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A Review of the Scholarly Works on ChatGPT Use in Education: Bibliometric Analysis

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A Review of the Scholarly Works on ChatGPT Use in Education: Bibliometric Analysis

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Abstract

The emergence of innovative artificial intelligence (AI) technologies, such as ChatGPT, which was just released in November 2022, has the potential to significantly transform the current state of education. Put another way, learning is changing as a result of chatbots' personalized assistance, group discussions and collaborations, evaluations of students' work, encouragement of self-directed learning, and raised student enthusiasm and engagement. A significant number of scholarly works has been done to examine the use of ChatGPT in education. This study aims to make a valuable contribution by conducting a bibliometric analysis of previous research, namely studies conducted throughout the study period, which mostly examined the implementation of ChatGPT in educational settings. The crucial data gathered from this analysis will help to identify the linkage and themes within the published literature. Lastly, this study will attempt to highlight the literature gap which future studies can be conducted in this very area of interest.

Introduction

Chat Generative Pre-trained Transformer, commonly known as ChatGPT, is an artificial learning (AL) tool that is driven by the technology of artificial intelligence. In general, advanced technology enables the tool to become more advanced in the future. It is a software consisting of language models that allow users to ask questions either in conventional or natural language. The software was first released on November 30, 2022, by the American company Open AI. Its users include educators, professionals, students, and others. Users will get answers in the form of human-like text by typing relevant questions. Its usage volume achieved more than one million users subscribed for its free account within five days of its introduction (Gregersen, 2023).

The development of ChatGPT has made it an invaluable helper in education and other fields. Its impact falls across a wide range of applications, including data processing, cause and effect generation, collaboration, and outreach. Meanwhile, the challenges of its introduction are increasingly becoming everyone's concern. Hence, as artificial intelligence (AI) evolution continues to boost, growing interest in examining the impact as well as challenges of ChatGPT in education can be seen.

As per Google Scholar, by November 2023, just a year after ChatGPT's introduction, more than 34,800 articles, reports, and news had been published on the topic of ChatGPT, in education. Ray (2023) stated that in March

2023, the research on ChatGPT in scientific communities found in Google Scholar is approximately tenfold lesser. It shows an enormous growth rate of attention on ChatGPT research among scholars. Thus, in this study, we attempt to provide a more comprehensive visualization of the ChatGPT usage in multidisciplinary literature using the bibliometric method. A bibliometric analysis offers an intellectual structure of a specific domain of large volumes in the literature (Donthu et al., 2021). We aim to fill the gap in the bibliometric analysis as a future guideline for scholars, industries, and policymakers in conducting research on ChatGPT by viewing the literature's structure.

The rest of the paper is structured as follows. The paper will begin with brief introduction followed by the development of the research questions to be used in the bibliometric review. Next, the paper will explain the methodology employed including the PRISMA searching strategy to the extraction, and analysis process. In the subsequent section, this study will also delve into reporting and provide comprehensive discussion based on the review findings. Finally, this study will be concluded by drawing a summary discussion on the review conducted and providing recommendations for possible future studies' direction.

Research Questions

The methodology portion of the study includes a description of the procedures utilized in this investigation, including the data searching procedure, data collection, extraction, and analysis. Using bibliometric, text-mining, and visualization technologies, the following research questions (RQ) are used to illustrate the review process and activities. Table 1 showed the research questions outlined and the analysis protocol that will be used to answer each of the research questions.

Table 1. Research Questions (RQ)

No.	Research Questions	Analysis Protocol
1	What is the current trend of publication on the topic of the use of ChatGPT in Education?	• Document Type • Discipline Area • Total number of publications • Number of publications by year • Annual growth rate
2	Who are the main contributors/researchers, affiliations, and countries on the topic of the use of ChatGPT in Education?	• Most relevant sources • Corresponding authors' countries • Countries' scientific production • Most cited countries • Most relevant affiliations • Authors' impact
3	How has the theme of scholarly works evolved on the topic of the use of ChatGPT in Education?	• Treemap • Thematic evolution • Trend topic

Methodology

In this review, the search strategy of PRISMA (Preferred Reporting Items for Systematic Reviews) and bibliometric analyses were employed. The use of PRISMA will extensively scan all literature published on the subject to find answers to the clearly defined research question, use various inclusion and exclusion criteria to identify the reports to be included in the review, and then synthesize the findings (Yun, 2023). The well-developed search strategy will be employed on the Scopus database in recognition of the credibility of Elsevier Scopus as one of the largest academic literature databases with close to 50 million records of around 5,000 publishers (Grimaldi et al., 2017). The search strategy begins by filtering and refining the literature by a combination of keywords. The preliminary search using the keywords of "ChatGPT" retrieved about 184 publications. By further refining the search with additional keywords of "ChatGPT" AND "Education" OR "Artificial Learning" OR "Education Technology", the search retrieved about 59 publications. By restricting the search to English language publications only, 58 articles were obtained. Table 2 illustrated the search inclusion and exclusion criteria used in refining the search for relevant publications.

Table 2. Search Criteria

Scopus Category	Searching Criteria.	No of Article
Keywords 1	"ChatGPT"	184
Keywords 2	"ChatGPT" AND "Education" OR "Artificial Learning" OR "Education Technology"	59
Document Type	All types of publication	59
Author name	All	59
Language	English	58

Figure 1 shows the PRISMA strategy employed in searching, screening, and refining articles for the bibliometric review. Bibliometric review is a rigorous method for exploring large volumes of scientific data and quantitative analysis of publications. The findings from this bibliometric review provide insight into the existing scholarly works done in this area of interest to determine the future direction of research that can be done. The data that dominates bibliometric analysis tends to be massive (i.e., hundreds or thousands) and objective in nature (i.e., frequency of keywords and topics), though its interpretations frequently rely on both objective (i.e., performance analysis) and subjective (i.e., thematic analysis) evaluations established through well-informed techniques and procedures (Donthu et al., 2021).

As a matter of fact, the main reasons for doing these types of analyses can stem from a number of factors, and there is a desire within many scientific fields to obtain an overview of the literature (Ellegaard &Wallin, 2015). Hence, the contributions from a bibliometric analysis are manifold. First, it provides an overview of the past scholarly works done in this area of interest by quantifying the past research that has been performed. Secondly, it aids in identifying the literature gaps by providing knowledge on the new trends and competing discussion surrounding the topic of interest.

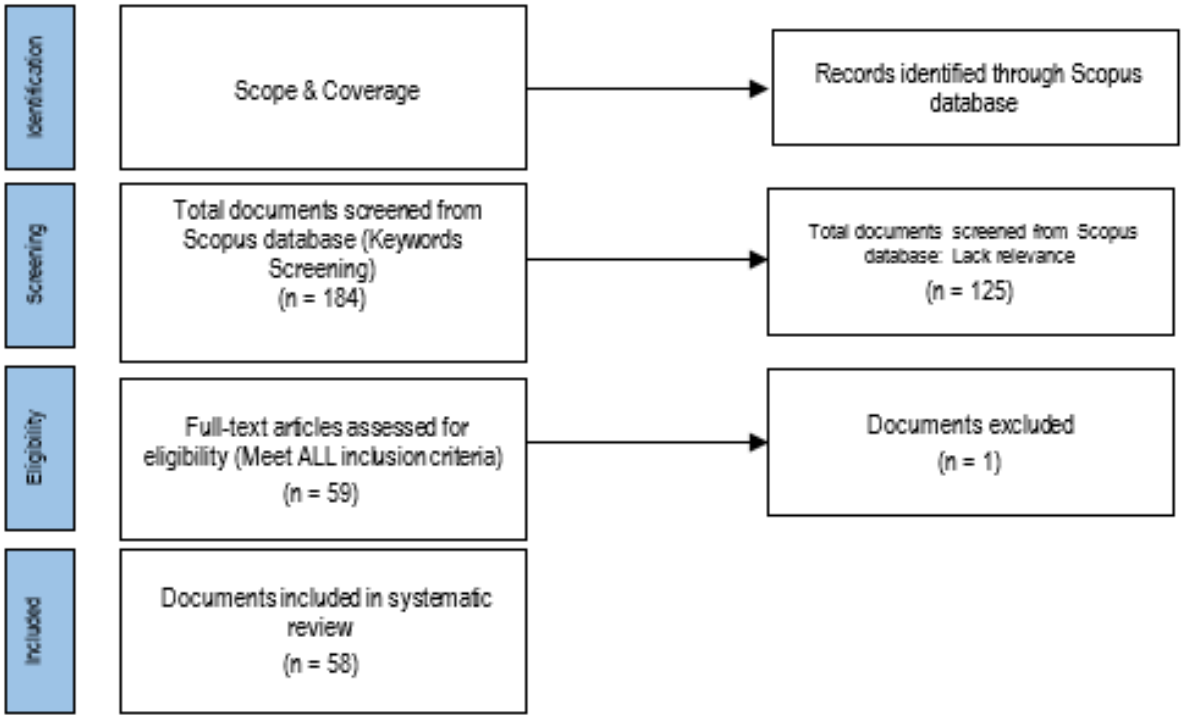

Figure 1. The PRISMA Diagram used to Find, Screen, and Select Articles

Results

A total of 58 journal articles were extracted from the Scopus database and were thoroughly analyzed with the help of the R studio application. At the early stage of this study, a descriptive analysis was provided to examine the details of the work that has been published in this area. Besides that, the descriptive analysis was performed to answer the research question 'What is the current trend of publication in this topic of interest'? The data from this preliminary analysis will provide a comprehensive overview of the existing scholarly work that has been done in the past. Table 3 shows the document profiles.

Table 3. Document Profiles

Description	**Results**
Main Information About Data	
Timespan	**2022:2023**
Sources (Journals, Books, etc)	44
Documents	**58**
Annual Growth Rate %	**5600**
Document Average Age	0.0172
Average citations per doc	2.483
References	**2240**
Document Contents	
Keywords Plus (ID)	202

Description	Results
Author's Keywords (DE)	169
Authors	
Authors	245
Authors of single-authored docs	25
Authors Collaboration	
Single-authored docs	25
Co-Authors per Doc	4.28
International co-authorships %	24.14
Document Types	
Article	30 (51.72%)
Editorial	6 (10.34%)
Erratum	1 (1.72%)
Letter	4 (6.90%)
Note	10 (17.24%)
Review	6 (10.34%)
Short Survey	1 (1.72%)

RQ1: What is the current trend of publication on the topic of ChatGPT use in Education?

As shown in Figure 2, the number of publications related to the topics of ChatGPT use in Education has been on the rise. Based on the observed linear increasing trend of the annual scientific production in Figure 2, there has clearly been substantial increase of scholarly works being done related to the topic of interest. Next, Figure 3 shows the publications by type.

From Figure 3, the majority of publications (51.7%) were found to be of journal articles. This is then followed by 17.2% notes, 10.3% editorial, and 10.3% review papers. Subsequently, Figure 4 shows the classification of the publications by their subject areas. It was noticeable that most of the publications on this topic were from the social science discipline with 34% of publications reported. This is followed by 12% of the publications from the medicine discipline, 14% of publications from other disciplines, and 10% from the computer science field.

Overall, it can be deduced that research topics related to the use of ChatGPT in education have been increasingly sought. Secondly, most research that has been done in this area of interest consisted of original journal articles. This reflected that this topic is being actively researched and thoroughly examined by scholars. Lastly, the figures reported on the subject area clearly depict that this topic is heavily discussed among scholars from the social science discipline. However, the high number of researches from the social science discipline was rather expected given that the nature of the topic itself is connected to the field of education. But the significant number of scholars from the medicine discipline who have undertaken research related to the use of ChatGPT in education was less expected.

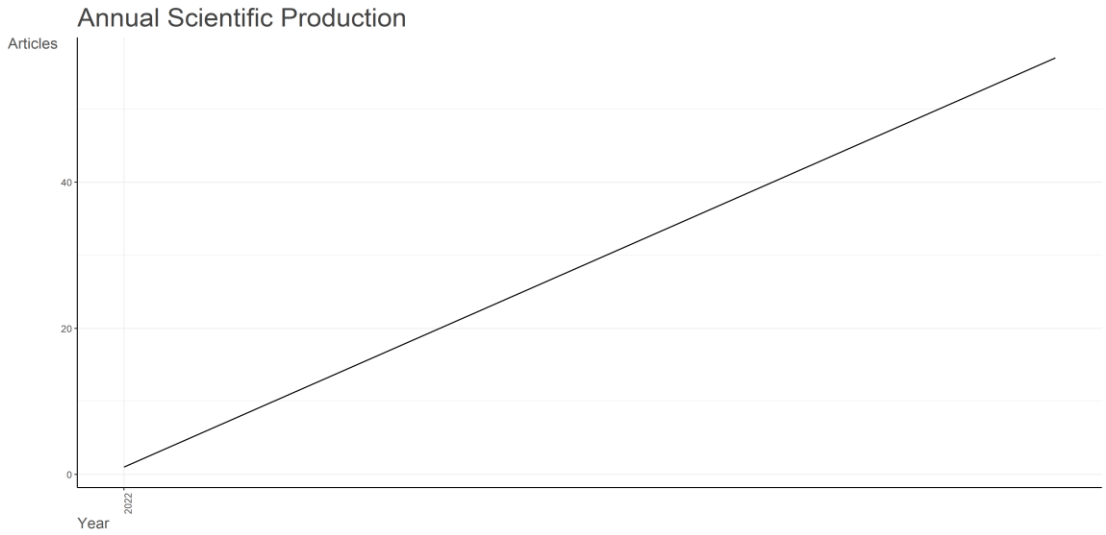

Figure 2. Annual Scientific Production (Total Publications from 2022 – 2023)

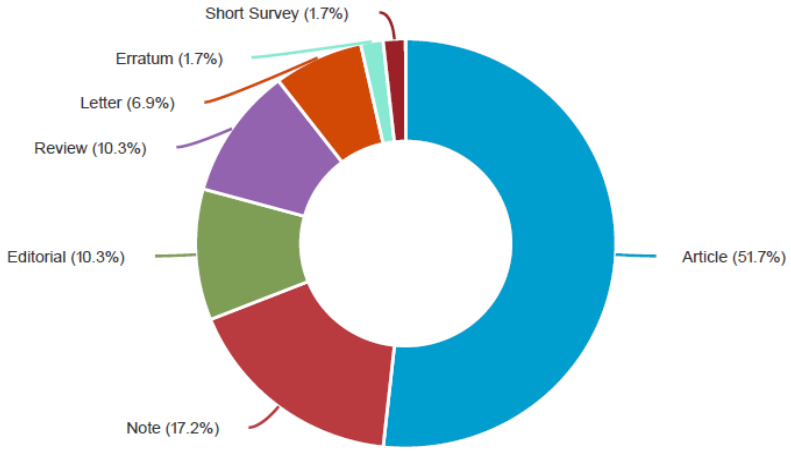

Figure 3. Publications by Types (Publications from 2022 – 2023)

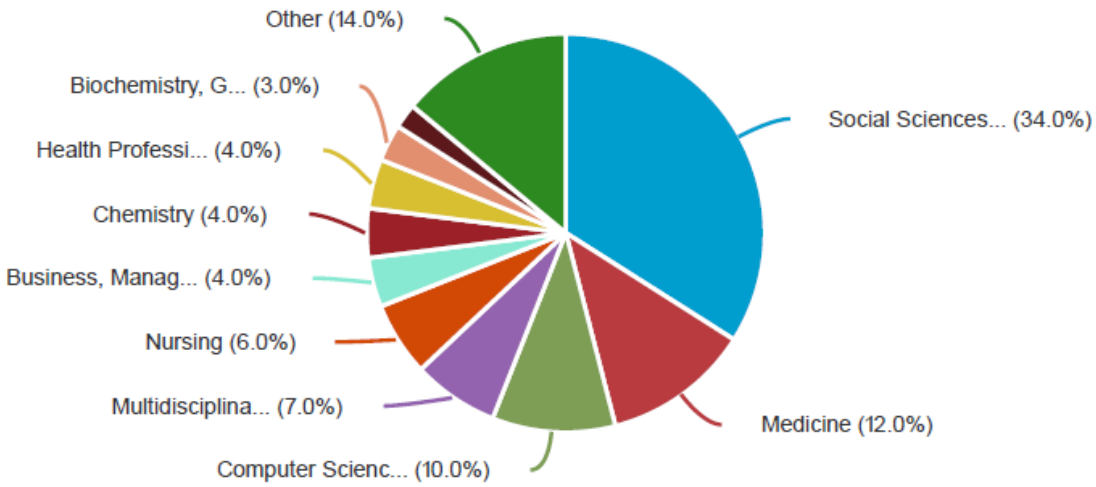

Figure 4. Publications by Subject Area (Publications from 2022 – 2023)

RQ2: Who are the main contributors/researchers, affiliations, and countries on the topic of ChatGPT in Education?

To answer the second research question, we examined the bibliometric results of the leading contributors to observe the current results of the research on ChatGPT in Education. The focus is given on the contributors' publications by countries, the most relevant sources, the most cited countries, the author's local impact, the author's production over time, the author's productivity through Loftka's Law and the most cited local authors in the bibliometric analysis. Figure 5 shows the most relevant sources in this area of interest. The sources that contributed to this area of interest were mostly found in *Nature* with 6 articles. Besides that, the relevant sources were also found in *JMIR Medical Education*, *Journal of Chemical Education*, *Journal of University Teaching and Learning Practice* with 3 articles found in each source, respectively. This is followed by 2 articles found in *Anatomical Sciences Education*, *Nurse Education in Practice* and *Resuscitation*.

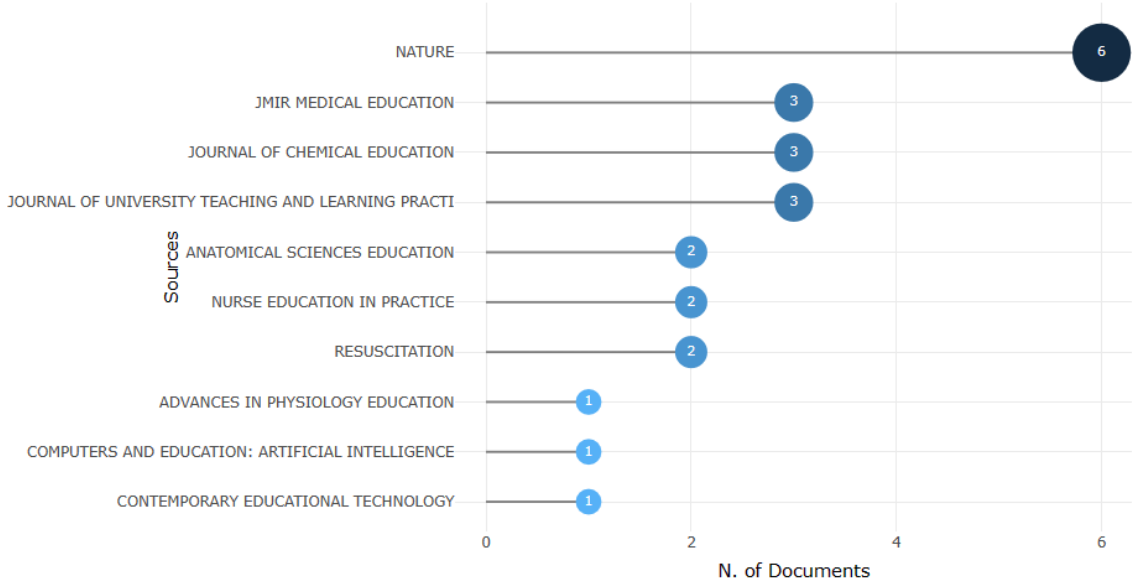

Figure 5. Most Relevant Sources

Next, we examined the database of the contributors by country. Figure 6 and Table 4 present the scientific production frequencies worldwide by the authors' affiliated countries. A large percentage of the publications were affiliated with the USA, followed by Australia and the United Kingdom. Table 4 shows that the USA has the highest scientific production with 47 sources reported, followed by the United Kingdom with 32 publications, and Germany with 28 publications. By inspecting in-depth, we highlighted the countries of the corresponding authors. The corresponding author is responsible for sending the article and handing all correspondence with the journal editor. In Figure 7, we find that the USA has the highest number of corresponding authors, followed by the United Kingdom and Australia. In terms of collaboration, we examined the intra-country (SCP) and inter-country (MCP) databases. It was revealed that the USA, United Kingdom, and Slovenia have the highest inter-country (MCP) collaboration. Similarly, the USA was found to have the highest intra-country collaboration (SCP) as well. This is followed by the United Kingdom with the second-highest intra-country collaboration (SCP). While Australia and China were found with the same number of intra-collaboration research papers.

Table 4. Top 10 Countries' Scientific Production

Rank	Region	Frequency
1	USA	47
2	UK	32
3	Germany	28
4	India	19
5	Australia	17
6	China	10
7	Italy	8
8	Pakistan	7
9	France	5
10	Canada	4

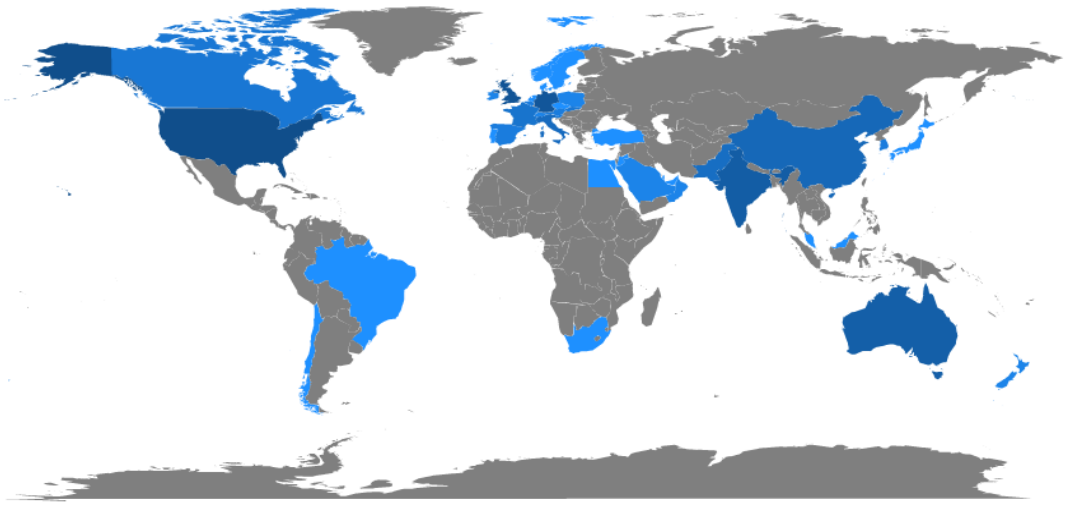

Figure 6. Countries Scientific Production

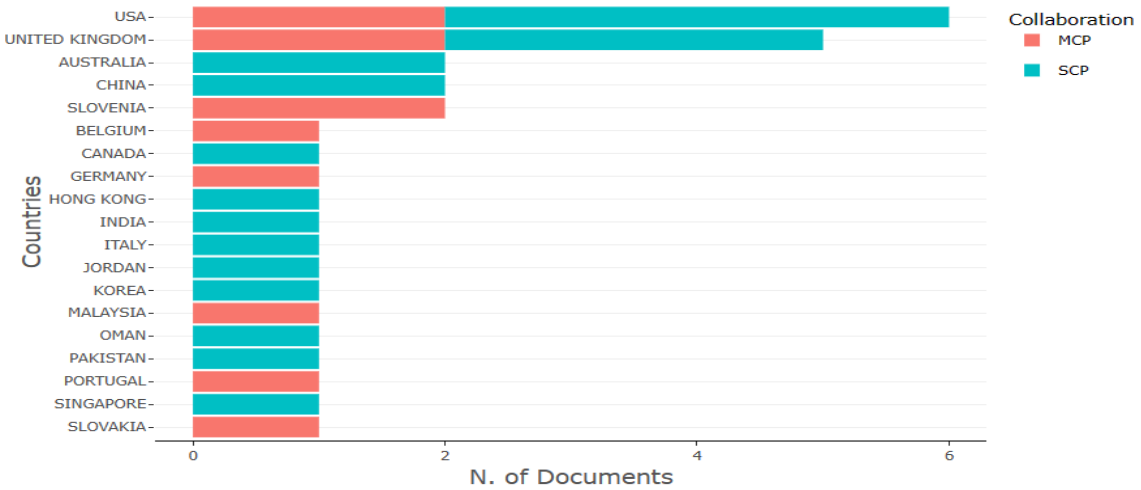

Figure 7. Corresponding Authors' Countries & Collaboration

The subsequent Table 5 displayed the total number of citations received by the different countries. The USA topped the list with the highest number of citations received (a total of 8 citations and an average of 1.30), followed by Belgium and Malaysia (a total of 3 citations and an average of 3.00).

Table 5. Most Cited Countries

Country	Total Number of Citations	Average Article Citations
USA	8	1.30
Belgium	3	3.00
Malaysia	3	3.00
United Kingdom	3	0.60
Australia	1	0.50
Italy	1	1.00
Pakistan	1	1.00
Slovakia	1	1.00
Slovenia	1	0.50
Canada	0	0.00

Table 6 presented the publications by affiliations. The top 10 most relevant affiliations showed the Technical University of Munich had the highest number of articles affiliated with it. This is followed by Ludwig-Maximilians-Universität Műnchen with 9 articles, Yale University School of Medicine with 7 articles, and Swansea University and the University of Maribor both with 6 articles each.

Table 6. Most Relevant Affiliations

Rank	Affiliation	Articles
1	Technical University of Munich	13
2	Ludwig-Maximilians-Universität Műnchen	9
3	Yale University School of Medicine	7
4	Swansea University	6
5	University of Maribor	6
6	The University of Hong Kong	5
7	Comenius University in Bratislava	4
8	Rutgers New Jersey School of Medicine	4
9	Smart Learning Institute of Beijing Normal University	4
10	Swinburne University of Technology	4

Next, we examined the authors who contributed to the publications on this topic. Table 7 showed the authors' local impact; the top 16 authors' local impact was well-reflected in Table 7. In this analysis, it was revealed that author Stokel-Walker C has published 2 scientific productions related to this topic, received 22 total citations, and has an H-index of 2. The rest of the authors were reported with an H-index of 1. Referring to the total number of citations, Stokel-Walker C has the highest number of total citations. This is followed by Thorp HH has 34 citations

received, 1 published document, and an H-index of 1. Meanwhile, Bockting CL, Bollen J, Van Dis EAM, Van Rooij R, and Zuidema W received 20 citations.

Table 7. Authors' Local Impact

Rank	Element	H-Index	Total Citations	Number of Publications	Publication Year Start
1	Stokel-Walker C	2	22	2	2022
2	Thorp HH	1	34	1	2023
3	Bockting CL	1	20	1	2023
4	Bollen J	1	20	1	2023
5	Van Dis EAM	1	20	1	2023
6	Van Rooij R	1	20	1	2023
7	Zuidema W	1	20	1	2023
8	Chartash D	1	8	1	2023
9	Chi L	1	8	1	2023
10	Gilson A	1	8	1	2023
11	Huang T	1	8	1	2023
12	Pavlik JV	1	8	1	2023
13	Safranek CW	1	8	1	2023
14	Socrates V	1	8	1	2023
15	Taylor RA	1	8	1	2023
16	Van Noorden R	1	8	1	2023

In general, the bibliometric reporting provided quantitative measurements that indicate the visibility, impact, and influence the literature has. For instance, the citation analysis and local impact measurement reflect the critical information of scientific quality and the impact for the scientific community. Besides that, indicators by countries such as the countries' scientific production, most cited countries, corresponding authors' countries, and collaborations offered insight into the groups of researchers classified by countries that are actively doing research on this topic of interest. In addition, the measurement indicator also illustrated the interrelations between these different groups of scholars in the scientific community (Barth et al., 2014).

RQ3: How has the theme of the scholarly works evolved on the topic of the use of ChatGPT in Education?

The evolution of the publication theme can be easily investigated using the treemap, trend topics, and thematic map. Figure 8 showed the evolution of keywords over time, and the statistics reported the keyword "artificial intelligence" as the most frequent keyword being used. This is followed by the use of terminologies such as "human", "language", "humans", "article" and "machine learning".

Figure 9 showed the tree map which clearly illustrated the percentage usage of the key terminologies by the past literature. Tree maps are a type of graphical data representation whereby the tree diagram's nodes are represented

as stacked rectangles. The large rectangles represent the data tree branches, whereas the smaller rectangles display the sizes of individual nodes within those branches. Based on Figure 9, it can be observed that the term "artificial intelligence" was recorded with the highest usage (frequency 26 and 14%), followed by the keyword "human" (frequency 16 and 9%), and "language" (frequency 9 and 5%).

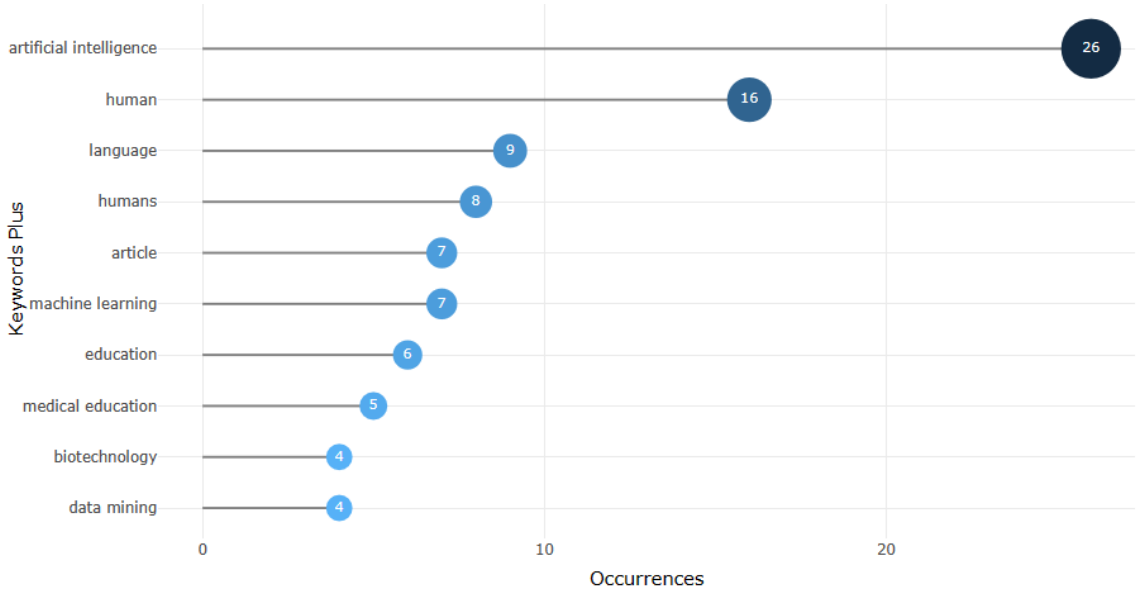

Figure 8. Most Frequent Words

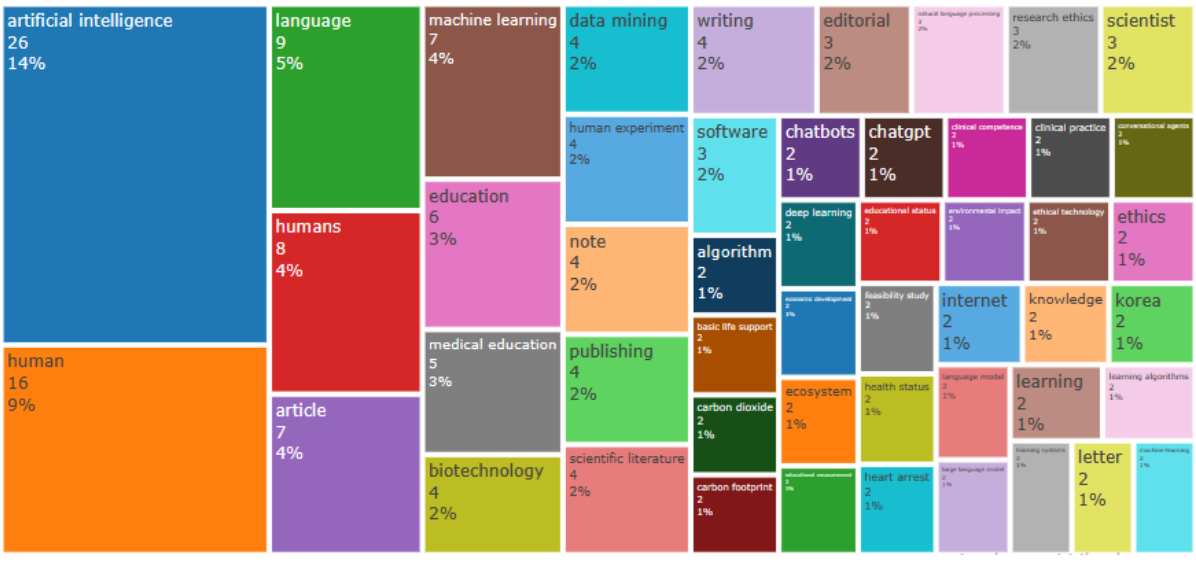

Figure 9. Tree Map

Meanwhile, Figure 10 illustrates the trend topic which demonstrate the evolution of the topics over time. The scholarly works appeared to be trending on three main themes, namely, "artificial intelligence", "human" and "language". The trend topic illustrated an overview of the term's evolution over time by indicating how frequent does the key words being used. The words that are more frequently used will be positioned higher and the ones that is used more recently will be located further to the right.

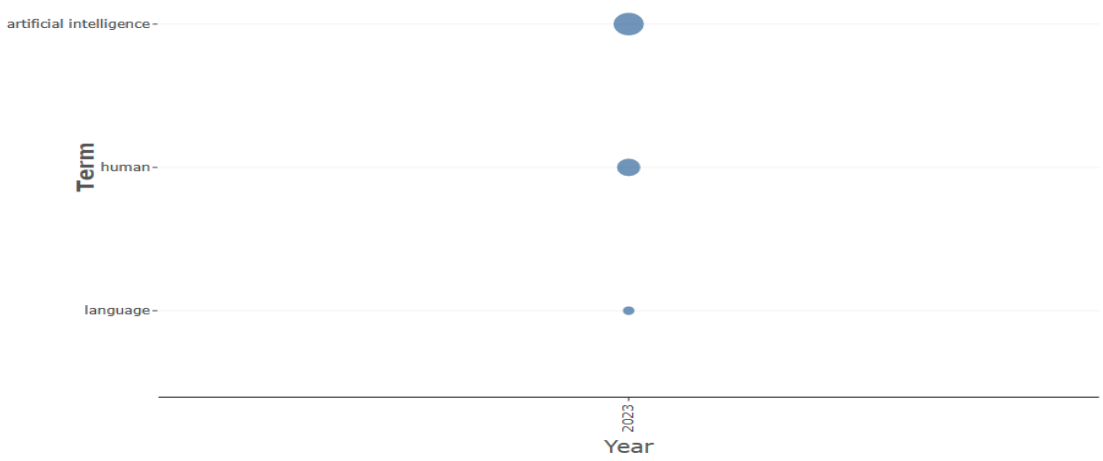

Figure 10. Trend Topics

On a separate note, Figure 11 visualized the thematic map which reflected the structure of the analysis's strategic diagram. The thematic map provides a clear visualization that allows easier identification of the thematic evolution of the study area. Besides that, the illustration of the thematic map provides a graphical depiction on the network of relationships between different scientific areas of publication.

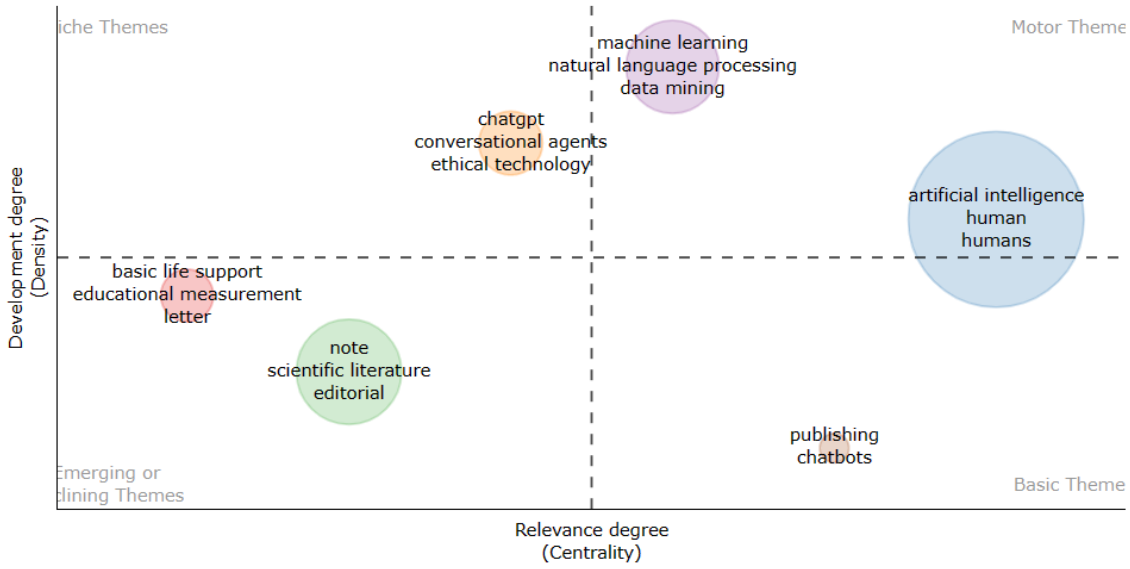

Figure 11. Thematic Map

The density is displayed on the x-axis and represents the ratio of relationships that are present to the total number of possible relationships (Peláez-Repiso et al., 2021). Each group's network density ranges from 0 to 1, where a value of 0 indicates that there are no relationships between group members while a value of 1 indicates that all members of the group are related to one another, which is the strongest possible relationship that can exist between group members. The strategic diagram was separated into four (4) quadrants, namely, Motor Themes, Peripheral and Marginal Themes, Emerging or Disappearing Themes, Generic, and Transversal Themes. The Motor theme (Driving theme) refers to the themes that are represented in the upper right quadrant. These themes have high density and strong centrality, and are considered as important well-developed themes. In other words, they are

highly contributory themes because of their high centrality and high density Both the "machine learning, natural language processing, data mining" cluster and "artificial intelligence, human, humans" cluster were identified under this theme. The upper left quadrant represented the Peripheral and Marginal themes (Niche themes) with high density but low centrality. There is a lot of potential in these themes as they possessed high density. The cluster found to fall under this quadrant consists of the cluster "chatbot, conversation agents, ethical technology". These topics are considered to be well-developed internally but isolated from the rest of the topics, having marginal importance within the scientific field (Peláez-Repiso et al., 2021). Represented at the bottom left quadrant of the strategic diagram is the Emerging or Disappearing themes (Declining themes). This theme is considered an underdeveloped theme with low density and weak centrality. Two distinct clusters, namely, "basic life support, educational measurement, letter" cluster and "note, scientific literature, editorial" cluster were reported under this theme.

Lastly, the lower right quadrant represented the Generic and Transversal themes (Basic themes). These themes are generally less well-developed with strong centrality but low density. It should be noted, however, that these topics remained important for the scientific field. "Publishing chatbots" cluster was found under this basic theme. Researches conducted on emerging themes has the potential to eventually transition into basic or motor themes later on. In summary, the data results with the graphical illustrations would contain considerable key information that can highlight the changes of the publication pattern and the evolution of the trends over the time. These critical information can be used to answer the respective research questions that has been postulated at the beginning of the bibliometric review.

Discussion

Bibliometric analysis is useful for deciphering and mapping the cumulative scientific knowledge and evolutionary nuances of well-established fields by making sense of large volumes of unstructured data in rigorous ways (Donthu et al., 2021). Bibliometric analysis has been apparently viewed as a valuable method for evaluating scientific production that is having a rising impact (Ellegaard and Wallin, 2015). The metric tools provided by the bibliometric analysis can be used to answer the following three (3) research questions:

Research Question 1 (What is the current trend of publication on the topic of ChatGPT use in Education?)

The findings showed that there has been massive growing interest in this topic within these two years alone, with an extraordinary growth of 5600%. The metric tool of the bibliometric analysis using the R studio showed positive linear growth of scientific publications on this topic of interest between the year 2022 and this date. The growth of the scholarly works appeared to mostly manifest from the social science field with 34% of the total publication. This is then followed by the others disciplinary field with an estimation of 14% of the total scholarly works. Meanwhile, the bibliometric reporting instrument also reflected that there have been active research papers produced with an estimated of 51.7% of articles being published, followed by Notes (17.2%) and Editorial papers with a mere 10.3%. The statistical reporting from the bibliometric analysis provides a clear indication of how the volume of scholarly work for this topic of interest grew over time.

Research Question 2 (Who are the main contributors/researchers, affiliations, and countries on the topic of ChatGPT in Education?)

The analysis in identifying the main contributors to the research of this field of interest and further exploring their affiliations and countries was performed in answering the second research question. It was reported from the finding that most of the articles published on this topic were from the USA, followed by Australia and the United Kingdom. Exploring further the collaboration pattern, the USA was found with the highest collaborated publications consisting of both inter-country and intra-country collaboration. The analysis based on the affiliations finds that the Technical University of Munich, a German University, has the highest number of affiliated articles. Meanwhile, the most relevant author reported was Stokel-Walker C (2 H-Index papers and 22 citations).

The data metrics help in providing an overview of the highly cited scientific production that is subdivided into a list of contributors by countries/affiliations. This interpretation of the data allows the ranking of contributors to be possible. In addition to that, information of how the scientific publications were found scattered around the globe can be examined using the bibliometric analysis tool. The metrics of publications by authors of different countries and affiliations reflected the general distribution of scholarly publishing involving international collaborations. Bibliometric review plays an increasing role in the ranking of research departments and institutions (Ellegaard and Wallin, 2015). As such, the data on the authors relevancy or citations index would benefit institutions/departments to analyze these data in their effort to improve on the publication ranking. In other words, bibliometric analysis can be used as an effective instrument to gauge the research performance in an institutions/country and offered possibility of new international collaboration for all researches.

Research Question 3 (How has the theme of the scholarly works evolved on the topic of the use of ChatGPT in Education?)

According to the science mapping analysis from this review, the word dynamic revealed the frequent use of keywords such as “artificial intelligence”, “human” and “language”. In addition, the thematic map has demonstrated the driving themes consisting of the clusters “machine learning, natural language processing, data mining” and “artificial intelligence, human, humans” which possess both high density and strong centrality. From this bibliometric analysis, one can deduce the evolution of the topics over the time and how the themes of the publications are developing. The findings from the thematic mapping highlight new trends of the studies, and this information will be useful to recommend potential directions for future study.

The knowledge on the new shift of research topics/ trends will create new awareness among researches of these new trends of study for them to undertake. From the bibliometric review conducted, it was clear that topics such as “machine learning”, “artificial intelligence”, “data mining”, “natural language processing” are the topics that need to be pursued as evidenced by their position at the top right quadrant of the thematic map analysis. These topics are in critical need for further exploration in view of their strong density and high centrality. Meanwhile, the topics that fell under the lower-left quadrant (emerging themes) namely “basic life support”, “educational measurement”, “editorial”, “letter”, “note”, “scientific literature” remains vital for the development. The pursued

of these emerging themes will allow these themes to eventually transit to the motor themes (high density and high centrality theme).

Recommendations

According to Paul and Criado (2020), bibliometric analysis identifies and predicts future study areas. Based on the bibliometric analysis, it appears that the number of scientific publications has been rising steadily, especially within the social science discipline. By rankings, the western countries seem to produce higher numbers of publications as compared to the other countries. It is important to highlight that the rate of publication by Asian countries remains fairly low, despite the topic becoming increasingly important. Besides that, the metric indicators from the bibliometric analysis help in identifying the impacts and contributions from the publications. For instance, the thematic map reflects how the theme is evolving rapidly over time, and this will determine the aspect that future studies' direction should focus on given the transformation identified. From the thematic map, one can conclude that "artificial intelligence" and "machine learning" were among the well-developed themes that called for more studies focusing on these areas. Meanwhile, the basic theme, though less-developed, would require more attention given in the effort to produce research of higher impact that can contribute to the less-developed theme.

The research trend as highlighted by the bibliometric instrument such as the thematic map has clearly pointed out the need to further explored the motor theme, namely, the topics of machine learning", "artificial intelligence", "data mining", "natural language processing" which possessed strong density and high centrality. Meanwhile, the basic themes that has low centrality but high density such as the "publishing", "chatbots" themes remain vital to be included as they are considered as generic topics frequently used. Meanwhile, the pursued of the development for the emerging themes "basic life support", "educational measurement", "editorial", "letter", "note", "scientific literature" will eventually push these themes to motor themes (high density and high centrality themes).

Conclusion

In conclusion, this bibliometric analysis presented a comprehensive quantitative overview of the scholarly work that has been done in this area of interest by gathering and extracting data from the Scopus database. The subsequent analysis using the bibliometric software of R studio provides scientific mapping that allowed extensive exploration of the intellectual sources and their structure in the selected research field. The bibliometric metric tool supports the identification of important contributions, impacts of publications, new trends emerging, and knowledge gaps in the topic of interest. For instance, the document profiles indicated clear consistent increasing scientific publications being produced within this topic studied. The data extracted on the disciplinary field involved in the research and the types of scientific productions portrayed further critical information of the details of these publications within the multi-disciplinary field with the various type of research undertaken.

Subsequently, the bibliometric method also allowed the exploration of how widespread the research is in this area. As illustrated by the metric indicators, scholars from various countries have been involved in scientific publication related to the topic of interest. The metrics clearly showed how the scientific publication was spread out across

different countries with certain regions reporting a significantly higher volume of publications. The amount of international collaborations was also taken into account in the evaluation process. In addition, the bibliometric tool has allowed ranking of the publications by affiliations or countries. It further implied the impact of the publications through indexes such as the citation analysis and local authors' impact. Lastly, bibliometric reviews contribute significantly to the formulation of future research paths, policy choices, and academic discourse by synthesizing and quantifying existing research. Through the thematic mapping and trend topics indicators, the bibliometric analysis offered information on the new trends emerging within the context of the topic of interest. The knowledge and metrics analysis will provide important information to help in chartering the direction of future study concerning the topic of interest.

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