of publications investigating the application of ChatGPT in educational research. Thus, this research aimed to present the bibliometric results to interpret the research patterns and themes of the application of ChatGPT in educational research.

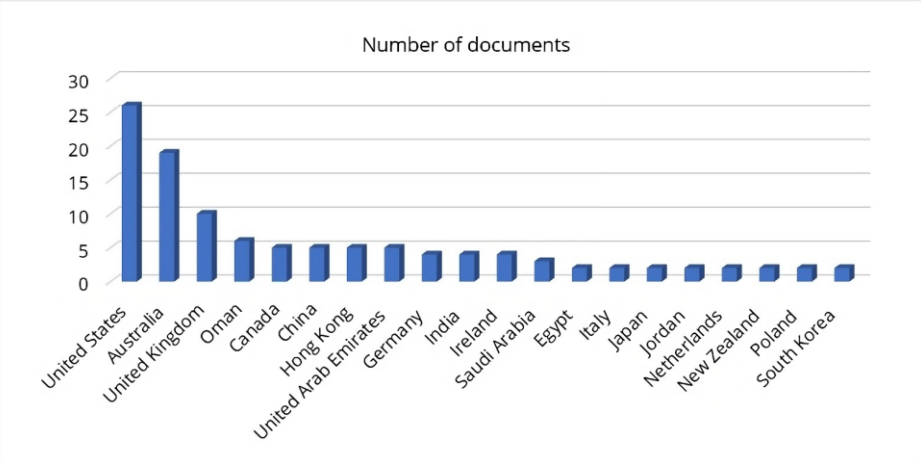

Figure 1. Top-20 countries published on ChatGPT (Source: Authors)

METHOD

Bibliometric data, which represent the relevant literature on a particular keyword or topic, are the most important for tracking research trends in a field. Conducting a bibliometric analysis requires careful work on the part of the researcher. In this research, we followed the following steps to identify the relevant literature to ensure transparency and reproducibility. The first step in bibliometric research is to select a database that best represents the relevant literature. Several databases, including the Scopus database, offer bibliometric analysis and research data sets. This study used the Scopus database, a rich data source of high-quality scientific articles, to create the data set. The Scopus database was selected because of the influence and dominance of the journals it contains in the field.

The Scopus database was searched using title, abstract, and keywords to identify the ChatGPT articles in the education field and create the data set. The search terms "ChatGPT" and "education" were used to obtain accurate and reliable results related to the literature. Bibliometric analysis was used to review previously published research on ChatGPT in education. Published documents were selected based on predetermined inclusion and exclusion criteria aligned with the study's objective. The inclusion criteria comprised peer-reviewed journals proceeding papers, books, book chapters, book reviews, editorial materials, reviews, early access publications, and letters. In addition, the inclusion criteria included the published documents in the English language and educational research under the social sciences category in the Scopus database.

In the subsequent phase, the authors read the article titles, abstracts, and, if necessary, the entire text to determine the article's relevance to the bibliometric analysis in this study. After filtering, published documents unsuitable for the inclusion criteria were excluded from the data set. As filtering options, the researchers chose "social sciences as a field and "English" as the language. A data set of 149 articles was obtained from the databases for the bibliometric analysis. A total of 82 publications were found appropriate for analysis within the aims and scope of this research. Of these 82 publications, fifty-one of the documents reached were articles. 13 were published as notes. The number of review articles was nine, editorials five, and letters four. After downloading all publications from the database, the obtained data were exported to a file and saved for analysis. Later, the final data set was saved as a "tab-delimited text file" compatible with VOSviewer and used for bibliometric analysis in this study.

RESULTS

Number of Publications & Their Distribution

The map in **Figure 1** displays, where scholars from 42 countries have published their work. Out of all the documents on ChatGPT related to education included in the study, the top five countries with the most publications were the United States (26), Australia (19), the United Kingdom (10), Oman (six), and Canada (five). These five countries accounted for 80% (66) of all the documents.

Table 1. Journals that published most articles

	ND	NC	OA	RS
Journal of University Teaching and Learning Practice	5	16	Yes	537/1,469
Medical Teacher	4	3	No	101/1,469
Journal of Chemical Education	4	1	No	190/1,469
Jmir Medical Education	4	54	Yes	199/1,469
Sustainability Switzerland	3	4	Yes	NA
British Journal of Educational Technology	3	3	No	9/1,469
Library Hi Tech News	3	1	No	NA
Computers and Education Artificial Intelligence	3	2	Yes	71/1,469
Innovations in Education and Teaching International	2	13	No	244/1,469
Education Sciences	2	13	Yes	326/1,469

Note. ND: Number of documents; NC: Number of citations; OA: Open access; & RS: Rank in Scopus

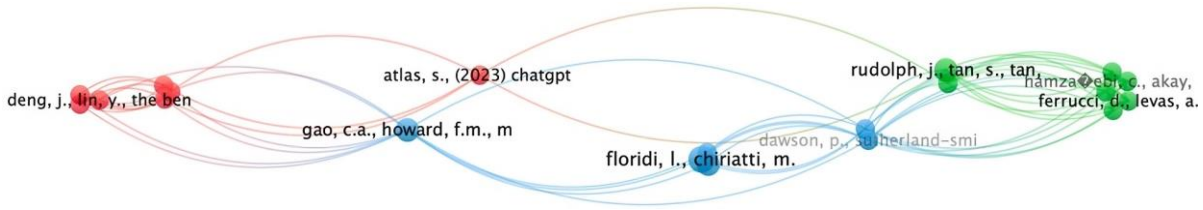

Figure 2. Results of co-citation analysis (Source: Authors, using VOSviewer Software)

In addition to the first five countries, researchers from the following countries published documents on ChatGPT and education: China (n=5), Hong Kong (n=5), United Arab Emirates (n=5), Germany (n=4), India (n=4), Ireland (n=4), Saudi Arabia (n=3), Egypt (n=2), Italy (n=2), Japan (n=2), Jordan (n=2), Netherlands (n=2), New Zealand (n=2), Poland (n=2), South Korea (n=2), Switzerland (n=2), Taiwan (n=2), and Turkey (n=2), respectively. In the other countries, researchers published one article per country: Bulgaria, Croatia, Cyprus, Denmark, France, Macao, Malaysia, Norway, Pakistan, Portugal, Qatar, Romania, Singapore, Slovakia, South Africa, Spain, Sweden, and Vietnam. To better comment on the results, we divided the countries into "developing countries" and "developed countries." Accordingly, based on these results, developed countries produced the most publications related to ChatGPT and education.

Journals That Published Most Articles

Numerous journals have published articles on ChatGPT and education. 54 journals published articles on ChatGPT and education, according to the results. The journals differ in the number of published articles, ranking, and publication model. **Table 1** displays the top ten journals based on the number of articles and citations. Journal of University Teaching and Learning Practice, Medical Teacher, Journal of Chemical Education, and JMIR Medical Education published most articles on ChatGPT. In particular, two journals, JMIR Medical Education (n=54) and Journal of University Teaching and Learning Practice (n=16), had the highest number of citations for ChatGPT articles.

As it is common knowledge, the Scopus database divides journals into categories based on their subject matter, with some journals having multiple categories due to their interdisciplinary nature. Except for Library Hi Tech News, nine of the top-10 journals have an education-related category.

Most Co-Cited Publications

In order to assess scientific impact and trends, we employed co-citation analysis to determine the documents that were cited most frequently among the publications that were included. **Figure 2** shows the results regarding co-citation analysis.

Table 2 displays the 20 most-cited documents from the Scopus database. 11 of the 20 most-cited documents were published in 2023, including Thorp (2023), Gao et al. (2023), and Rudolph et al. (2023). The most-cited documents are from 2006 to 2023. Other pre-2013 co-cited documents, such as Ferrucci et al. (2013), Hamzacebi et al. (2009), and McCarthy et al. (2006), were methodological or conceptual papers about AI.

Table 2. Top-20 most co-cited publications in the Scopus database

No		NCC	CFA
1	Thorp (2023). ChatGPT is fun, but not an author.	6	USA
2	Floridi and Chiriatti (2020). GPT-3: Its nature, scope, limits, and consequences.	4	UK
3	Gao et al. (2023). Comparing scientific abstracts generated by ChatGPT to real abstracts with detectors and blinded human reviewers.	3	USA
4	Rudolph et al. (2023). ChatGPT: Bullshit spewer or the end of traditional assessments in higher education?	3	Singapore
5	Zawacki-Richter et al. (2019). Systematic review of research on artificial intelligence applications in higher education–Where are the educators?	3	Germany
6	Gilson et al. (2023). How does ChatGPT perform on the United States medical licensing examination? The implications of large language models for medical education and knowledge assessment.	3	USA
7	Ferrucci et al. (2013). Watson: Beyond jeopardy!	2	USA
8	Hamzacebi et al. (2009). Comparison of direct and iterative artificial neural network forecast approaches in multi-periodic time series forecasting.	2	Turkey
9	Hassabis (2017). Artificial intelligence: Chess match of the century.	2	UK
10	McCarthy et al. (2006). A proposal for the Dartmouth summer research project on artificial intelligence, August 31, 1955.	2	USA
11	Perkins (2023). Academic integrity considerations of AI large language models in the post-pandemic era: ChatGPT and beyond.	2	Vietnam
12	Dawson and Sutherland-Smith (2018). Can markers detect contract cheating? Results from a pilot study.	2	Australia
13	Dawson et al. (2019). Can software improve marker accuracy at detecting contract cheating? A pilot study of the Turnitin authorship investigate alpha.	2	Australia
14	Dowling and Lucey (2023). ChatGPT for (finance) research: The Bananarama conjecture.	2	Ireland
15	Mhlanga (2023). Open AI in education, the responsible and ethical use of ChatGPT towards lifelong learning.	2	South Africa
16	van Dis et al. (2023). ChatGPT: Five priorities for research.	2	Netherlands
17	González-Pérez and Ramírez-Montoya (2022). Components of Education 4.0 in 21st century skills frameworks: Systematic review.	2	Mexico
18	Tlili et al. (2023). What if the devil is my guardian angel: ChatGPT as a case study of using chatbots in education.	2	China
19	Atlas (2023). ChatGPT for higher education and professional development: A guide to conversational AI.	2	USA
20	Deng and Lin (2023). The benefits and challenges of ChatGPT: An overview.	2	China

Note. NCC: Number of co-citations & CFA: Country of the first author

Publications on ChatGPT for Academic Writing

The most co-cited article by Thorp (2023) examined the influence of ChatGPT on academic writing by testing it on an exam and final project assigned to students at an American public university. Thorp found that while ChatGPT provided accurate information, it still has room for improvement in academic writing. In another co-cited study, Floridi and Chiriatti (2020) analyzed GPT-3 and presented ChatGPT with three mathematical, semantic, and ethical tests. According to their findings, GPT-3 is designed to pass only some of these tests. In addition, they emphasized that any interpretation of GPT-3 as the emergence of a general form of AI is uninformed science fiction. Another study in this category, van Dis et al. (2023), introduced five key issues regarding using ChatGPT on how researchers work and indicated implications for the research community.

Publications on Artificial Intelligence & Its Potential & Benefits

Two highly cited documents presented the uses of AI in specific fields and their potential benefits. For example, In their publication, Ferucci et al. (2013) proposed a plan for integrating AI technology into the healthcare sector. They also provided a detailed roadmap for successfully implementing and improving performance in this emerging domain. Enhancing diagnostic and treatment accuracy was underscored, as it directly impacts patient care quality. In their study, Hamzacebi et al. (2009) compared iterative and direct methods for carrying out multi-period forecasting using artificial neural networks. Among the other co-cited documents, two articles introduced AI (McCarthy et al., 2006) and its use of it in a chess match (Hassabis, 2017).

Three co-cited articles were conducted to understand the uses of AI on contract cheating (Dawson & Sutherland-Smith, 2018; Dawson et al., 2020) and academic integrity (Perkins (2023). The study of Dawson et al. (2020) conducted an empirical investigation into using authorship analysis or machine learning techniques to prevent contract cheating. They asserted that the heightened detection rates indicate the feasibility of implementing software to enhance detection rates. In their previous publications, Dawson and Sutherland-Smith (2018) conducted a study in which examiners were compensated to grade a combination of authentic student work and tasks designed to detect contract cheating. 62% of the time, according to their analyses, the judges detected contract violations. Analysis of specificity revealed that graders correctly identified authentic student work 96% of the time. Perkins (2023) researched academic integrity concerns related to using AI tools in formal assessments. This research demonstrated that these tools could generate original and coherent text that cannot be detected by existing technological recognition methods or trained academic staff. This highlights a significant academic integrity issue associated with students using these tools. Also, he found that students' using AI tools did not necessarily result in plagiarism or a violation of academic integrity.

Publications on Use of ChatGPT in Research

A recent paper by González-Pérez and Ramrez-Montoya (2022) examined the constituents of Education 4.0. The teaching and learning approaches, as well as the major stakeholders engaged, were identified. A comprehensive analysis of the existing literature was carried out. Two studies provide a comprehensive analysis of the possible uses of ChatGPT in education. For example, Mhlanga (2023) thoroughly examined the conscientious and ethical utilization of ChatGPT in education. The study asserts that using ChatGPT in educational settings necessitates safeguarding privacy, ensuring fairness, preventing discrimination, maintaining openness in its usage, and considering several other concerns outlined in the report. In their study, Deng and Lin (2023) analyzed to explore the possible applications of ChatGPT and its limitations.

The following four papers explored the use of ChatGPT in research writing. For instance, Dowling and Lucey (2023) examined the utilization of ChatGPT in the research procedure. Their investigation unveiled that the recently implemented AI chatbot ChatGPT, may substantially assist in financial research. Gao et al. (2023) employed ChatGPT to produce research abstracts using titles and journals as input. It was found that ChatGPT is capable of generating believable scientific abstracts, but it relies on completely produced data. Rudolph et al. (2023) conducted a comprehensive literature review and conducted ChatGPT experiments. Their study explored the relevance of ChatGPT to higher education, specifically assessment, learning, and teaching. Using a qualitative instrumental case study, Tlili et al. (2023) analyzed ChatGPT in education among early adopters. They carried out a three-step investigation and assessed ChatGPT's performance concerning educational impact, quality of responses, usability, personality and emotions, and ethical considerations. The researchers additionally analyzed user experiences in ten distinct instructional settings. The investigation uncovered multiple concerns, encompassing dishonesty, the veracity and precision of ChatGPT's replies, distortion of privacy, and manipulation. Additional investigation is required to guarantee the secure and conscientious use of ChatGPT in educational environments.

Publications on Best Practices for Using ChatGPT

Three articles focused on showing best practices for researchers. For example, Atlas (2023) conducted a study on using ChatGPT in higher education. The study aimed to demonstrate how ChatGPT can aid students, educators, and professionals in writing, communication, and learning. Additionally, the study explored how to create effective prompts to maximize the benefits of ChatGPT. Additionally, he suggested ways to use ChatGPT responsibly and ethically. In another study, Rudolph et al. (2023) conducted a thorough literature review on ChatGPT practices and found many benefits. Additionally, in the same year, van Dis et al. (2023) identified five key issues researchers should consider when using ChatGPT and discussed the implications for the research community.

Publications on Review of Artificial Intelligence in Education

Through a systematic review, Zawacki-Richter et al. (2019) conducted a study to provide a comprehensive review of research on use of AI in higher education. They show that most AIEd research papers focused on computer science and STEM disciplines and employed quantitative methods in their empirical studies.

Table 3. List of keywords revealed in co-occurrence keyword analysis & their frequency of occurrence

Cluster 1		Cluster 2		Cluster 3		Cluster 4		Cluster 5	
Keywords	FO	Keywords	FO	Keywords	FO	Keywords	FO	Keywords	FO
Human	8	Generative ai	8	Education	15	AI	8	ChatGPT	46
Humans	8	Generative artificial intelligence	6	Communication/ writing	3	Medical education	7	Artificial intelligence	34
Chatbots	6	Academic integrity	5	Curriculum	3	Natural language processing	7	Large language models	8
Artificial intelligence (ai)	5	Ethics	5	Learning	3	Chatbot	5	Higher education	4
Nursing education	4	Large language model	5	Learning outcomes	3	Gpt	3	Educational technologies	3
Education nursing	3	OpenAI	5	Technology	3	Machine learning	3	Plagiarism	3
Nursing	3								

Note. FO: Frequency of occurrences

Results From Keyword Analysis & Emerging Themes From Documents

VOSviewer provides researchers with a keyword co-occurrence analysis. This type of analysis enables researchers to visualize similarities between literature-based keywords and terms. Researchers can employ co-occurrence analysis to construct a network of terms that illuminates a specific discipline's prevailing research patterns and intellectual framework. To do this study, a co-occurrence map was utilized, incorporating all keywords, and a threshold of three occurrences per keyword was selected. VOSviewer yielded 31 keywords in keyword co-occurrence analysis. **Table 3** contains a complete list of co-occurring keywords.

A link represents the connection between two co-occurring keywords. The results depicted in **Figure 3** showcase words of varying dimensions, featuring a prominent circle and other interconnected elements. According to van Eck and Walton (2020), the size of a circle in network visualization represents the frequency of a term across all documents. This indicates that "impact" is a cluster's most frequently occurring keyword. After analyzing the keywords, we noticed that five different colored clusters emerged. Each cluster had its own set of unique keywords. The keywords within each cluster were very similar, representing the main concepts of a new theme that has been widely studied. We named each cluster according to the semantic links between the most frequently occurring concepts and the most frequently cited documents. For example, cluster 1 (red) consists of the terms " human," "humans," "chatbots," "artificial intelligence (ai)," "nursing education, "education, nursing," and "nursing" appeared frequently. According to the frequently used keywords in the documents, research focuses on human, humans, AI, and nursing education regarding using ChatGPT in educational research. Thus, we named cluster 1–*ChatGPT in medical and nursing education* (red; seven keywords). We labeled the remaining clusters using the same method: cluster 2–*Use of generative AI and ethical dimensions* (green with six keywords), cluster 3–*Educational outcomes* (blue with six keywords), cluster 4–*Large language models and medical education* (yellow with six keywords), cluster 5–*ChatGPT and artificial intelligence* (purple with six keywords). Details regarding emerging themes from the five clusters are explained in the following sub-titles.

Cluster 1: ChatGPT in medical & nursing education

In Cluster 1, keywords such as "human," "humans," "chatbots," "artificial intelligence (AI)," "nursing education," "education, nursing," and "nursing" appeared frequently. These keywords indicate that there has been much research on using ChatGPT in medical and nursing education. This trend may be prominent due to the need to continue medical education in the field and the interests of medical and nursing education researchers. In addition, the clustering of keywords may also indicate that some level of research has examined the performance of ChatGPT in medical (Huh, 2023) and nursing education (e.g., Seney et al., 2023; Sun et al., 2023).

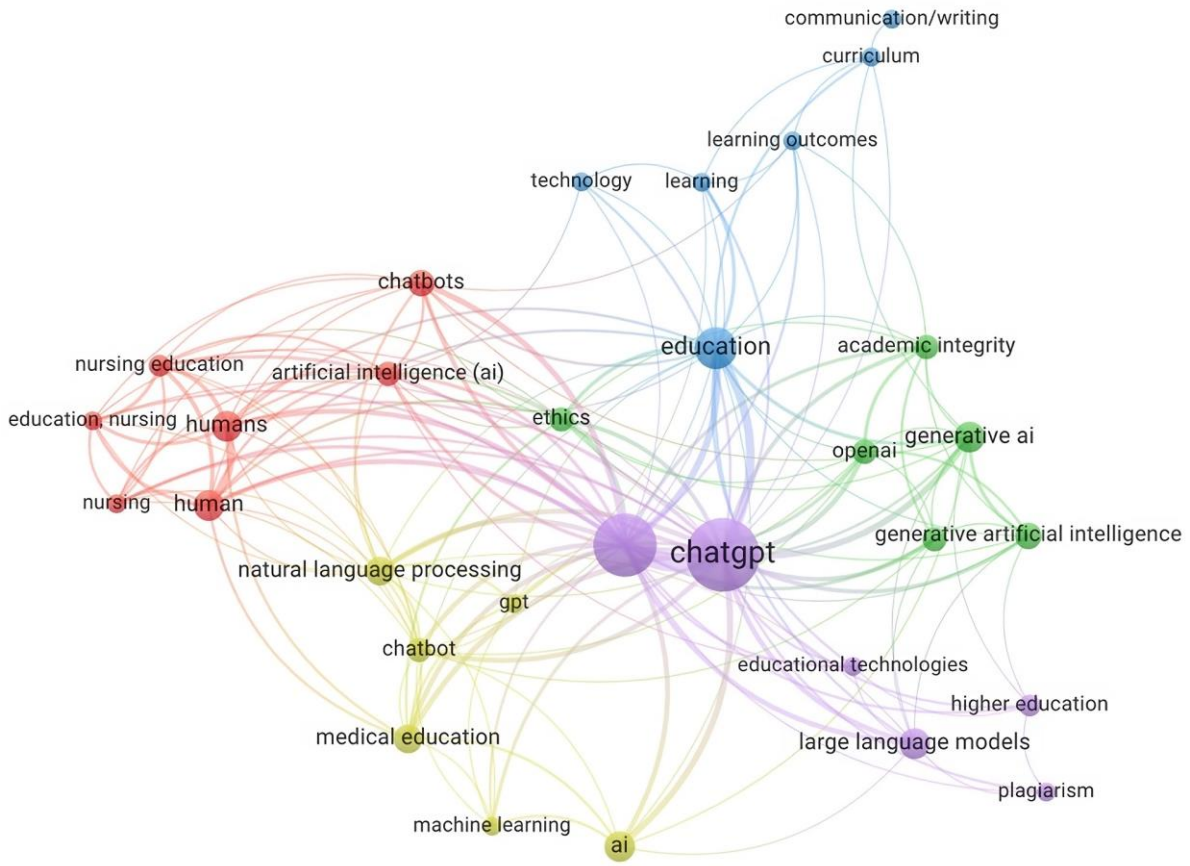

Figure 3. Results of keyword co-occurrence analysis (Source: Authors, using VOSviewer Software)

We noted that the terms "human" and "humans" are closely associated with "nursing education" and "nursing." When we examined the documents related to the keywords "human" and "humans," we found that medical and nursing education researchers produced eight articles. For example, Huh (2023) conducted a study to compare the knowledge and interpretation abilities of ChatGPT and medical students in Korea. Both ChatGPT and medical students were given an exam in parasitology. The findings revealed that ChatGPT performed worse than medical students, and the accuracy of ChatGPT's answers was not dependent on the difficulty level of the tasks. However, the study showed a relationship between acceptable explanations and correct answers. The researchers concluded that ChatGPT's knowledge and interpretation of the exam are currently not at the same level as that of medical students in Korea. An article by Masters (2023a) explored the ethical quandaries encountered by Health Professions Education instructors and administrators when employing AI systems in their instructional settings. In the same year, Sun et al. (2023) published another research examining the potential applications, limitations, and disadvantages of ChatGPT. This information can help nursing educators make informed decisions about incorporating technology into their curricula and courses.

In addition, we found that five of eight studies regarding human, humans and nursing education have been published as editorial (Arif et al., 2023; Teixeira da Silva, 2023); letter to the editor (Subramani et al., 2023), contemporary issues (Choi et al., 2023), and teaching tip (Seney et al., 2023) in the journals. This result means that research has put various efforts into understanding the nature of ChatGPT for teaching at higher education levels, and more research regarding the use and effectiveness of ChatGPT in education has not yet been conducted.

Cluster 2: Use of generative AI & ethical dimensions

Cluster 2 includes the keywords "academic integrity," "ethics," "generative AI," "generative artificial intelligence," and "large language model." The emergent keywords indicate that researchers have been concerned with "academic integrity" and "ethics" in using generative AI in educational research. For example,

research by Chaudhry et al. (2023) included an empirical study to test the ability of ChatGPT to solve various tasks and compare its performance to that of the highest-scoring student(s). Their paper outlined the constraints and emphasized the consequences of the recently implemented AI-powered ChatGPT in the academic field. In this cluster, a study by Skavronskaya et al. (2023) examined the use of AI and robotics in tourism education. They specifically focused on ChatGPT and analyzed it from a cognitive science standpoint. The study also offered suggestions for reducing AI plagiarism in tourism education. This study advocated for using cutting-edge pedagogical approaches in response to technological advancements. It emphasized the significance of ethical principles in integrating AI into tourist education.

The study of Crawford et al. (2023) has identified the use of ChatGPT by educators to create supportive learning environments for students. They highlighted that ChatGPT possesses the potential to improve learning and enhance student results. A study by Lim et al. (2023) provided valuable insights for management educators. This showcases how generative AI can revolutionize education by being a valuable tool for educational reform.

In addition, it was found that researchers have used the keywords “academic integrity” and “ethics” together in their research. Namely, researchers discussing the ethical dimension of ChatGPT have assessed its uses in terms of academic integrity and ethics. Masters (2023b) did a study on identifying the initial documented instance of a medical educator misusing ChatGPT. The study also emphasized the insights that can be gained by journal editors, reviewers, and educators, as well as the wider consequences of this issue if it remains unaddressed. In the same year, Kooli (2023) performed another study investigating the utilization of chatbots in education and research. The study examined the advantages and constraints of AI systems and chatbots in augmenting human expertise.

In addition, the discussion included ethical dilemmas associated with the utilization of AI systems and chatbots in research, as well as the potential risks of misuse and exploitation. Effective solutions were also proposed to address these ethical dilemmas. In addition, Crawford et al. (2023) offered five editorial decision-making principles for editors in their editorial to guide the Journal of University Teaching and Learning Practice as well.

Another finding is that some of the studies in this cluster focused on using AI in education and research. The cluster analysis results showed that the keyword “large language model” was closely associated with keywords such as academic integrity, ethics, and generative AI. For example, to illustrate the potential connections between these keywords, Cooper’s (2023) study explored how ChatGPT answers questions related to science education, identified some opportunities for using ChatGPT for science educators, and presented an example of using ChatGPT as a research tool. In another study, Perkins (2023) conducted a study on academic integrity in the context of students’ use of AI tools in formal assessments. After analyzing the academic integrity issues faced by universities and students in large language models, he concluded that using AI tools does not necessarily lead to plagiarism or a breach of academic integrity. According to a study by Dwivedi et al. 2023, three areas require further research: knowledge, transparency, and ethics; the digital transformation of organizations and societies; teaching, learning, and scientific research. The other studies on large language models focused on the use of ChatGPT in education and research, highlighting its advantages and benefits (Bauer et al., 2023; Frederick, 2023; Ivanov & Soliman, 2023; Kasneci et al., 2023; Karaali, 2023).

Cluster 3: Educational outcomes

Cluster 3 (blue) comprises the keywords of communication/writing, curriculum, education, learning, and learning outcomes. Most of the keywords in this cluster are educational outcomes associated with ChatGPT, referring to its impact on learning outcomes. Among the studies examining the effects of ChatGPT, for example, Wu and Yu (2023) conducted a meta-analysis of 24 studies. Their results showed that AI chatbots greatly affected students’ learning outcomes and had a larger effect on students in higher education than elementary and secondary education students. They explained that the novelty effect of AI chatbots could improve learning outcomes in short interventions but diminish in long interventions.

In another research, Uddin et al. (2023) examined the application of ChatGPT with 42 construction students enrolled at a large public university in the United States. They introduced students to ChatGPT and

its capabilities in a classroom setting. Students were also instructed on how to use ChatGPT to aid in hazard recognition. The results suggest that incorporating ChatGPT into safety education and training can improve hazard recognition, benefiting the next generation of construction industry professionals. Research by Halaweh (2023) provided educators with techniques and strategies for effectively implementing ChatGPT in teaching and research. The other research explored how ChatGPT can be used when writing a discussion section of a lab report (Humphry & Fuller, 2023) and what opportunities there are for students and faculty to use ChatGPT (Emenike & Emenike, 2023). A recent study by Tlili (2023) focused on using ChatGPT in education. Finally, in this cluster, a part of the research has discussed the possible effects of using ChatGPT in education (e.g., Fernandez, 2023; Kasneci et al., 2023; Lim et al., 2023).

Finally, Wardat et al. (2023) investigated the viewpoints of students and educators about using AI in mathematics education, particularly following the implementation of ChatGPT. The study concluded that ChatGPT is a useful teaching tool, but caution should be exercised, and guidelines for safe use should be developed. The study also identified several research directions and issues that need to be addressed to ensure the safe implementation of chatbots, especially ChatGPT.

Cluster 4: Large language models & medical education

Cluster 4 consists mainly of terms related to AI, chatbot, GPT, machine learning, medical education, and natural language processing. Most studies in this cluster focused on large language models for medical education (e.g., Eysenbach, 2023; Gilson et al., 2023). For example, Gilson et al. (2023) did a study to assess the efficacy of ChatGPT in answering questions from the United States medical licensing examination. The responses were evaluated to ascertain the level of interpretability for users. Giannos and Delardas (2023) conducted a study to assess the capabilities of ChatGPT by examining its performance on standardized admissions examinations in the United Kingdom. The aim was to investigate the potential of ChatGPT in this context.

Jeon and Lee (2023) investigated the relationship between ChatGPT and teachers, specifically examining how they complement each other in the classroom. Eleven language teachers participated in a two-week trial, where they utilized ChatGPT. The data analysis highlighted four clearly defined functions of ChatGPT: interlocutor, content provider, teaching assistant, and evaluator. In addition, the study recognized three primary responsibilities of teachers: coordinating diverse resources with high-quality educational decisions, fostering active inquiry among students, and cultivating ethical awareness of AI. In addition, Day (2023) carried out a subsequent, more methodical, although preliminary, inquiry into the precision of the citations and references produced by ChatGPT. The investigation findings indicate that the references produced by ChatGPT are not dependable.

Cluster 5: ChatGPT & artificial intelligence

Co-occurring keywords in these clusters include ChatGPT, AI, large language models, higher education, educational technologies, and plagiarism. It is quite clear that the links in this cluster are too dense, and the number of occurrences is very high, especially for ChatGPT and AI keywords, compared to the others identified in the previous clusters. Researchers have shown interest in using ChatGPT for research and education due to its frequent occurrence and connection to AI. This line of research also addresses the need and opportunities for using ChatGPT in teaching and research. In addition, ChatGPT and AI keywords have dense links between them. This finding appears in the number of occurrences in the keyword analysis. For example, the keyword co-occurrence analysis shows that in this cluster, researchers are exploring the effects of ChatGPT on student writing (Cotton et al., 2023; Perkins, 2023; Yan, 2023), the use of ChatGPT in higher education (e.g., Farrokhnia et al., 2023; Strzelecki, 2023), the use of ChatGPT as an educational technology (Halaweh, 2023; Kasneci et al., 2023), a definition of AI for higher education pedagogy (Bearman & Ajjawi, 2023).

DISCUSSION

This paper aimed to conduct a bibliometric analysis and a comprehensive overview of publications on ChatGPT in educational research. This research also aimed to present the bibliometric results to interpret the

research patterns and themes of the applications of ChatGPT in educational research. This study (n=82) provided results from a bibliometric analysis. First, the number of publications in the Scopus database shows that the research topic of ChatGPT in educational research has attracted greater interest from researchers. All of the reviewed publications were published in 2023. This finding indicates that ChatGPT will continue to be one of the important research topics in educational research.

Second, the results show that in the top five countries with the highest number of documents published, 80% (n=66) of all documents on ChatGPT in education were included in this study. Except for Oman, researchers in the other four countries (the United States, Australia, the United Kingdom, Oman, and Canada) have published the most research on ChatGPT in education. These four countries are developed states. Third, a noteworthy research finding is that the journals that have the most publications are not the highly esteemed ones in the educational research category in the Scopus database. For example, the Journal of University Teaching and Learning Practice ranked 537th at Scopus. High-impact journals may take longer to publish articles on a topic because they use more rigorous peer-review processes. This could explain the finding.

Fourth, It is noteworthy that half of the publications identified are open-access articles, while the other half are not. The first two journals with the most cited publications regarding ChatGPT are open-access journals (see **Table 1**, Journal of University Teaching and Learning Practice and JMIR Medical Education). One reason for this could be that the open-access journal provides more access to researchers. Open-access publication has the potential to enhance readership among scholars, practitioners, and other stakeholders. Nevertheless, an imbalanced allocation of literary works exists between industrialized and developing nations regarding the quantity of publications and the prominence of cited documents.

Fifth, according to the results of this study, research on ChatGPT in education has been shaped by the efforts of researchers in universities in developed countries. It has become a popular topic in these countries. As English-speaking countries (i.e., the United States, Australia, and the United Kingdom) have become more prominent, there are more and more publications by researchers working in universities in these developed countries. Overall, Researchers from 42 countries conducted a comprehensive study on various topics related to ChatGPT. The discussed topics encompassed the use of ChatGPT in medical and nursing education, the ethical implications of generative AI, the influence of ChatGPT on educational achievements, the integration of big language models in medical education, and the involvement of ChatGPT in the field of AI. The analysis found that most publications were written by scholars from wealthy countries, specifically the United States, Australia, the United Kingdom, Oman, and Canada. In addition, the investigation discovered that specific documents were frequently mentioned together in the literature. This finding highlights the need for equal promotion, distribution, and exchange of information regarding new technologies and their use in educational research.

Sixth, the findings of this study show that most studies on ChatGPT are currently too theoretical and conducted to understand how it can be used by students and researchers in educational contexts. These studies are in their infancy to understanding applications and practices regarding ChatGPT. Some studies have focused on using ChatGPT in writing for research (e.g., Dowling & Lucey, 2023; Gao et al. (2023; Rudolph et al., 2023; Tlili et al., 2023). In addition, scholars have attempted to examine the effects of ChatGPT in research (Deng & Lin, 2023; González-Pérez & Ramrez-Montoya, 2022; Mhlanga, 2023). Namely, from a theoretical and practical perspective, many researchers have addressed the use of ChatGPT in educational contexts, and this issue is frequently discussed in the publications analyzed in this study. In addition, medical and nursing education programs are the most studied disciplines. Finally, large language models, natural language processing, generative AI, human, humans, academic integrity, nursing, nursing education, ethics, and higher education as keywords and topic studies frequently appeared in the publications. The review results show that researchers have extensively utilized and examined various keywords or terms associated with ChatGPT in education.

CONCLUSIONS

During the recent emergence of new revolutionary technology, this research attempted to answer how ChatGPT is being studied and utilized in educational research by scholars. The current state of research reveals an unprecedented number of publications on ChatGPT by scholars from around the world who are

rapidly investigating a vast array of topics related to the application of ChatGPT in education and research. The documents identified by the co-citation analysis focused on identifying issues in the use of ChatGPT for research, the use of AI and its potential and benefits, the use of ChatGPT in research, and best practices for the use of ChatGPT, as well as AI in education. Through keyword co-occurrence analysis, it was identified that ChatGPT is being used in medical and nursing education as a topic of interest, the use of generative AI and ethical dimensions, educational outcomes, large language models and medical education, and ChatGPT and AI.

The results of this bibliometric study are encouraging as they demonstrate a level of scientific participation in ChatGPT. The results presented in this study confirm an established trend toward using ChatGPT in educational research based on a bibliometric analysis using the Scopus database. Thus, this study provides insights into how scholars use ChatGPT and provides implications and suggestions for future research. More specifically, further bibliometric research on ChatGPT is essential to uncover future research patterns, themes, and trends and provide more comprehensive findings for future research. Given the limitations already mentioned in this study, additional databases, such as EBSCO, ERIC, and Web of Science, should be considered to develop a larger corpus of ChatGPT data for future research. However, the results of this bibliometric analysis can be considered a basis for educators, researchers, teachers, and policymakers who monitor the use of ChatGPT in education and can support further research efforts. The study explores using AI in education across various disciplines to address multidimensional challenges. Therefore, the research patterns and topics uncovered in this study are important in educational research to contribute to further studies using ChatGPT.

Recommendations & Limitations

This study offers a thorough analysis of research that explores the innovative use of ChatGPT in educational research. However, some limitations are worth mentioning. This bibliometric review aimed to provide a comprehensive overview of how the use of ChatGPT in educational research has been positioned in previous studies. Therefore, the findings of this study may be useful for future research in this area. Additional research is required to provide a more comprehensive analysis. The time this research was conducted may influence the results. Furthermore, our search parameters, including only Scopus-provided and English-language documents, may have excluded relevant studies that were unavailable through Scopus or written in other languages. It is worth mentioning that while Scopus is the most comprehensive database of scholarly literature across all disciplines and includes conference proceedings published as journal articles, it may not contain conference proceedings specifically focused on the utilization of ChatGPT in educational research. Hence, it is possible that these variables could influence the outcomes of this research. In the future, bibliometric analyses of ChatGPT's global utilization in educational research may necessitate expanding their search parameters to encompass more papers.

In addition, our analysis strategy reveals some questions regarding the quality of publications and the efficacy of using ChatGPT in educational research on learning and teaching. Future research can focus on this issue. In addition, further research should utilize a variety of methodologies to investigate similarities and differences between emerging themes. Finally, at the time of our search, unpublished studies addressed the application of ChatGPT in educational research and could not be involved in the analysis of this research. Some journals have an extensive peer review procedure and a stringent publication procedure. This could result in several unpublished studies not being included in the current analysis. Therefore, researchers may consider conducting a follow-up analysis in the future. Finally, the educational implications of ChatGPT depend on how it is used and integrated into established teaching methods. Therefore, researchers should focus on future research on how ChatGPT is used and integrated into teaching methods.

Author contributions: All authors were involved in concept, design, collection of data, interpretation, writing, and critically revising the article. All authors approved the final version of the article.

Funding: The authors received no financial support for the research and/or authorship of this article.

Ethics declaration: The authors declared that the study did not require ethics committee approval since it is a review of existing literature.

Declaration of interest: The authors declare no competing interest.

Data availability: Data generated or analyzed during this study are available from the authors on request.

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