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Application of the Chatbot in University Education: A Bibliometric Analysis of Indexed Scientific Production in SCOPUS, 2013-2023

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Abstract. Universities today are employing tools based on artificial intelligence to improve the educational service in general. The chatbot represents an online communicative interaction tool which contributes to solving daily queries required by students, teachers or graduates. However, there are few bibliometric review studies on the chatbot that show in which areas there is a greater concentration or lack of scientific production at the university level. The objective of this article is to explore and describe the research trends regarding the application of the chatbot in university education through the bibliometric analysis of

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publications indexed to Scopus. The research is of an exploratory-descriptive level, developed under a quantitative approach. The study covered the scientific production between the years 2013 and 2023, identifying 210 manuscripts. It was identified that there is a growing trend in scientific production, particularly in scientific articles and conference papers. The most cited article was published in 2018 and has 162 citations. Therefore, it is concluded that there is a greater concentration in the scientific production of manuscripts focused on improving the university educational service, applying significantly to the improvement of academic performance, administrative management and university wellbeing. However, there is a gap that needs to be reduced in terms of the lack of scientific studies in which the chatbot is used as a tool to identify the satisfaction of university students. In addition, there is a lack of research on the use of a regulatory framework that regulates the application of the chatbot at the university level.

Keywords: chatbot; education; university; bibliometric analysis; scientific production; Scopus

1. Introduction

The development of science and technology is booming, and education a cannot be exempt from these advances; therefore, a broader view is required to recontextualise the function of the academy in the labour and social sphere (Villarroel, 2021). In recent years, globalisation has had a great impact on world society and, as a consequence, has generated a higher level of technological penetration that aims to streamline and facilitate many of the everyday processes, including education (Artavia-Díaz & Castro-Granados, 2021). However, today it is becoming increasingly evident that artificial intelligence, a field of computer science that attempts to understand and simulate characteristics of human intelligence (Jiménez et al., 2023), has acquired a solid scientific foundation and has produced many successful applications, including in academia, and that it has significant implications for the teaching and learning process (Vera, 2023). In the educational field, artificial intelligence, hand-in-hand with various knowledge regarding education, has as its main objective to generate programs that allow the development of adaptive and personalised learning environments with a high capacity for interaction between students (Ocaña-Fernández et al., 2019; Padilla, 2019). This implementation of new paradigms in the educational field requires knowledge, resources and planning, which, at this juncture, are framed in virtual systems based on artificial intelligence (Martín-Ramallal et al., 2022). Under the aforementioned, artificial intelligence is capable of altering various forms of social interaction, has affording it the potential to revolutionise and transform educational institutions (Flores-Vivar & García-Peñalvo, 2023). Thus, an area of vital importance and topicality for artificial intelligence is the conversational agents called chatbots (Cotrina-Aliaga et al., 2021; Vázquez et al., 2018). Chatbots allow the creation of a communication channel that is capable of simulating a communication interface that serves as an authentic virtual tutor in learning (Manzano et al., 2020); or even becoming a teaching assistant, learning companion or personal

tutor of the student (Deng & Yu, 2023).

Chatbots represent virtual human communication interaction tools (Alagarsamy & Mehrolia, 2023; Wang et al., 2023); through the exchange of audio or text (Hsu & Lin, 2023; Smutny & Schreiberova, 2020; Xing et al., 2022). Chatbots make use of natural language processing, and today are part of the most advanced technological tools for automatic and personalised interaction (Baabdullah et al., 2022; Brustenga et al., 2018; Drouin et al., 2022; Zhou et al., 2023). Human-chatbot interactions represent a form of social interaction carried out online (Dippold, 2023]. They provide the user with the ability to understand their emotions and feelings through affective computing tools (Benke et al., 2022). Compared to traditional IT tools that are used to interrelate the service offered with the customer, chatbots are made up of functionalities that allow them to provide social and emotional understanding (Song et al., 2022). They show a high capacity to process requirements from various users and then suggest a collaboration process that responds to their needs (Cheng et al., 2022). In general, they join other user-oriented applications and fulfil the purpose of being easy and consistent means between organisations and clients (Nguyen et al., 2022), helping them to find information, provide feedback and even file complaints (Chen et al., 2022, Fan et al., 2022; Liu et al., 2023). The rapid increase in the production of chatbot applications has attracted the attention of various fields, such as industry and academia (Balakrishnan et al., 2022). To examine the performance of the interaction in the use of the chatbot as a conversational agent, the time spent in communication and the satisfaction of the event experienced by the user are taken into account (Rhim et al., 2022).

In the field of universities, the use of chatbots is yet to be explored, but it certainly offers many possibilities to improve the educational service in general (Suárez et al., 2022), generating a new learning space (Llugcha, 2023). Chatbots contribute to expedite learning as well as the resolution of doubts in the student (Bueno, 2022), while., in the case of the teacher, chatbots help them to maintain permanent contact with students and free them from repetitive tasks (Miguel et al., 2022). In general, chatbots present characteristics such as interaction, self-management, and accessibility, that is, resources that contribute to the construction of educational technological processes (Castillo, 2020; Yang & Chen, 2023). They facilitate the issuance of quick responses with high service availability regardless of the place and time in which the student is (Dokukinaa & Gumanova, 2020; Lee & Yeo, 2022; León-Granizo & León-Granizo, 2020). A chatbot can not only provide the student with benefits for interdisciplinary learning, but also promote the ability to classify information and knowledge formation (Iku-Silan et al., 2023; Sáiz-Manzanares et al., 2023). However, it is important to highlight that these assistants do not replace people, since their function is complementary; therefore, the work of teachers and administrative staff of an institution continues to be vital (Torres et al. 2022). On the other hand, it is necessary to train the teacher and students with a certain level of knowledge to be able to manipulate or develop a chatbot, particularly in subjects that are

not related to computing (Rodríguez et al., 2021). In addition, great care must be taken that students are fully aware that the exchange of information is being carried out with a conversational agent and not with a human being, since various studies indicate the presence of effects on the level of satisfaction at student expectations (Go & Sundar, 2019; Huang & Lee, 2022).

Based on what has been stated, this article aims to explore and describe research trends regarding the application of the chatbot in university education through bibliometric analysis of scientific production indexed in the Scopus database. The analysis will be carried out for the period from 2013 to 2023. This study seeks to contribute to the generation of prior knowledge for the purpose of preparing systematic review studies or meta-analysis in the field of chatbots and its contribution to the improvement of the processes imbedded in university education. Thus, this manuscript has been structured based on the following points: introduction, methodology, results, discussion, conclusions, limitations, and future studies. Likewise, the research questions (RQ) defined for the development of this bibliometric review article are detailed below:

- RQ1: What is the scientific production of manuscripts by year of publication regarding the chatbot and its application in university education?
- RQ2: What are the types of manuscripts published regarding the chatbot and its application in university education?
- RQ3: What is the scientific production of open and restricted access manuscripts regarding the chatbot and its application in university education?
- RQ4: What are the most cited manuscripts regarding the chatbot and its application in university education?
- RQ5: Which are the magazines with the largest number of publications regarding the chatbot and its application in university education?
- RQ6: What are the words with the highest rate of occurrence in the titles of the manuscripts regarding the chatbot and its application in university education?
- RQ7: What are the words with the highest rate of occurrence in the abstracts of the manuscripts regarding the chatbot and its application in university education?
- RQ8: What are the thematic areas with the highest incidence that have been published regarding the chatbot and its application in university education?

2. Methodology

2.1 Research level and focus

This study is exploratory-descriptive level. It is of an exploratory level since it seeks, in principle, to investigate the scientific production of chatbots applied to university education through the identification of bibliometric indicators, from the Scopus database, such as the number of manuscripts published per year, types of manuscripts, number of manuscripts published in open access and restricted access sources, most cited manuscripts and journals with the largest number of manuscripts in this field of study. Exploratory studies investigate

patterns that are initially established as little known or that there is little information in this regard, which is why the researcher is interested in examining their characteristics (Galarza, 2020). Thus, it is also descriptive since it seeks to determine the research trends regarding the chatbot in university education, through the content analysis of the manuscripts included for the study, also relying on the analysis of the words with the highest rate of occurrence in the titles and abstracts identified in the manuscripts under analysis. Descriptive research is carried out when seeking to describe, based on its main components, a specific reality or context (Alban et al., 2020). In this way, the quantitative approach will also be used for the analysis of the collected data, Given that it is intended to develop a bibliometric analysis regarding the scientific production of the chatbot and its application in university education, it will seek to quantify the scientific activity through the application of quantitative treatments. Studies with a quantitative approach seek accurate and objective knowledge of reality, knowledge that is observable, measurable and quantifiable, for which the aid of mathematics and statistics is required (Rojas et al., 2022).

2.2 Database and manuscript search equation

In order to define and establish the manuscripts that will be part of the bibliometric analysis on the scientific production of the chatbot and its application in university education, the database from which the data will be extracted was established as a relevant aspect in this process of documents and bibliometric information; therefore, for this study, it was decided to use the Scopus database. This is due to its recognition in the academic world of the rigor that it submits to different scientific journals for the indexing of manuscripts to this database. Likewise, Scopus stores scientific documents related to the subject under study and provides bibliometric information for processing and analysis. Scopus represents one of the main scientific information databases, allowing researchers to access current information, of greater specialty and preponderance by technological topics (Garcés-Giraldo et al., 2022). On the other hand, Scopus is the largest database of citations and abstracts of peer-reviewed literature and has a greater reach than WoS (Web of Science) both geographically and thematically, so it is considered a highly suitable database for conducting research bibliographic reviews (Pedraza-Navarro et al., 2022).

Once the database to be used was defined, the search equation was established in order to identify the manuscripts with a higher level of relationship and link with the topic under study. It should be noted that the search equation in the case of the Scopus database responds to a certain syntax, which makes it particular or different compared to other databases. In this way, in accordance with the topic under study, the search equation was expressed as follows: (TITLE-ABS-KEY (chatbot)) AND (TITLE-ABS-KEY (university AND students)). This search equation will optimise the manuscript selection process (Sastoque et al., 2020), through which the analysis of the bibliometric indicators that will contribute to answering each of the research questions will be carried out (Quezada et al., 2020).

2.3 Manuscript extraction method

The method used for the extraction of manuscripts is shown in Figure 1, the same as validated by Izhar et al. (2023), in which three phases are defined that will lead to the determination of the manuscripts to be included in the analysis of the bibliometric indicators. This method comprised firstly establishing the subject under study, scope or specific criteria of the manuscripts (year of publication and type of manuscript) and eligibility related to the result obtained from the search equation. A total of 212 manuscripts was identified for this study at this stage. The second phase consisted of filtering the manuscripts identified in the previous phase applying the criterion that defines the period of years of publication of the manuscripts (2013-2023). In this study, it was identified that only two manuscripts were not considered within the study time frame; therefore, when developing this second phase, the number of manuscripts was reduced to 210. The third phase consisted of defining the manuscripts included for their analysis and processing of their bibliometric indicators; this was achieved from the exhaustive review of the title, abstract and full content of each manuscript, ultimately identifying 114 manuscripts.

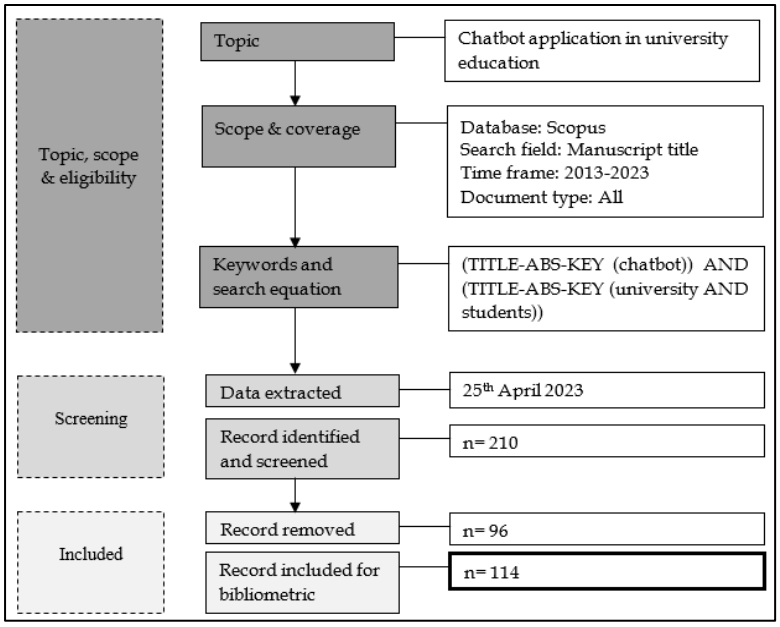

Figure 1. Method used to extract manuscripts

3. Results

3.1 Scientific production of manuscripts by year of publication regarding the chatbot and its application in university education

Of the 114 articles included for the phase of analysis and processing of bibliometric indicators, it was identified that the years in which the least scientific production was carried out on the application of the chatbot in university education, were 2013 and 2017, both with a single publication. Likewise, from 2018 to 2021, it has been identified that scientific production experienced a sustained growth, reaching a total of 70 manuscripts published in those four years. In addition, in 2021 it was identified that the scientific production reached its maximum value, with 33 published manuscripts.

Another aspect to highlight is that, considering that in these ten years the average scientific production is 11 manuscripts, from the year 2022 to date the scientific production has remained above average; even in 2023 it has, to date, already exceeded the average in eight manuscripts. Figure 2 shows the scientific production of manuscripts by year of publication.

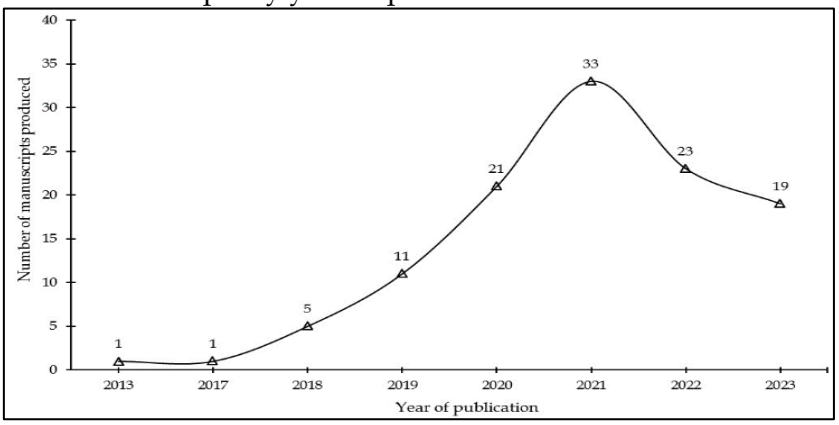

Figure 2. Production of manuscripts by year of publication

3.2 Types of published manuscripts regarding the chatbot and its application in university education

In relation to the types of manuscripts that have been developed regarding the application of the chatbot in university education, of the 114 manuscripts extracted from the Scopus database, five types of manuscripts were identified, these being: "Scientific articles", " Chapter of the book", "Conference paper", "Letter", "Review articles". Of the 114 manuscripts reviewed, 55 are "Scientific articles" representing 48.246%, 52 are "Conference paper" representing 45.614%, five are "Chapter of the book" representing 4.386%, and finally "Letter" and "Review articles" with only one manuscript each, representing 0.877% of the total number of manuscripts. Figure 3 shows the percentage distribution of types of manuscripts identified in the Scopus database regarding the application of the chatbot in university education.

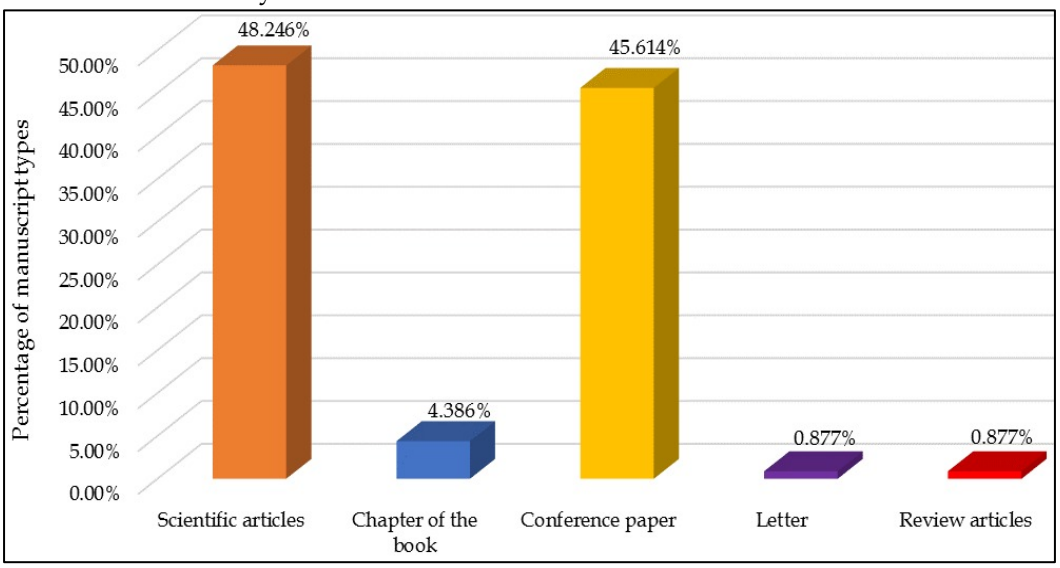

Figure 3. Percentage distribution of the types of manuscripts

3.3 Scientific production of open and restricted access manuscripts regarding the chatbot and its application in university education

Regarding the scientific production of open and restricted access manuscripts, it is necessary to refer to Tosar (2022) who established that open access manuscripts are those scientific documents in which researchers or readers can access the entire content for free. Casate-Fernández and Senso-Ruiz (2017), on the other hand, state that restricted access manuscripts are those scientific documents in which researchers who are not registered with the journal that published the manuscript have restricted access to the entire document. In many cases, only the summary of the published research is accessed. Based on what was indicated from the 114 manuscripts obtained from the Scopus database, 79 manuscripts are restricted access representing 69.30%, and 35 manuscripts are open access representing 30.70%. Figure 4 shows the percentage of open access and restricted access manuscripts.

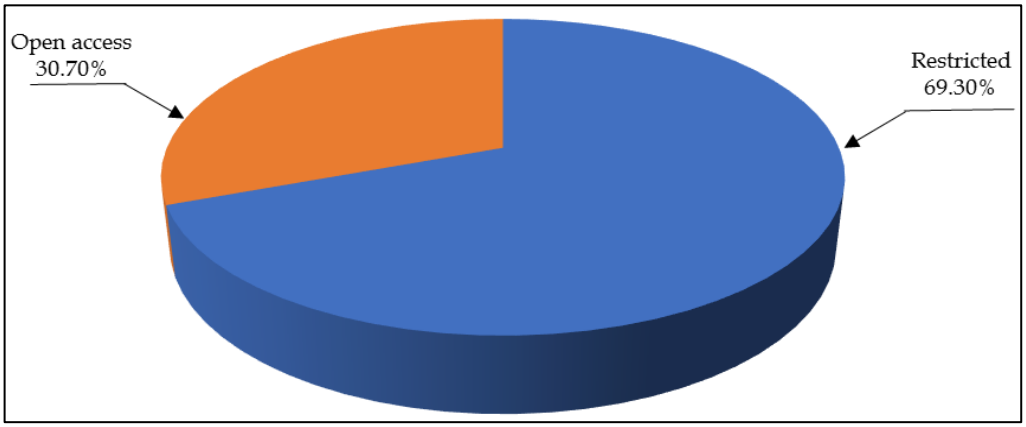

Figure 4: Percentage distribution of open and restricted access manuscripts with respect to the chatbot application

When carrying out a more exhaustive analysis regarding the types of open access manuscripts, it was identified that these, in turn, can be categorised as golden, green, hybrid and bronze. In this regard, Alhuay-Quispe and Bautista-Ynofuent (2021) point out that gold category manuscripts are published in an open access journal indexed by the DOAJ (Directory of Open Access Journals); so also, the green category comprises paid access manuscripts on the publisher's page, but with a free copy in a repository, while hybrid category manuscripts are free manuscripts under an open license in a paid access journal. Finally, the bronze category manuscripts are free access manuscripts on the publisher's page, but without a clearly identifiable license. Table 1 shows the categorisation of the manuscripts identified as open access in which 71.43% are gold access, 14.29% are green access, 5.71% are hybrid access and 8.57% are bronze access.

Table 1: Categorisation of open access manuscripts

Open Access Manuscripts Category	Number of manuscripts	Percentage distribution
Golden	25	71.43%
Green	5	14.29%

Hybrid	2	5.71%
Bronze	3	8.57%

3.4 Most cited manuscripts regarding the chatbot and its application in university education

In relation to the most cited manuscripts, the findings of Ronda-Pupo (2021) were taken into account, which established that the number of citations of a manuscript represents the impact and significance that its results had with respect to other studies: it represents the degree of significant contribution to other manuscripts in the same field of studies. Based on Table 2, the list of the twenty manuscripts with the highest number of citations in the Scopus database, linked to the chatbot and its application in university education, is shown. In other words, of the 114 manuscripts chosen for the bibliometric review study, the manuscript with the highest number of citations is "Using psychological artificial intelligence (Tess) to relieve symptoms of depression and anxiety: Randomised controlled trial" with 162 citations, which represents 19.19 % of the total citations of all the manuscripts under analysis. The second most cited manuscript is "Chatbot for university related FAQs", with 155 citations, which represents 18.36% of the total citations.

Table 2: The twenty manuscripts with the highest number of citations

Reference	Manuscript Title	Number of citations	Percentage
Fulmer et al. (2018)	Using psychological artificial intelligence (Tess) to relieve symptoms of depression and anxiety: Randomized controlled trial	162	19.19%
Ranoliya et al. (2017)	Chatbot for university related FAQs	155	18.36%
Ghose and Barua (2013)	Toward the implementation of a topic specific dialogue based natural language chatbot as an undergraduate advisor	72	8.53%
Colace et al. (2018)	Chatbot for e-learning: A case of study	52	6.16%
Dibitonto et al. (2018)	Chatbot in a campus environment: Design of Lisa, a virtual assistant to help students in their university life	44	5.21%
Villegas-Ch and Palacios (2020)	Proposal of an Architecture for the Integration of a Chatbot with Artificial Intelligence in a Smart Campus for the Improvement of Learning	40	4.74%
Santoso et al. (2018)	Dinus Intelligent Assistance (DINA) Chatbot for University Admission Services	36	4.27%
Dekker et al. (2020)	Optimizing Students' Mental Health and Academic Performance: AI-Enhanced Life Crafting	30	3.55%

Patel et al. (2019)	AI and Web-Based Human-Like Interactive University Chatbot (UNIBOT)	29	3.44%
Almahri et al. (2020)	Understanding Student Acceptance and Use of Chatbots in the United Kingdom Universities: A Structural Equation Modeling Approach	27	3.20%
Vázquez-Cano and López (2021)	Chatbot to improve learning punctuation in Spanish and to enhance open and flexible learning environments	25	2.96%
Al-Ghadhban and Al-Twairesh (2020)	Nabiha: An Arabic dialect chatbot	23	2.73%
Huang et al. (2019)	Designing and evaluating three chatbot-enhanced activities for a flipped graduate course	23	2.73%
Chang et al. (2022)	Promoting students' learning achievement and self-efficacy: A mobile chatbot approach for nursing training	21	2.49%
Ralston et al. (2019)	A voice interactive multilingual student support system using IBM Watson	21	2.49%
Mckie and Narayan (2019)	Enhancing the Academic Library Experience with Chatbots: An Exploration of Research and Implications for Practice	21	2.49%
Gabrielli et al. (2021)	Engagement and effectiveness of a healthy-coping intervention via chatbot for university students during the COVID-19 pandemic: Mixed methods proof-of-concept study	19	2.25%
Lee et al. (2020)	Using a Multiplatform Chatbot as an Online Tutor in a University Course	15	1.78%
Singh et al. (2019)	Rule-based Chabot for student inquiries	15	1.78%
Liu et al. (2022)	Using AI chatbots to provide self-help depression interventions for university students: A randomized trial of effectiveness	14	1.66%
Total		844	100%

3.5 Journals with the largest number of publications regarding the chatbot and its application in university education

Regarding the journals with the highest number of manuscripts published and indexed to the Scopus database on the subject of chatbots and their application in university education, it was identified that, of the 92 journals that published the 114 manuscripts under analysis in this bibliometric review study, 13 present at least two publications, while 72 present only one publication. Table 3 shows

the scientific journals with the highest number of publications, the journal with the largest number of publications being *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics*) with nine publications, representing 7.89% of the total articles under analysis. This journal presents an H index equal to 446 according to the Scimago SJR 2022 ranking; it is located in the Q3 quartile. However, there are four journals located in the best quartile, that is, quartile Q1, namely: "Education and Information Technologies", "Educational Technology and Society", "Interactive Technology and Smart Education" and "Sustainability", whose number of manuscripts published regarding the topic under study are two.

Table 3: Scientific journals with the highest number of publications

Name of journals	H-index	Scimago SJR Quartile 2022	Number of publications	Percentage
Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)	446	Q3	9	7.89%
ACM International Conference Proceeding Series	137	not quartile	4	3.51%
Lecture Notes in Networks and Systems	27	Q4	4	3.51%
CEUR Workshop Proceedings	62	not quartile	2	1.75%
Education and Information Technologies	61	Q1	2	1.75%
Educational Technology and Society	103	Q1	2	1.75%
IAENG International Journal of Computer Science	26	Q3	2	1.75%
Intelligent Systems Reference Library	35	Q4	2	1.75%
Interactive Technology and Smart Education	27	Q1	2	1.75%
International Journal of Mechanical Engineering and Robotics Research	15	Q3	2	1.75%
Lecture Notes in Electrical Engineering	40	Q4	2	1.75%
Sustainability (Switzerland)	136	Q1	2	1.75%

3.6 Words with the highest rate of occurrence in the titles of the manuscripts regarding the chatbot and its application in university education

Using the VOSviewer software, we proceeded to analyse the words with the highest occurrence rate in the titles of the 114 manuscripts chosen from the Scopus database. For this, the VOSviewer software was configured to show the results of those words that have at least three occurrences, obtaining 17 words as a result. Table 4 shows the words of the titles of the manuscripts, the number of occurrences, the percentage distribution of occurrence and the link strength of each word. The words of the titles with the highest occurrence are "Chatbot" with 34.93%, followed by "Students" with 14.38%, while the words with the

lowest occurrence are "Anxiety" with 2.05% and "Academic performance" with the same percentage.

Table 4. Words with the highest rate of occurrence in the titles of the manuscripts.

Title words	Occurrence number	Percentage	Link strength
Chatbot	51	34.93%	39
Student	21	14.38%	21
Chatbots	10	6.85%	9
University Student	8	5.48%	16
University	7	4.79%	10
Higher Education	6	4.11%	5
Artificial intelligence	5	3.42%	8
Ai Chatbot	4	2.74%	5
Covid	4	2.74%	8
Implementation	4	2.74%	3
Knowledge	4	2.74%	8
Motivation	4	2.74%	6
Pandemic	4	2.74%	6
Wear	4	2.74%	7
Virtual Assistant	4	2.74%	6
Academic performance	3	2.05%	5
Anxiety	3	2.05%	5
Total	146	100%	167

In addition, through the VOSviewer software, the co-occurrence network can be generated, which shows the relationships or links between the words used most frequently in the titles of the analysed manuscripts. At this level the relationship or link of each word is known as link strength. From Figure 5 it can be seen that, of the seventeen words with the highest occurrence, the word "chatbot" is the one with the greatest link strength or is the word that has a higher level of relationship or link with the other sixteen words. Graphically, it can be seen that the largest circle belongs to the word "chatbot", referring to the fact that it presents the greatest link strength among all the words with the highest occurrence in the 114 titles of the manuscripts.

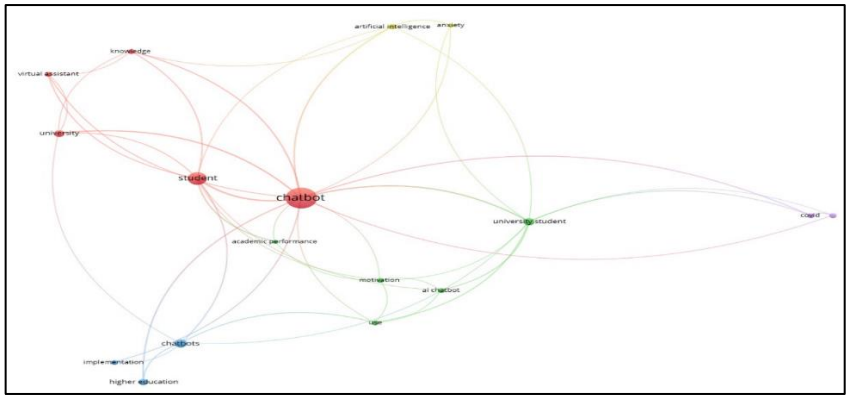

Figure 5. Network of co-occurrence between the words most frequently used in the titles of the manuscripts

However, in order to establish how the words with the highest level of occurrence are grouped or associated among all of them, the cluster density network was generated, in which five clusters were identified, differentiated by colours, as shown in Figure 6. These are composed as follows:

- The first cluster is made up of the words: chatbot, knowledge, student, university and virtual assistant.
- The second cluster is made up of the words: academic performance, AI chatbot, motivation, university students and use.
- The third cluster is made up of the words: chatbots, higher education and implementation.
- The fourth cluster is made up of the words: anxiety and artificial intelligence.
- The fifth cluster is made up of the words: Covid and pandemic.

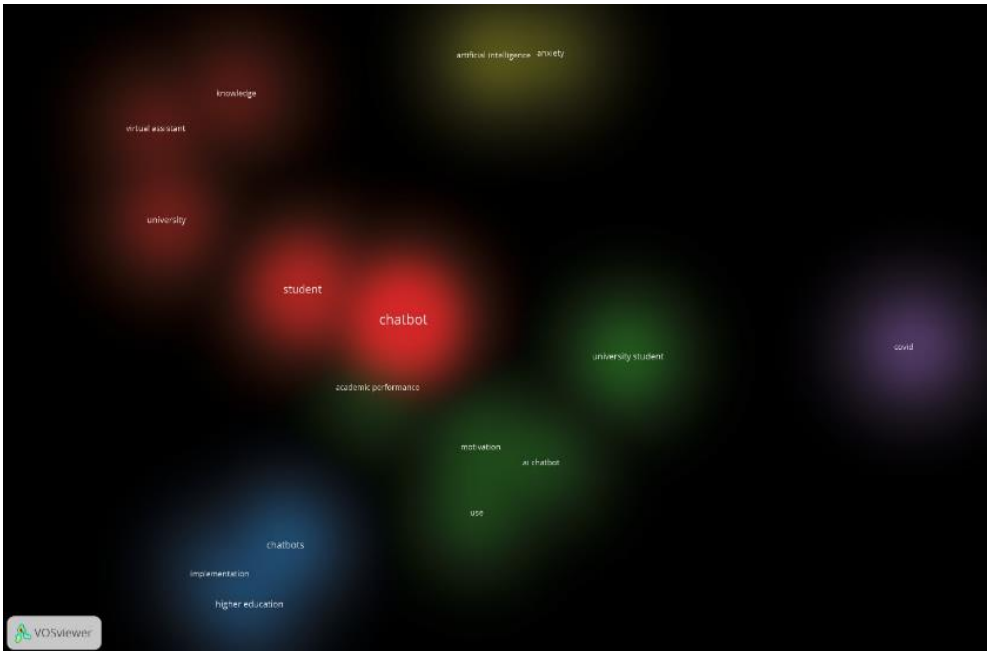

Figure 6. Cluster density network of words with the highest level of occurrence in manuscript titles

3.7 Words with the highest rate of occurrence in the abstracts of the manuscripts regarding the chatbot and its application in university education

Using VOSviewer, the Scopus database was analysed to obtain the abstract words with the highest occurrence by author. For this, the VOSviewer software was configured to show the results of those words that have at least seventeen occurrences, obtaining as a result the 20 words of the abstracts with the highest occurrence. This result is displayed in Table 5, which details the number of occurrences of the words, their percentage and the value of the link strength. It shows that the most relevant keyword is "chatbot" (7.96%), followed by "students" (7.44%) and "university" (5.63%).

Table 5. Words of the abstracts with the highest occurrence

Abstract words	Occurrence number	Percentage	Link strength
Chatbot	105	13.19%	651
Student	98	12.31%	605
University	75	9.42%	468
Studies	59	7.41%	379
Paper	40	5.03%	249
Technology	35	4.40%	248
Wear	34	4.27%	228
User	34	4.27%	220
Research	30	3.77%	210
College student	30	3.77%	186
Education	29	3.64%	219
Question	29	3.64%	199
Time	29	3.64%	197
Course	28	3.52%	187
Info	28	3.52%	188
Application	26	3.27%	201
Interaction	25	3.14%	185
Artificial intelligence	21	2.64%	157
Data	21	2.64%	143
Participant	20	2.51%	147
Total	796	100%	5267

Thus, it was also possible to generate the co-occurrence network, which shows the relationships or links between the words used most frequently in the abstracts of the manuscripts under analysis. From Figure 6, it can be seen that, of the 20 words with the highest occurrence, the word "chatbot" is the one with the greatest link strength, with a value of 651. Graphically, it can be seen that the largest circle belongs to the word "chatbot", referring to the fact that it presents the greatest link strength among all the words with the highest occurrence in the 114 titles of the manuscripts.

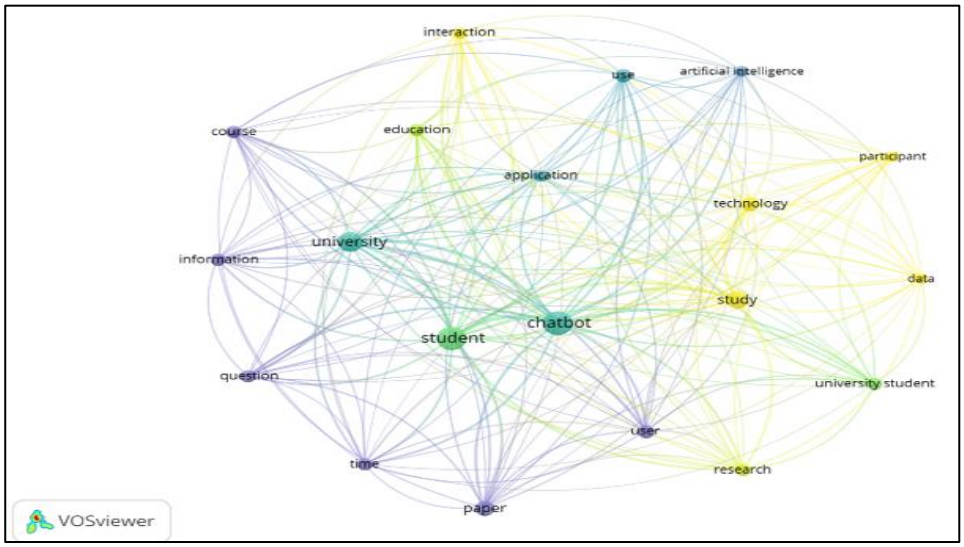

Figure 6. Network of co-occurrence between the words used most frequently in the abstracts of the manuscripts

3.8 Thematic areas with the highest incidence that have been published regarding the chatbot and its application in university education

In relation to the thematic areas with the highest incidence that have been published regarding the chatbot and its application in university education, a content analysis of the 114 manuscripts was carried out, in order to categorise it according to the thematic area developed, with which five thematic areas could be identified. Table 6 shows the categories of the five categories, in which it is observed that the category with the greatest number of manuscripts developed is the one related to the "Improvement of academic performance using chatbot in the teaching and learning process" with 49 manuscripts. Next, there are the manuscripts related to "Administrative and resource management in the university environment through the chatbot" and "Monitoring of the wellbeing of the university student through the chatbot" with 29 and 23 manuscripts, respectively. The thematic areas with the least scientific production are those related to "Student learning a second language through chatbot" and "Academic tutoring with chatbot", with eight and five manuscripts, respectively.

Table 6. Categorisation of the manuscripts analysed by thematic area of study

Thematic areas	Number of manuscripts	Percentage
Improvement of academic performance using chatbot in the teaching and learning process	49	42.982%
Administrative and resource management in the university environment through chatbot	29	25.439%
Monitoring the wellbeing of university students through the chatbot	23	20.175%
Learning a second language with chatbot	8	7.018%
Academic tutoring with chatbot	5	4.386%

4. Discussion

From the results obtained regarding the scientific production of manuscripts by year of publication on the application of the chatbot in university education, it was identified that, between the years 2018 and 2021, a sustained growth in the scientific production of manuscripts indexed to the Scopus database has been identified, reaching a total of 70 manuscripts published in those four years. Prior to these years, that is, from 2013 to 2017, only two indexed manuscripts were identified in the Scopus database. In addition, in the year 2021 it was identified that the scientific production reached its maximum value, with 33 published manuscripts. In this regard, in their study on the history of the chatbot and its applications, Adamopoulou and Moussiades (2020) show that there is a significant increase in publications indexed to Scopus in recent years. Although this study does not strictly focus on education, it does show a growth in scientific production on chatbots in general. Likewise, also supporting what was identified in this bibliometric review study regarding the trend in the growth of scientific production on the chatbot application specifically in the educational field. In their systematic review study on chatbot and its applications in education, Okonkwo and Ade-Ibijola (2021) point out that, between 2015 and

2021, 624 manuscripts on the mentioned subject were identified in the Scopus database, of which only 73 manuscripts were freely accessible to their content. This number reflects the growing trend in scientific production on chatbot applications in education. Likewise, regarding the availability of the complete content of the manuscript, it was identified that, of the 114 manuscripts obtained in the Scopus database, 79 manuscripts were restricted access and 35 manuscripts were open access. In this regard, it has become evident in recent years that manuscripts on chatbots as applied to university education are being published to a greater extent in restricted access journals, making it difficult to access the full content of the manuscripts.

In addition, by continuing to review the work developed by Okonkwo and Ade-Ibijola (2021), it was identified that they define as inclusion criteria for the extraction of documents for their systematic review study, that these must be scientific articles and conference papers; therefore, it is understood that the 73 manuscripts to which they refer are composed of only these two types of documents, while in this bibliometric review it was identified that, of the 114 manuscripts reviewed, 55 were "Scientific articles" and 52 were "Conference paper", numbers well above other types of documents such as "book chapters", "letters to the editor" or "review articles". Although there is evidence of a coincidence between the "types of documents" in which research on chatbot in education is reflected to a greater extent, the numbers differ due to the fact that the cited study only focused between the years 2015 and 2021, while this bibliometric review covers until April 2023; being the scientific production from the year 2022 to this date and consisting of 44 manuscripts.

In relation to the most cited manuscripts regarding the chatbot and its application in university education, it was identified that the manuscript with the highest number of citations is that developed by Fulmer et al. (2018), entitled "Using psychological artificial intelligence (Tess) to relieve symptoms of depression and anxiety: Randomized controlled trial", with 162 citations. This article shows the positive impact of using a chatbot as a therapeutic agent or tool for university students who suffer from some type of mental problem. The second most cited manuscript is that by Ranoliya et al. (2017), entitled "Chatbot for university related FAQs", with 155 citations, in which a chatbot application for a university is designed, which is used for students to consult common questions regarding the services offered by universities. In both cases, it is shown that the topic of the chatbot turns out to be relevant in these times, since the most cited manuscript, in less than five years and has achieved an average of 32 citations per year, a relatively significant number for a scientific publication.

Regarding the journals with the highest number of manuscripts published and indexed to the Scopus database on chatbot and its application in university education, it was identified that, of the 92 journals that published the 114 manuscripts under analysis, 13 present at least two publications, while 72 present only one publication. The journal with the largest number of publications being *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* with an H index

equal to 446 and, according to the Scimago SJR 2022 ranking, located in quartile Q3. However, when searching for a relationship between this journal and the most cited manuscripts, such as those developed by Ranoliya et al. (2017) and Fulmer et al. (2018), it is identified that these works were not published in this journal, with a high H index, and, on the contrary, these manuscripts were published in journals that only contain a publication on chatbot in university education. Therefore, it opens the possibility for researchers who develop studies in this field to have a greater number of journals to publish, with the possibility of making their research visible regardless of whether the journal has published a greater number of manuscripts in previous years, or if it belongs to a particular quartile or whether the impact number of the journal is high or low.

Finally, in relation to the words with the highest rate of occurrence in the titles and abstracts of the manuscripts regarding the chatbot and its application in university education, it was identified through the VOSviewer software that these are "chatbot" and "students". While when analysing the co-occurrence or link between words, five clusters were identified, with the first and second clusters containing the largest number of associated words. The words that make up these clusters are “chatbot, knowledge, student, university and virtual assistant” and “academic performance, AI chatbot, motivation, university students and use”. In this regard, Auqui (2021), in his systematic review study on chatbot in the university student's learning process, based on research published from 2015 to 2020, identified that the most used words in 24 selected articles are chatbot, learning and artificial. Although this result supports what was found in this bibliometric review study, the studies were carried out at different time intervals, so it could be established that the trend of manuscripts on chatbot in university education is increasing in recent years. In addition, in accordance with what has been indicated, it was also identified that the thematic areas with the highest incidence that have been published regarding the chatbot and its application in university education are: Improvement of academic performance using chatbot in the teaching and learning process (42.982%); Administrative and resource management in the university environment through the chatbot (25.439%); Student wellbeing monitoring through the chatbot (20.175%); Learning a second language with chatbot (7.018%); and Academic tutoring with chatbot (4.386%). In their systematic review on the use of chatbots in education. Okonkwo and Ade-Ibijola (2021) indicated that the topics addressed in publications on chatbot in education are teaching and learning (66%), administration (5%), evaluation (6%), consulting (4%) and research and development (19%). From the qualitative point of view, the results of this bibliometric review and the results obtained in the cited research, there is agreement in the categorisation carried out in the manuscripts analysed. From the quantitative point of view, the differences that exist are due to the fact that the cited study took Scopus, ScienceDirect, Springer, IEEE Xplore, ERIC and Taylor & Francis as its databases, while in this study only the Scopus database was used.

5. Conclusion

From the bibliometric review study on the application of the chatbot in university education, it was identified that there is a growing trend in scientific production, particularly scientific articles and conference papers regarding this field of study. In addition, it was identified that, to a greater extent, these manuscripts have been published in journals with restricted access to the full content of the manuscript. Thus, it was also identified that the journal with the largest number of publications is *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics*). Finally, it was identified that the thematic areas with the highest incidence regarding the chatbot and its application in university education are: Improvement of academic performance using chatbot in the teaching and learning process; Administrative and resource management in the university environment; Monitoring of the wellbeing of the student; Learning a second language; and Academic tutoring with chatbot. Based on what has been indicated, it is concluded that there is a greater concentration in the scientific production of manuscripts focused on improving the university educational service, being applied significantly in the improvement of academic performance, administrative management and university wellbeing. However, there is a marked gap regarding the scientific production in which the chatbot is used as a tool to identify university student satisfaction. This also identifies the lack of published studies on the use of a regulatory framework that regulates the application of the chatbot at the university level. Therefore, it is recommended that future studies cover these fields of knowledge based on systematic reviews of the literature and meta-analysis.

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