The ChatGPT Impact on Education: A Comprehensive Bibliometric Review

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This bibliometric study involves 241 articles about ChatGPT within education, revealing a robust study field with an extraordinary annual growth rate of 23,900% and a high level of international collaboration (18.67%). The results also show that leading countries contribute distinct insights. Five unique study clusters emerged from co-occurrence analysis, concentrating on the development, role, and practical impact of ChatGPT. The multidisciplinary scope of the research highlights ChatGPT's broad applicability from transformations to ethical dilemmas. Sentiment analysis also showed that teaching is essential, especially in higher education and medicine. The limitations of this study are concentrated on specific databases. Future research suggests adding more databases, the ethical, and pedagogical implications.

Keywords: ChatGPT, bibliometric analysis, sentiment analysis, education field

INTRODUCTION

The Industrial Revolution disrupted many business processes in organizations, starting from the Industrial Revolution 1.0 to the current Industrial Revolution 4.0 with the characteristics of a lot of automation or robotics to help and advance society, not to replace the role of humans (Ellitan & Anatan, 2020; Kumar et al., 2019). Technological developments give rise to pros and cons regarding its use and utilization. One that is currently developing is artificial intelligence technology, which is widely used by many parties ranging from industry to academia and is starting to disrupt the fields of education and research (Ivanov & Soliman, 2023).

Research on Artificial Intelligence (AI) continues to develop and has attracted researchers' attention from 1983 until now (Duan et al., 2019) and is widely used in various fields of science (Pannu, 2015; Xu et al., 2021). One form of artificial intelligence is ChatGPT, which was first released in November 2022 and immediately attracted much attention from parties, both academic circles and industry circles, in a short time (Houston & Corrado, 2023; Hsu & Ching, 2023), which allows users to obtain information (Dwivedi et al., 2023).

ChatGPT faced numerous advantages and disadvantages during its development, generating controversy (Dwivedi et al., 2023; Gašević et al., 2023). In the education field, the popularity of ChatGPT is seen negatively since students may frequently search for solutions using AI, potentially attempting fraud (Tlili et al., 2023) and affecting elements of student integrity (Barrot, 2023). On the other hand, research showed that ChatGPT may assist in the teaching and learning process (Kohnke et al., 2023) and give examples of good, quality, and accurate replies (Keiper et al., 2023). ChatGPT has also been widely used in various fields of inquiry (Dwivedi et al., 2023).

Previous research on AI in higher education has highlighted three main benefits. Firstly, AI can act as a virtual tutor, greatly enhancing learning. Secondly, AI can predict students' learning moods. Lastly, AI can predict students' learning styles (Hinojo-Lucena et al., 2019). Furthermore, a study has been conducted on using ChatGPT as a beneficial tool for academic research (Kirtania, 2023; Stojanov, 2023). The subject of ChatGPT being an AI has caught the interest of numerous researchers. However, the discussion is still partial in terms of its benefits in the learning process (Graves, 2023; Marquez et al., 2023) or concerning the negative aspect of fraud and ethics (Barrot, 2023; Tlili et al., 2023) and integrity of academicians (Cotton et al., 2023; Perkins, 2023; Sullivan et al., 2023) thus, there has been a lot of controversy and debate surrounding the application of this AI, specifically ChatGPT, in the academic fields (Naidu & Sevnarayan, 2023; Paul et al., 2023), additionally, ChatGPT still offers free virtual assistant features that provide users with many conveniences (Lo, 2023; Rudolph et al., 2023). This research will be conducted with two approaches to explore and answer about using ChatGPT in education. First, researchers will explore the research patterns, relationships, and trends with bibliometric analysis by utilizing two major bibliometric techniques analysis: performance analysis and science mapping analysis (Donthu et al., 2021; Mukherjee et al., 2022) second, this research study will conduct the sentiment analysis from the research articles to classify the positive and negative perspectives from academics and researchers (Birjali et al., 2021; Fellnhofer, 2023).

LITERATURE REVIEW

Artificial Intelligence and Its Utilization in Education

Artificial intelligence (AI) has come a long way from its inception in the 1950s. Deep learning algorithms and neural networks have been critical in creating generative AI models, allowing them to analyze, understand, and create content similar to human-generated output. Among these models, OpenAI's ChatGPT stands out for its versatility and broad application in various industry sectors. (Ray, 2023).

Despite the significant progress in AI, a universally accepted definition of AI remains to be determined. AI generally refers to a machine's capacity to learn from experience, adapt to new inputs, and execute tasks similarly to human actions (Duan et al., 2019). For many scholars, AI is defined as a system's ability to accurately interpret external input, learn from it, and apply that knowledge to achieve specific objectives through flexible adaptation (Haenlein & Kaplan, 2019).

AI can be categorized based on the types of intelligence, encompassing analytical, human-inspired, and humanized AI, each representing different forms of intelligence, such as cognitive, emotional, and social intelligence (Kaplan & Haenlein, 2019). Additionally, AI can be classified by its evolutionary stage into Artificial Narrow, General, and Super Intelligence (Haenlein & Kaplan, 2019).

The rapid advancements in Big Data and Natural Language Processing technologies, including improved computing storage capabilities and faster data processing machines, have revitalized AI with the availability and power of Big Data. As a result, AI has penetrated the business landscape and public conversation around the world within society (Haenlein & Kaplan, 2019).

The development of technology and Big Data has brought AI into the spotlight across various disciplines, leading to debates and controversies regarding its potential to replace human roles in industries such as manufacturing, healthcare, and even education (Dwivedi et al., 2021). Consequently, the progress of AI faces numerous challenges, encompassing economic, social, ethical, technological, political, legal, and organizational aspects (Dwivedi et al., 2021) As a response, several countries in Europe and Asia have issued draft policies concerning AI ethics guidelines to regulate AI's domain and minimize the risks associated with its application in diverse fields of study (Smuha, 2021). From the public perspective, the existence of regulations has not diminished the intention to use AI, as its implementation is seen as a means to enhance the quality of life by efficiently processing vast amounts of information in a relatively short time (Chatterjee, 2019; Chatterjee et al., 2021).

In education, the development of Artificial Intelligence (AI) that has attracted the most attention is ChatGPT which reaches more than 100 million active users (Eysenbach, 2023). ChatGPT can offers various conveniences with the potential to increase efficiency in the learning process and communication between lecturers and students (Li & Xing, 2021). With its ability to provide answers and solutions based on massive data analysis and knowledge contained in its models, ChatGPT can assist students in answering assignment questions or find information quickly as a group member or working together on projects (Lewis, 2022). In addition, as a learning aid, ChatGPT can be used as a virtual tutor available 24/7, assisting students in understanding complex concepts and improving their skills independently (Choi et al., 2023).

However, on the other hand, advances in AI, such as ChatGPT also pose serious problems in the educational context. One of the challenges is plagiarism in higher education, where students can easily generate from the prompt that they input through application, resulting in a high-quality working assignment (Choi et al., 2023). This can undermine academic integrity and harm the efforts of teachers and educational institutions to measure the extent to which students have achieved their understanding and competencies (Cotton et al., 2023; Marron, 2023; Naidu & Sevnarayan, 2023; Sullivan et al., 2023). In addition, such AI tools can affect students' skills in critical and analytical thinking (Chan, 2023; Warschauer et al., 2023), because they tend to rely on answers from the system without developing the ability to solve problems based on assignments or case study with their approach (Chan & Lee, 2023). Thus, lecture faces difficulties in terms of a student conducting their own work and student with chatbot assistance (Chan, 2023; Cotton et al., 2023).

A previous study with a literature review approach with the theme of AI in higher education showed that most of the research articles showed negative sentiments regarding using AI in higher education rather than the positive aspect of using AI to increase academic productivity. Furthermore, the most common theme related to academic integrity and avoidance of using AI (Sullivan et al., 2023).

Bibliometric Analysis

Bibliometric analysis is defined as the study of authorship, publishing, and literature usage pattern using many different statistical techniques (Baker & Lancaster, 1991) and bibliometric analysis also can be considered as a study that deals with the application of statistical and mathematical methods with the quantitative techniques to gain some insight and understanding from the collected research articles (Pritchard, 1969).

Generally, bibliometric studies are used to analyze and categorize bibliographic material to create representative summaries of the existing literature (Donthu et al., 2021). To conduct the bibliometric analysis, there are two common techniques that use, 1) performance analysis and 2) science mapping analysis (Donthu et al., 2021; Mukherjee et al., 2022). The bibliometric analysis aims to analyse patterns, relationships, and trends within the literature of a particular field or across multiple disciplines (Hou et al., 2015; Liu et al., 2018).

Performance analysis in bibliometric studies related to a descriptive examination of the characteristics and context of the articles under scrutiny. This analytical approach is widely employed due to the rich information associated with the articles, such as the researchers' data, institutional affiliations, countries of research, article citations, and the journals where the articles are published (Baier-Fuentes et al., 2019; Donthu et al., 2021; Gaviria-Marin et al., 2018).

In contrast, science mapping is the technique in the bibliometric analysis to analyze then visualize the intellectual structure and relationship of scientific networks among research publication fields or domains and the evolution of disciplines of knowledge that are being developed or trend (Guleria & Kaur, 2021; Tibaná-Herrera et al., 2018). During the process of development, multiple tools can be utilized to conduct bibliometric network analysis or science mapping, such as Bibexcel, Biblioshiny, BiblioMaps, CiteSpace, CiNetExplorer, SciMat, Sci2Tool, and VOSviewer (Moral-Muñoz et al., 2020).

R is a reliable statistical programming language because of its capabilities to conduct performance analysis and visualization techniques based on various sources of documents such as Scopus or Web of Science with several types of files formatted like Bibtex atau Plain Text atau Comma Separated Values (Linnenluecke et al., 2020). R also provides the Shiny package, created by RStudio Team (Aria & Cuccurullo, 2017; Chang et al., 2023), is a Java-based software and robust tool for building interactive web applications for research analysis and this tool is also equipped with a user-friendly interface to create a data visualization through R studio which provides analysis without coding (Huang et al., 2021; Linnenluecke et al., 2020; Moral-Muñoz et al., 2020).

While VOSvierwer application is a program that visualizes bibliographies or datasets of research articles that contain bibliographic data fields such as authors' information, title, publisher, and abstract (van Eck & Waltman, 2022). The VOSviewer program can handle graphical representations of bibliometric maps and is particularly effective for showing large bibliometric maps in a way that is easily understood (Aria & Cuccurullo, 2017).

Sentiment Analysis

Sentiment analysis has evolved as a critical technique in academic research, providing a framework for discovering underlying emotions and views within textual data. The foundation of this technique is conducted by using an advanced machine-learning method that focuses on the subjective elements of a document, thereby increasing the precision of sentiment identification (Pang & Lee, 2004, 2008).

The numerous uses of sentiment analysis in education are wide and diverse. At its essence, it is a tool for gathering data, especially in the digital age where online platforms are dominant. For example, during the huge increase in online learning during the COVID-19 epidemic, sentiment analysis was critical in determining the success of e-learning systems. Many studies established this field by capturing the public's perspective of online education during these challenging times using tweets (Lubis et al., 2022; Mansoor et al., 2020).

Furthermore, sentiment analysis has evolved as a critical tool in academic research, and the integration of Artificial Intelligence (AI) has aided in this advancement. AI has transformed sentiment analysis with numerous methodologies such as deep learning, naive Bayes, and sophisticated models such as ChatGPT, giving enhanced precision and efficiency in determining underlying emotions and perspectives in textual data (Haque et al., 2022; Javaid et al., 2023).

METHODOLOGY

During the bibliometric analysis, researchers conduct the three-step review process. Firstly, researchers collect relevant research articles based on research objectives. Secondly, researchers clean the data from collected articles and perform data analysis and synthesis (Donthu et al., 2021). Bibliometric analysis evaluates the collection of articles data from reputable journals to gain a comprehensive understanding of a particular field of study and its evolving trends and dynamics (C. Chen et al., 2010).

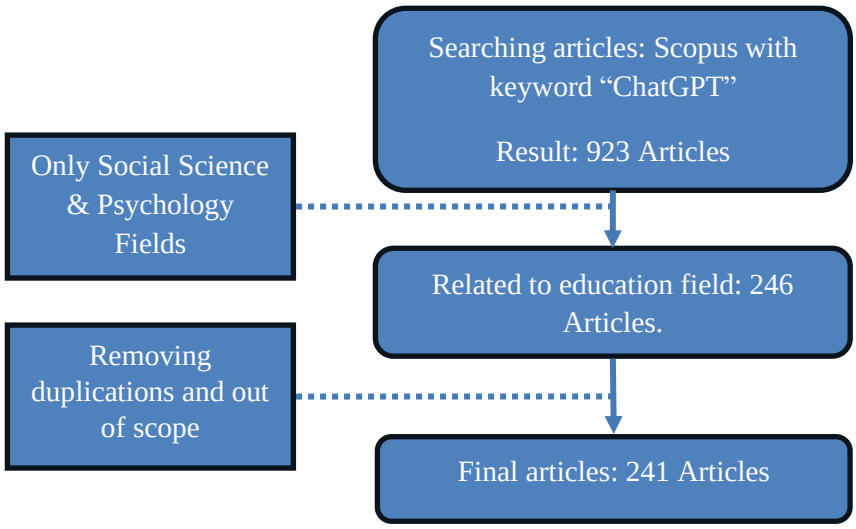
Collected and Cleaning Data

The data taken from the Scopus database from 2022 through 2023 have more than 69 million articles from various journal that are separated into four quartiles (Moral-Muñoz et al., 2019, 2020). Scopus also provided more than 5,000 publishers from wide range countries (Hossain et al., 2022). To achieve the research objective, in 14 July 2023, we collect data by using the "ChatGPT" as keyword and resulting in 923 articles. Thus, we filter our data for only in social science and psychology area because an education

field is in both area and resulting 246 articles. After we reread the tittle, abstract, and content (if needed), we only use 241 articles that include and need further analysis in this research. Reasoning takeout the 5 articles due to a duplication of articles that makes bias and not acceptable (Da Silva et al., 2020; Linnenluecke et al., 2020) and out of scope which do not match our research objective.

The following are the stages of the bibliometric research that will be carried out are as follows (Figure 1):

FIGURE 1
STEPS IN THE IDENTIFICATION AND SCREENING OF DATA



The research strategy described in this part entails science mapping research with two primary bibliometric tools, VOSviewer and R. Science mapping is an effective method for visualizing and analyzing the structure of scientific knowledge in a specific field or domain. In this context, researchers are likely interested in interpreting thematic landscapes and interactions between research topics and authors in their field of study, which may or may not be relevant to ChatGPT in education.

VOSviewer is a bibliometric software tool developed by Leiden University in 2019 (Moral-Muñoz et al., 2020). This application specializes in visualizing and analyzing bibliographic data such as bibliometric networks, co-authorship networks, and co-citation networks that can help researchers understand the structure of intellect generated by this application (Guleria & Kaur, 2021). VOSviewer can comprehensively visualize and accurately describe and link the document corpus (Leydesdorff et al., 2015; Tibaná-Herrera et al., 2018).

R is a popular tool among researchers that is a highly reputable statistical programming language and software environment (Gandrud, 2020) that also can be used to conduct bibliometric analysis from many types of files such as Bibtex, Plain Text, or Comma Separated Values (Linnenluecke et al., 2020). R has a biblioshiny package that allows researchers to conduct the science mapping without coding and read the result easily (Aria & Cuccurullo, 2017; Moral-Muñoz et al., 2020).

Nowadays, ChatGPT is a popular and powerful tool in education system with many features like handling large data, interactive teaching and learning process, virtual assistant, and case-based education (Javaid et al., 2023). For instance, this tool provides many advantages that support education aspects such as to remembering, prediction support, translation creation as well as provide sentiment analysis (Javaid et al., 2023; Wang et al., 2023).

RESULT

This part talks about the main results of our study, which came from bibliometric analysis. We used a collection of 241 carefully chosen articles that fit the study's objective for this analysis. The results cover a wide range of study topics, from writing trends to regional contributions.

Performance Analysis

The bibliometric analysis shows that between 2022 and 2023, there was a vast increase in the number of research papers. This growth is shown in Table 1, which shows that the topic is not only new (the average age of the documents is only 0.00415 years), but it is also quickly becoming important to scholars. The study also shows a lot of international collaboration (18.67%), with contributions from scholars from many countries.

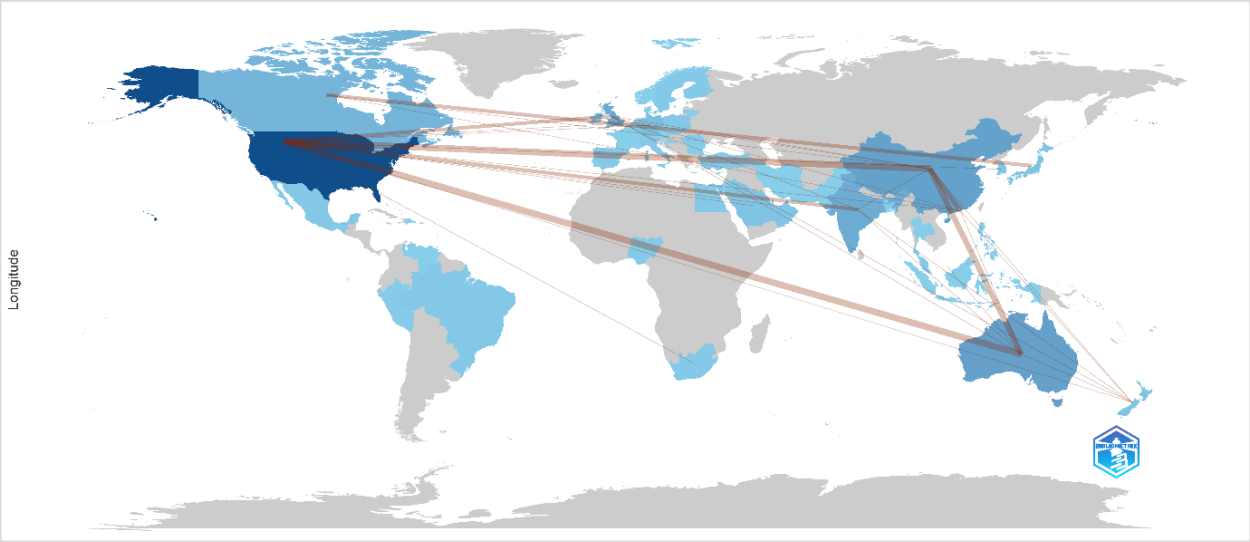
TABLE 1
GENERAL INFORMATION OF COLLECTED ARTICLES

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2022:2023
Documents	241
Annual Growth Rate %	23,900
Document Average Age	0.00415
Average citations per doc	3.116
References	7418
AUTHORS INFORMATIONS	
Authors	643
Single-authored docs	98
Co-Authors per Doc	2.85
International co-authorships %	18.67
DOCUMENT TYPES	
Article	144
Book chapter	3
Conference paper	3
Editorial	25
Erratum	1
Letter	21
Note	26
Review	18

Research Collaboration

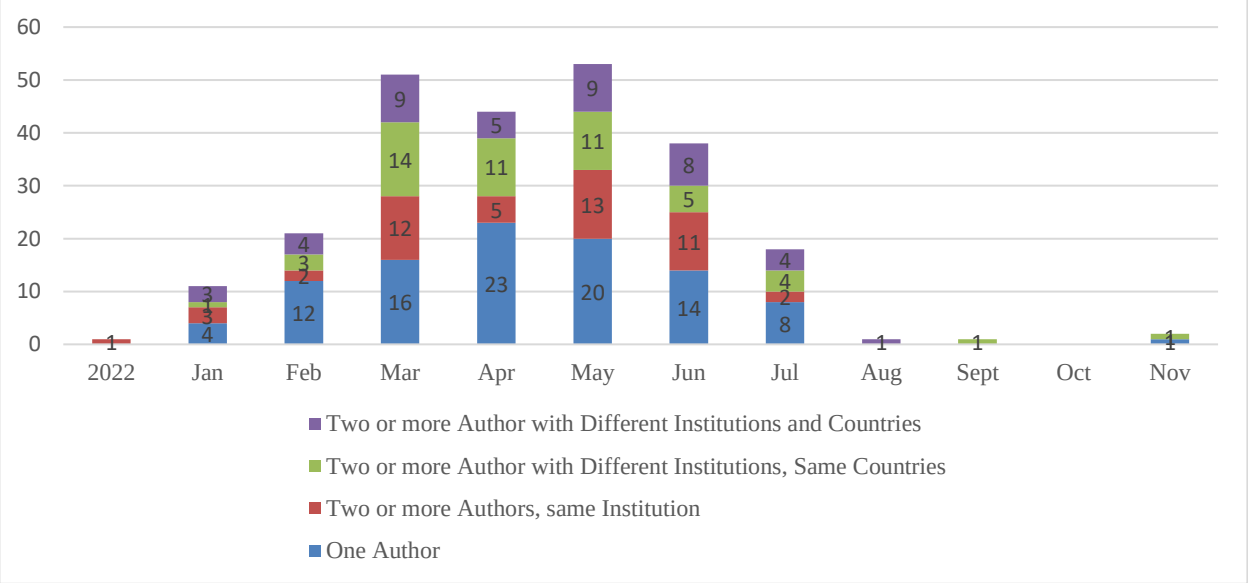
Figures 2 and 3 provide a more comprehensive analysis of the partnership patterns. The data presented demonstrates that the United States, China, and Australia are the primary contributors to scholarly research on this subject matter. This implies these nations are at the leading edge of technological advancements and educational research (Bok, 2015; Brush et al., 2020; Schmitt & deCourcy, 2022).

FIGURE 2
RESEARCH COLLABORATION MAP



Furthermore, Figure 3 presents that the ChatGPT topic has motivated the authors to conduct collaborative research with other authors from many institutions and countries as well as the individual author (e.g. in April 2023, the composition of a single author is around 52% compared to collaborative authors from different institutions and countries with 36%).

FIGURE 3
RESEARCH COLLABORATIONS BY MONTH IN YEAR 2023



Most Productive Universities

FIGURE 4
MOST PRODUCTIVE UNIVERSITIES

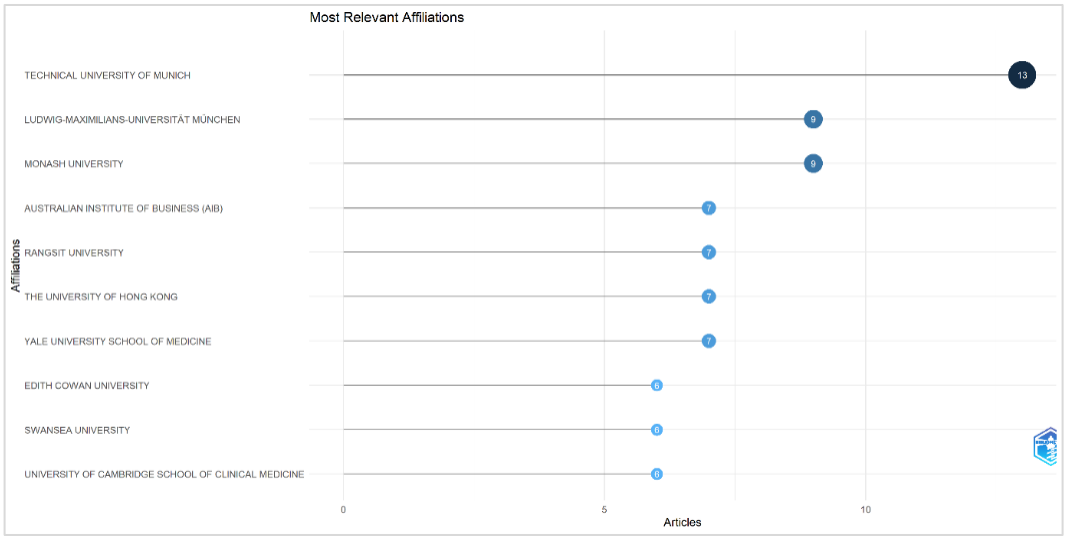
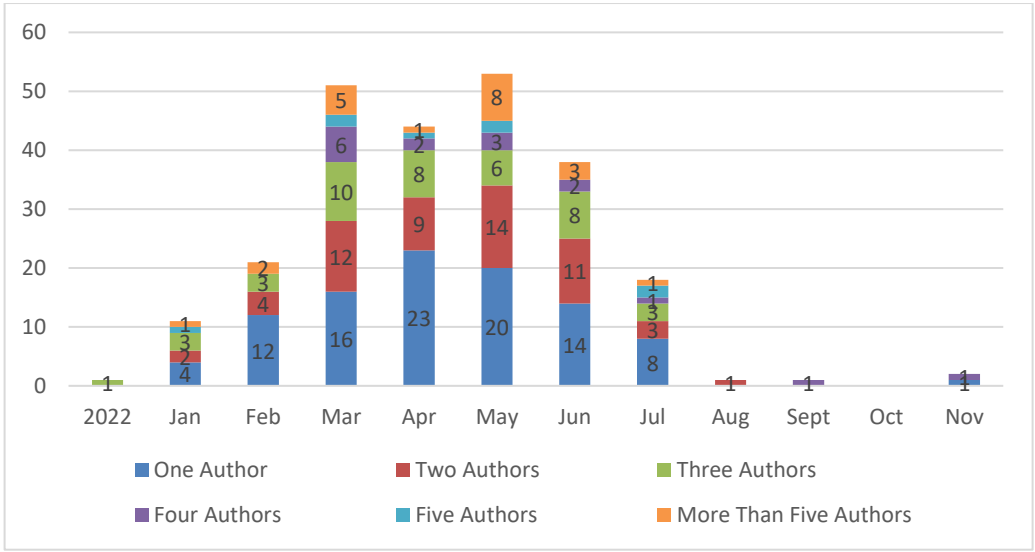


Figure 4 illustrates a dynamic and collaborative academic ecosystem in which universities from many countries actively analyze the ChatGPT phenomena. While the Technical University of Munich takes the lead, contributions from other universities show extensive academic interest and a multidisciplinary approach to understanding ChatGPT's role and potential in education.

Authorship Trends

FIGURE 5
NUMBER OF AUTHORS BY MONTH



Align with Figure 3, In Figure 5, we can see the growing interest in the ChatGPT topic within the education field and attract the researchers to conduct collaborative research with two or more researchers

from 2022 to 2023. Our result shows that the composition of multiple authors compares to the single authors as data collected 42%:58% in average ratio. This trend highlights that the ChatGPT topic suggests that research is subject across disciplines of knowledge and diverse expertise.

Journal Distribution

TABLE 2
JOURNAL DISTRIBUTIONS

Sources	H-Index	Total Citation	# Articles
LIBRARY HI TECH NEWS	22	207	13
JOURNAL OF APPLIED LEARNING AND TEACHING	2	0	9
ACCOUNTABILITY IN RESEARCH	35	304	6
MEDICAL TEACHER	131	2,990	6
SUSTAINABILITY	136	145,304	6
ASIAN JOURNAL OF PSYCHIATRY	55	5,678	5
JMIR MEDICAL EDUCATION	23	590	5
JOURNAL OF CHEMICAL EDUCATION	95	4,738	5
JOURNAL OF UNIVERSITY TEACHING & LEARNING PRACTICE	15	430	5
COMPUTERS AND EDUCATION: ARTIFICIAL INTELLIGENCE	17	531	4
ECONOMIC AND POLITICAL WEEKLY	65	944	4
ASSESSING WRITING	44	385	3
BIOLOGICAL PSYCHOLOGY	139	1,236	3
BRITISH JOURNAL OF EDUCATIONAL TECHNOLOGY	110	4,147	3
COLLEGE AND RESEARCH LIBRARIES NEWS	24	113	3

Table 2 overviews the top 15 journals publishing articles on ChatGPT in education. Although the publications are relatively new, our finding shows that most articles with high-impact factors are published in the high-impact journal. With 13 articles, the "LIBRARY HI TECH NEWS" journal indicates great interest in the relationship between technology and education research fields. Close following other leading journals such as the "ACCOUNTABILITY IN RESEARCH," the "MEDICAL TEACHER," the "ASIAN JOURNAL OF PSYCHIATRY", and "SUSTAINABILITY," each of which generated a critical number of articles.

Fields of Application

Table 3 shows several educational research fields that have studied the ChatGPT topic. The distribution clearly shows data on the areas where ChatGPT has been the most researched.

The most common topic is "Higher education," which accounts for 26.56% of the articles. This dominance indicates that higher educational institutions and researchers are actively exploring the potential uses of ChatGPT, perhaps in areas such as the learning process or higher education challenges regarding these issues. "General education" follows with a 23.24% share. This category most likely covers various educational themes, from primary to secondary school, demonstrating the versatility of ChatGPT applications to various educational levels.

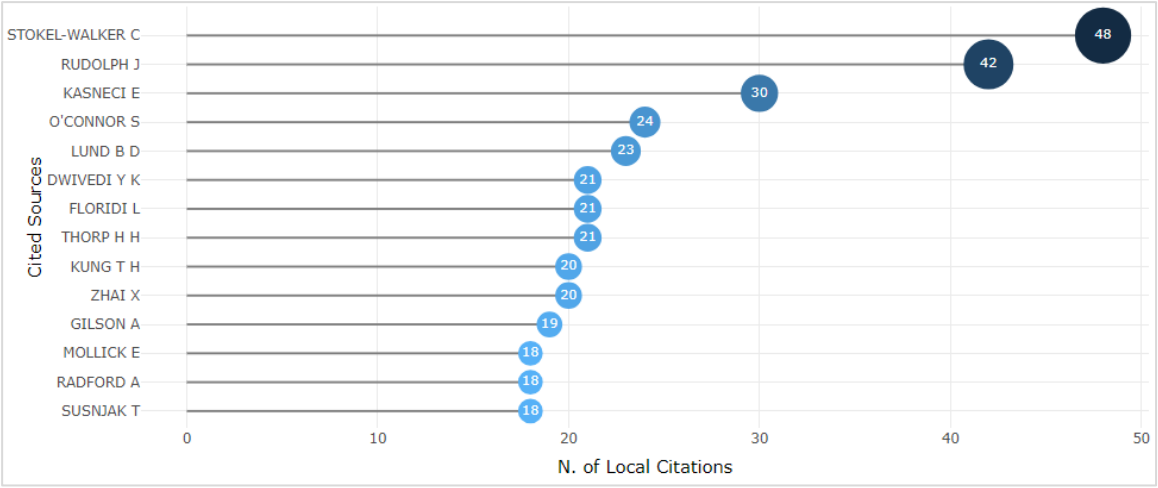
TABLE 3
CLASSIFICATION FIELD OF AREA OF ARTICLES

Category of Education	Count	Distribution
Higher education	64	26.56%
General education	56	23.24%
Medical	45	18.67%
Computer science	30	12.45%
Business and management	16	6.64%
Natural science	13	5.39%
Others	17	7.05%

Other fields, such as medical and computer science, contribute 18.67% and 12.45% regarding the ChatGPT topics in the education field of research, which could utilize the ChatGPT to conduct action simulations or case studies.

Number of Citations

FIGURE 6
NUMBER OF CITATIONS

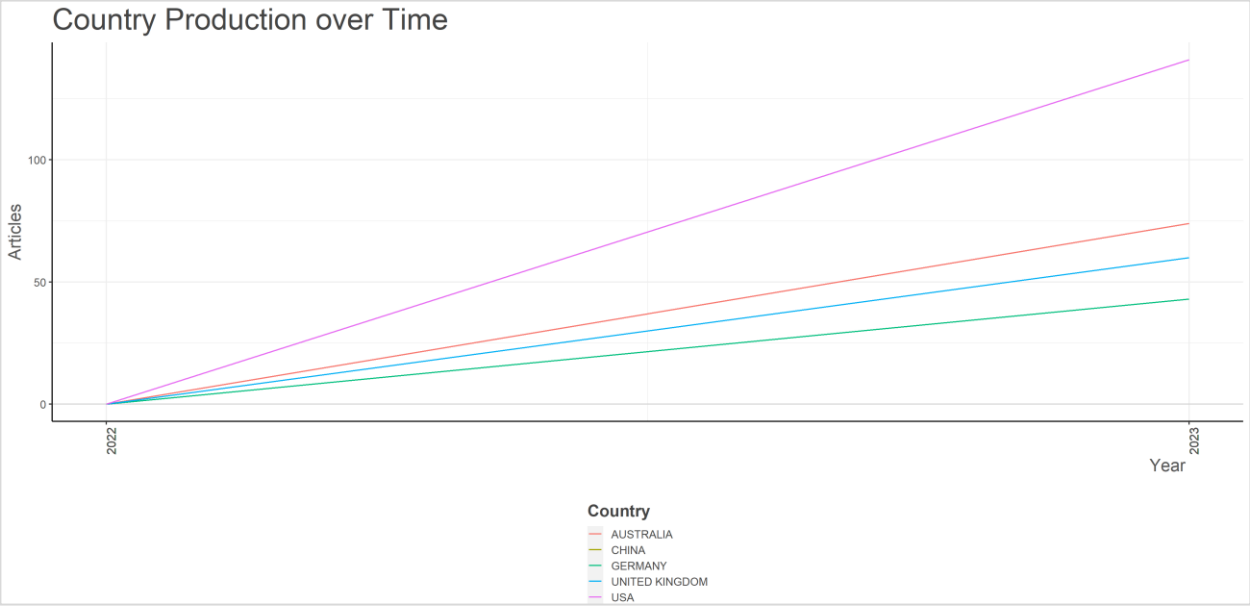


As a reliable measure of academic research impact, relevance, and quality, citation analysis has long been an important component of bibliometrics (Gurzki & Woisetschläger, 2017; Nicolaisen, 2010). This technique has been the focus of extensive literature, aiming to provide a comprehensive overview of its evolution, methodology, and applications (Mostafa, 2023; Newman, 2004). In this context, with the same approach, emerging ChatGPT topics in educational research are quickly gaining recognition, especially regarding citation impact, as shown in Figure 6. Stokel-Walker is an influential author in this emerging field, with 48 citations for his work that he has received from other academics demonstrating its significance and impact. His work related to ChatGPT's role as a co-author in academic publications has encouraged many academic scholar discussions. Other distinguished researchers with similar citation counts as Stokel-Walker include Rudolph J, Kasneci E, and O'Connor S, who have received 42, 30, and 24 citations each. In various educational contexts, including student assessment and the learning process, their studies examine the debates, opportunities, and issues surrounding ChatGPT utilization during the educational

process. The high citation counts for these writers support the general bibliometric notion that citation analysis may accurately assess the innovative character of research, highlighting the expanding awareness of ChatGPT-related research.

Most Productive Countries

FIGURE 7
MOST COUNTRIES WITH THE GREATEST ARTICLES PRODUCTION



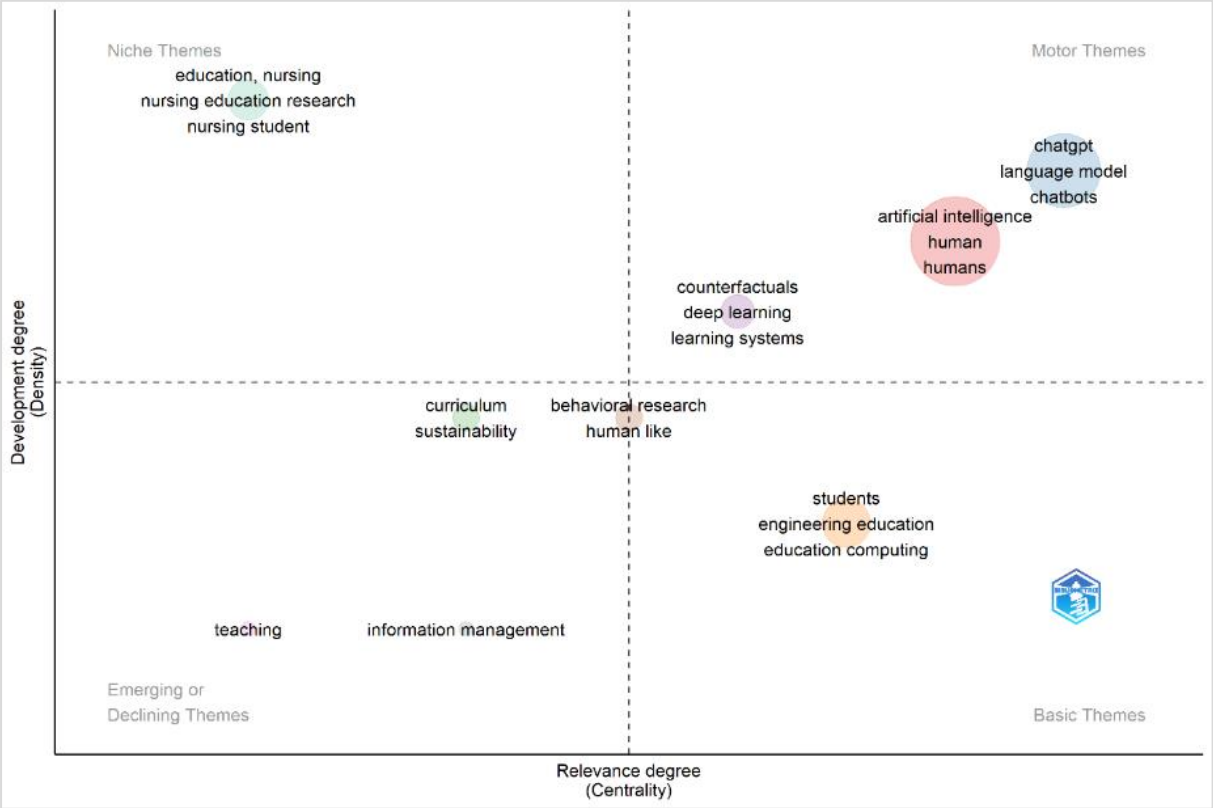
The ChatGPT topic has rapidly gained traction and pursuing researchers to exploring the topic; as a result, as shown with the Biblioshiny application in Figure 7, even though the research began in late 2022, the momentum of production of articles within the year 2023 during the data collected per July 2023 shows consistency to publish their research article in the education context. The global interest in the topic is very apparent, with 586 institutions from 646 countries involved in the discussions. Geographically, the United States has the most articles (141), followed by Australia (74). China and the United Kingdom also contribute significantly, each with 60 articles, while Germany closes out the top five with 54 research articles. This geographical distribution emphasizes the ChatGPT topic's worldwide appeal and illustrates the regions at the centers of this academic interaction.

Research Trend Topic

Figure 8 provides an engaging insight into the emerging research trends around the ChatGPT dilemma, which was just recently discovered at the end of 2022 but already gain researchers' attention. Despite its disruption, the issue has attracted many academics, each diving into distinct elements of ChatGPT's potential and uses.

The core elements of this academic debate are artificial intelligence and language modelling. These fundamental subjects indicate that academics are eager to explore the underlying algorithms and language skills that make ChatGPT a flexible tool, particularly in educational contexts. Consistent with the emphasis on education, the data indicates distinct sub-themes that have attracted much attention. The main subjects, "student and engineering education" and "educational computing," emerge, demonstrating a fundamental interest in how ChatGPT might be utilized in general and specialized educational curricula. Surprisingly, "nursing education" emerges as a niche issue, indicating an increasing interest in exploring ChatGPT in healthcare education.

FIGURE 8
RESEARCH TREND TOPICS



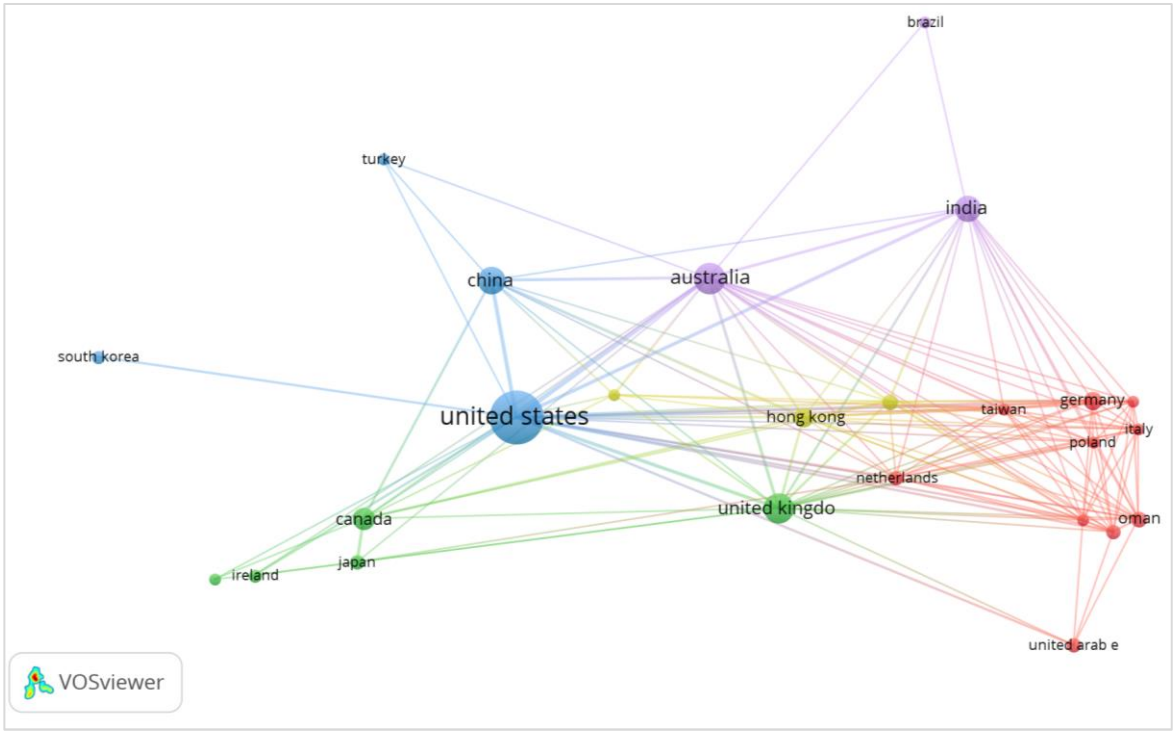
Furthermore, rising themes such as “teaching,” “curriculum sustainability,” and “behavior research” indicate an expanding extent of research. These themes demonstrate that the academic community is looking beyond ChatGPT’s technology aspects to explore its potential influence on pedagogical methods, curriculum design, and even student behavior.

Science Mapping Analysis

In this part, researchers conduct the science mapping analysis with the VOS Viewer application to elaborate the research findings, such as co-authorship, co-occurrence, bibliographic coupling, and co-citation analysis (van Eck & Waltman, 2022).

Co-authorship networks may be used to visualize and comprehend the global research landscape by emphasizing significant key researchers, collaborations, and developing trends (Börner et al., 2005; C. Chen & Song, 2019). In co-authorship networking, we may see research exchanges or collaborations within a social environment. These networks not only gather the dynamics of research networks but also assist in reconstructing research cooperation networks between two or more researchers (Milojević, 2010; Mostafa, 2023; Newman, 2004). These networks are critical for analyzing the flow of knowledge, disseminating novel ideas, and establishing multidisciplinary disciplines (K. Chen et al., 2019; Wagner & Leydesdorff, 2005). The size of each node in these networks indicates the number of publications from a particular country, offering insights into the research output and importance of various geographical regions. The strength of the linkages between nodes, on the other hand, represents the extent of research collaboration across countries, offering information on international collaboration and knowledge exchange (Ding, 2011; Lu et al., 2022).

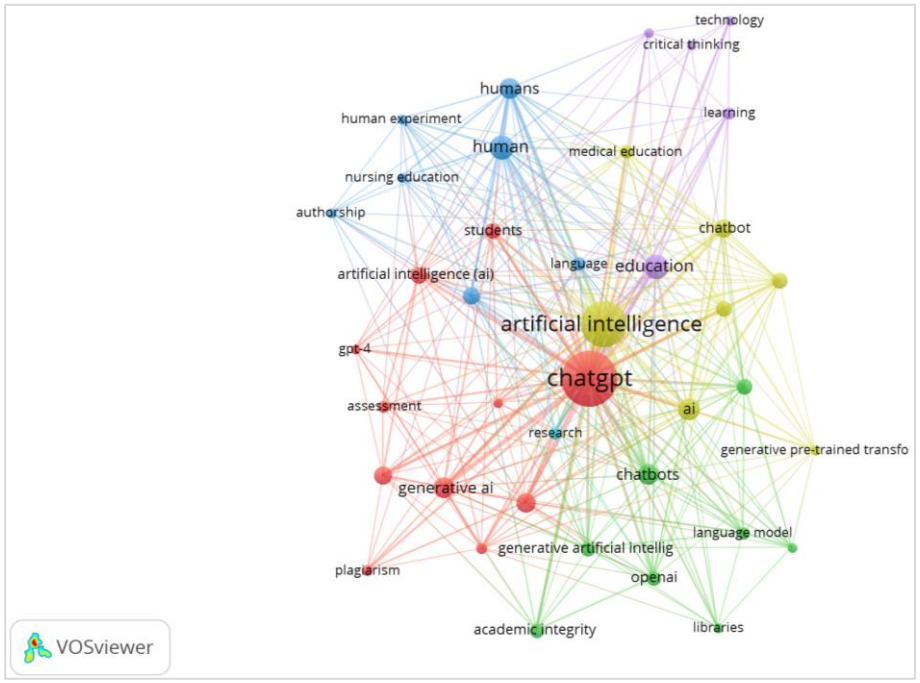
FIGURE 9
CO-AUTHORSHIP COUNTRIES COLLABORATION NETWORK



The United States is the most influential country regarding research output, illustrated in Figure 9, followed by Australia, the United Kingdom, and China. This dominance in the research environment is due to funding, infrastructure, and academic culture (King, 2004; Marginson, 2022). Figure 10 further shows that these nations have five distinct research collaboration groups. These clusters may represent specialized research topics or shared research interests among nations (Fortunato et al., 2018; Kong et al., 2019). Understanding these clusters may assist governments and organizations in identifying opportunities for collaboration and grant research within these countries.

According to Figure 10, the co-occurrence network visualizes the ChatGPT topic as consisting of five clusters that represent the term or keywords that most researchers use to provide insights into trending topics, emerging areas of research, and the relationships between different terms or concepts (van Eck & Waltman, 2022; Xie et al., 2020). First, relate to the development of ChatGPT as generative AI to GPT-4 which may affect the utilization of ChatGPT for the student to conduct their assessment or regarding the ethical and plagiarism issues. The second relates to the ChatGPT origin created by Openai and its functions like chatbots, language models, and generative artificial intelligence. The third cluster has a different point of view in the education field that ChatGPT also can improve the student critical thinking, engagement, and learning process. The fourth cluster is similar to the second cluster, which shows ChatGPT as artificial intelligence with chatbot function and generative artificial intelligence in education. The fifth cluster, which examines ChatGPT's broader uses in professional and academic settings, argues that the technology might exceed educational boundaries and is highlighted to be a valuable asset in a wide range of human-related fields. This cluster might provide an entry point for multidisciplinary studies on ChatGPT's application in industries other than education, such as healthcare, business, and social sciences.

FIGURE 10
CO-OCCURRENCE NETWORK ANALYSIS



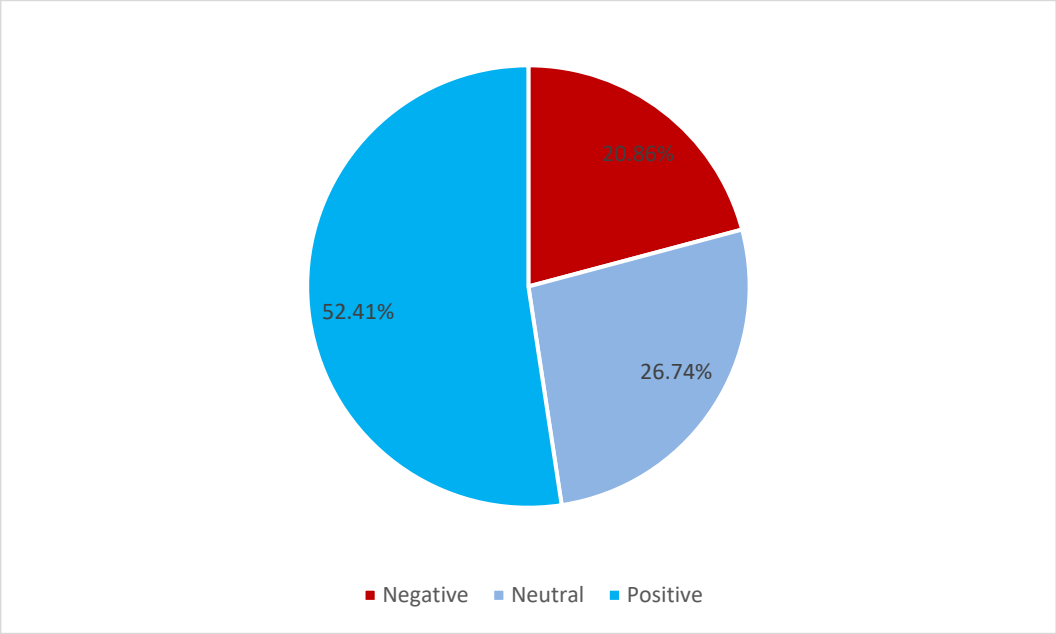
Sentiment Analysis

Sentiment analysis in education has gained significant attention, especially with the rise of e-learning, MOOCs, and other online platforms (Gandhi et al., 2023; Han et al., 2020; Jadhav, 2023). For instance, implementing sentiment analysis in the learning and teaching evaluation is essential in the educational system (Lalata et al., 2019; Pramod et al., 2022; Roaring et al., 2022).

For instance, Ardianto et al. (2020) applied sentiment analysis to gauge opinions on e-sports in the education curriculum, emphasizing the importance of classifying sentiments into positive, negative, and neutral categories. Similarly, a Study using sentiment analysis on tweets about online education during the COVID-19 pandemic, highlighting the effectiveness of e-learning and the general sentiment of the public towards it (Lubis et al., 2022). Pang and Lee (2004) proposed a machine-learning method for sentiment analysis that focuses on the subjective portions of a document, further emphasizing the importance of accurate sentiment classification 3. Mehmood et al. discussed the significance of sentiment analysis in the competitive environment of the education sector, particularly for the marketing and brand promotion of universities.

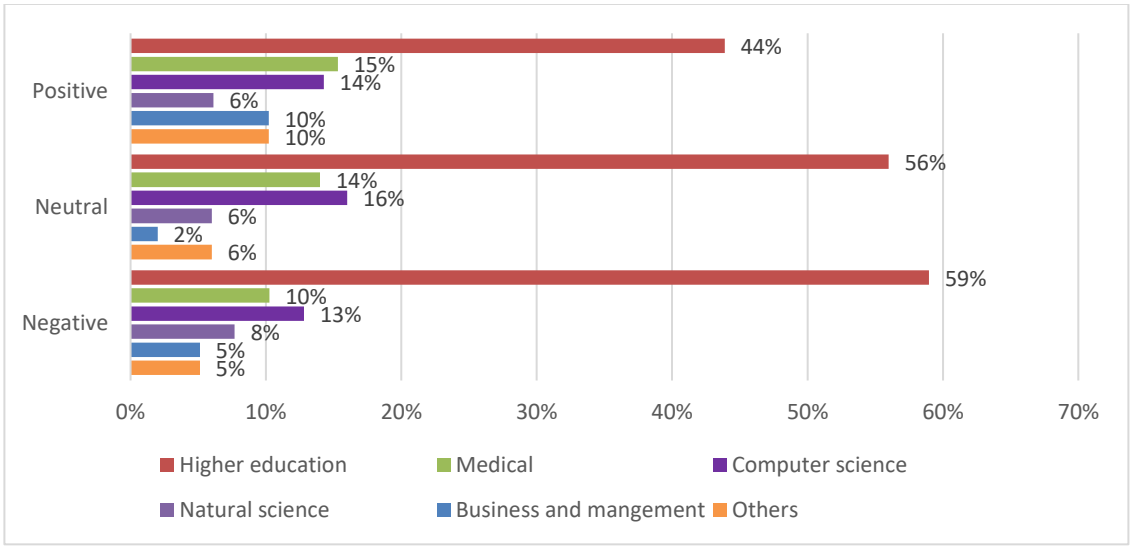
In this part, we provide the sentiment analysis by analyzing the abstract and then labeling it into three classifications: positive, negative, or neutral (Carrillo-de-Albornoz et al., 2018; Sharma et al., 2023; Taj et al., 2019). This labeling also assists by The ChatGPT, which was already used in the previous study (Javaid et al., 2023; Praveen & Vajrobol, 2023; Wang et al., 2023). This AI method has also already been used to label text data using several techniques such as deep learning, bidirectional encoder representation from transformers (BERT), and machine learning (Shaik et al., 2023). In summary, as Figure 11 shows, our study found that most of the research articles within the ChatGPT theme in the Education field show 52.41% as positive, 20.86% as negative, and 26.74% as neutral.

FIGURE 11
SENTIMENT ANALYSIS RESULT



If we break down the result, Figure 12 shows that the ChatGPT topic among researchers in higher education is highly concerning and exploring the negative effects of the usage of ChatGPT (59%) in the academic domain, such as student integrity, plagiarism, and cheating, compare to the positive usage of ChatGPT to assist, increase engagement, attraction, and interaction of student or exploring the student critical thinking. The contrary result for the medical domain shows that the ChatGPT can provide a better understanding for the student by conducting the simulation with ChatGPT rather than the negative side, such as the student plagiarism or cheating.

FIGURE 12
DETAILED SENTIMENT ANALYSIS IN EDUCATION FIELDS



DISCUSSION

The bibliometric analysis of 241 articles on the ChatGPT topic in education reveals a growing field of research with significant contributions from various countries and academic institutions that publish in high-quality journals with annual growth levels reaching 23,900%. The rapid growth in articles and high international collaboration (18.67%) underscore the global interest in this emerging technology (Bok, 2015; Brush et al., 2020; Schmitt & deCourcy, 2022). The United States, China, and Australia emerge as the leading countries in this research landscape, each contributing unique perspectives and expertise to the discourse (Cao, 2017; Freeman & Strong, 2017; Joyce, 2019; Probert, 2015; Veugelers, 2017).

Regarding the research cluster analysis, our co-occurrence analysis resulted in five clusters of the area with specific purposes such as the ChatGPT initiative and development, the role and utilization of ChatGPT, and the practical implications of ChatGPT on education perspective, which affect the ethical and integrity issues or enhance the learning process of students.

The analysis also highlights the multidisciplinary nature of ChatGPT research on education, with contributions from fields as diverse as higher education, general education, medical studies, and computer science. This multidisciplinary research suggests that ChatGPT has broad applications, from pedagogical advances to ethical considerations (Gandhi et al., 2023; Han et al., 2020; Jadhav, 2023; Lalata et al., 2019; Pramod et al., 2022; Roaring et al., 2022). Our analysis also reveals emerging research trends in these topics such as "teaching," "curriculum sustainability," and "behavior research". This indicates that these themes demonstrate that the academic community is looking beyond ChatGPT's technological aspects to explore its potential influence on pedagogical methods, curriculum design, and student behavior.

Sentiment analysis extends our understanding of the field by revealing a complex landscape of positive, negative, and neutral sentiments about ChatGPT's role in education (Carrillo-de-Albornoz et al., 2018; Sharma et al., 2023; Taj et al., 2019). This complexity is mainly present in higher education, where concern about academic integrity combines with optimism about ChatGPT's ability to enhance student learning, engagement, and critical thinking. This ChatGPT is utilized in medical education to assist students with its simulation capabilities.

CONCLUSION AND LIMITATION

The results of a bibliometric analysis of 241 articles on ChatGPT in education present an attractive overview of a growing field of study with important global contributions. The exponential yearly growth rate of 23,900% and significant international collaboration (18.67%) indicate the global interest in this emerging technology. Leading countries like the United States, China, and Australia offer distinct perspectives, enhancement, and expertise for global discussion. The co-occurrence analysis revealed five clusters, each concentrating on a different component of ChatGPT, ranging from its origins and role to its educational implications. These clusters also emphasize ethical considerations and the potential of technology to improve student learning.

The research's multidisciplinary nature indicates that ChatGPT has many applications, including educational transformations and ethical debates. Sentiment analysis adds to our understanding by identifying a complex landscape of perspectives on ChatGPT's role within education, especially in higher education and the medical disciplines, where it is both acclaimed for its potential and challenged for its ethical implications.

This study has several limitations that should be acknowledged. First, the analysis is based on a limited number of articles published between 2022 and 2023, which may not fully capture the diversity of perspectives on ChatGPT in education. Second, the sentiment analysis is based on abstracts and may not reflect the nuanced arguments in the full articles. Third, the study focuses primarily on articles published in Scopus, potentially not covering other high-impact factor journals such as Web of Science.

Future research could address these limitations by expanding the scope of the bibliometric analysis to include articles from a broader time frame and articles databases. Additionally, qualitative studies could provide deeper insights into the ethical and pedagogical implications of ChatGPT in education. Given the

technology's rapid development and growing influence in educational settings, ongoing research is essential to understand its full impact and potential.

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