IJAAR PUBLISHING®

Scholarly Journal of Science and Technology Research & Development | ISSN: 2955-0807
Vol. 3, Issue 3 (March, 2024) | www.ijaar.org/sjstrd

A systematic review and meta- analysis of the impact of the Application of ChatGPT in Education

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ABSTRACT: *The study identified the impact of the application of AI ChatGPT in education based on a systematic review of literature and meta-analysis. Data were gathered from studies published from 2022 to 2023 in five leading scientific databases in the world of education (Web of Science, Scopus, Google Scholar, ERIC and Dialnet). The sample consisted of 12 studies, and using a descriptive and quantitative methodology, the most significant data are presented. The results show that the implementation of ChatGPT in the educational environment has a positive impact on the teaching and learning process, however, the results also highlighted the importance of teachers being trained to use the tool properly. Although ChatGPT can enhance the educational experience, its successful implementation requires teachers to be familiar with its operation. These findings provide a solid basis for future research and decision-making regarding the use of ChatGPT in the educational context.*

Keywords: ChatGPT; artificial intelligence; education; impact; systematic review

Rabiu, M. G. & Nuhu, M. U. (2024). A systematic review and meta- analysis of the impact of the Application of ChatGPT in Education. *Scholarly Journal of Science and Technology Research & Development*. 3(3), 1-16.

INTRODUCTION

Over the past decades, artificial intelligence (AI) has experienced tremendous growth and has transformed many aspects of the society. AI has positioned itself at the forefront of research areas ranging from medicine and robotics to education and autonomous driving. Broadly speaking, artificial intelligence refers to the ability of a computer system to mimic the behaviour of the human brain. This involves receiving information in the form of external data, learning through training and based on that learning, achieving the goals for which it was designed (Brazdil, 2021).

The implementation of artificial intelligence in education has had a significant impact, evidenced by improvements in the efficiency of the educational process, the promotion of global learning, the personalisation of learning, the creation of more intelligent contents and the optimisation of educational management in terms of effectiveness and efficiency (Jara, Ochoa & Usos, 2021). Nowadays, new technologies play a fundamental role in optimising the teaching–learning process. Education is not limited to being a mere product but is a process in which learning goes beyond the simple acquisition of knowledge. In this sense, artificial intelligence (AI) emerges as a new technology with great potential in the field of education, as AI-based systems could foster personalised learning, adapting to the needs and interests of each leaner or student (García, Mora & Ávila, 2020).

Within education, it is critical to recognise that the implementation of AI raises significant challenges and ethical considerations. Issues such as data privacy, equity of access to education and the impact on the role of the teacher require careful attention. It is essential to address these aspects in a responsible manner to ensure that AI is used in a beneficial and equitable way for all learners (Incio, Capuñay, Estela,Valles, Vergara & Eleras, 2021). In this regard, it is critical to find a balance between technology and the essential role of educators or teachers to ensure that the focus remains on the holistic development of students and their preparation for an ever-changing or dynamic world. Due to the short time between the launch of ChatGPT (end of November 2022), no systematic reviews addressing its impact on education have been found (Neuman, Rauschenberger & Schön, 2022). Therefore, the main objective of this systematic review is to analyze the existing literature on the use of ChatGPT in education in order to identify its impact, benefits, challenges and areas of application in the teaching and learning process. In this regard, the following research questions are addressed:

i. What is the general state of scientific research on the use of ChatGPT in education?
ii. What are the benefits and challenges of implementing ChatGPT in the classroom?
iii. What are the future trends and emerging research areas in the use of ChatGPT in education?

ChatGPT IN EDUCATION

The use of ChatGPT in education has generated considerable interest due to its potential to enrich the learning experience of students. By providing quick and personalised responses, this system has the ability to address individual student needs, offer immediate feedback and facilitate the understanding of complex concepts. In this way, it becomes a promising tool that promotes a student's active participation and cognitive advancement by adapting to their learning pace and offering continuous support in their knowledge acquisition process (García & Uso, 2023).

Following this line, it has proven to be a valuable tool to promote the development of writing skills in students. By interacting with the system, students can receive grammatical corrections, suggestions for improvement and detailed feedback on their writing, which gives

them the opportunity to improve their written communication and achieve greater effectiveness in their written expression (Osorio & Explorando, 2023). Thus, this application presents itself as an invaluable assistance tool for scientific writing; however, it is essential to understand that it should not be considered as a complete solution for scientific content creation. Writers must exercise their knowledge and experience to validate and complement the information provided by the tool. However, it also excels in its ability to facilitate group discussions and promote collaborative student participation in projects and assignments. This fosters a sense of community among learners by allowing interaction and an exchange of ideas (Qadir, 2022).

Several studies have tried to explore the potential impact of artificial intelligence, especially with the famous ChatGPT tool for students in education. Various applications of artificial intelligence in education were studied, such as personalised learning experiences, adaptive testing, predictive analytics and chatbots. As a result, it shows an incredible potential to improve learning efficiency and provide personalised educational support to both students and teachers. However, it is essential to consider the risks and limitations associated with these technologies, such as data privacy, cultural differences, language proficiency and associated ethical implications (Wang, Lund, Marengo, Pagano, Mannuru, Teel & Pange, 2023).

Its influence over the last year has sparked a growing interest in education. This innovative tool has positioned itself as a disruptive technology that is revolutionizing the way students are taught, promoted, and supported in academic environments. In this sense, educational centres are rethinking how to incorporate this technology into their didactic models in order to improve the teaching and learning process of educational agents (García, 2023). Therefore, teachers must approach this tool in the classroom and present it as an additional resource that complements the learning process. However, it is crucial to highlight that this tool does not replace the cognitive processes necessary in learning or other sources of information such as books, articles or interactions with others.

METHODOLOGY

Following an explicit and systematic search strategy, with inclusion and exclusion criteria, a systematic review of the literature was carried out. For this, the researchers adhered to the recommendations of the PRISMA Statement (Page, McKenzie, Bossuyt, Boutron, Hoffmann, Mulrow, Shamseer, Tetzlaff, & Brennan, 2020)

Search Strategy

The selected databases were Web of Science, Scopus, Google Scholar, ERIC and Dialnet. The search string (Table 1) was applied in the three international databases in the field of education, in the fields of title, abstract and/or keywords. The literature search was conducted between September and October 2023, with an initial identification of 154 records.

Table 1. Search strategy.

Topic	Search Terms
Artificial Intelligence	“Google Bard” OR “Chatbot” OR “Artificial Intelligence”
Context	“Education” OR “Educational Institution”

Inclusion and Exclusion Criteria

After eliminating duplicate studies (n = 73), the inclusion and exclusion criteria were established to ensure that the selected studies were relevant and met the set objectives. These criteria were applied independently by two reviewers to ensure objectivity and to minimize bias in the selection of studies. The researchers decided to limit the search to articles published from the year 2022 onwards, as this was the year in which this artificial intelligence chatbot developed by OpenAI was launched.

Table 2. Inclusion and exclusion criteria.

	Inclusion Criteria	**Exclusion Criteria**
Publication period	Published between 2022—present (February, 2024)	Published before 2022
Type of document	Scientific article published in peer-reviewed journal	Not an article published in a peer-reviewed journal
Type of study	Theoretical and empirical research	Other research (review, opinions, letters to the editor...)
Language	English	Neither in English
Population	Education	No focus on education
Research topic	Use of ChatGPT in education	Does not use Google

Methodological Quality Assessment

The study adopted the Johanna Briggs Checklist (JBI) which is a tool used to assess the methodological quality of research studies. It consists of a set of criteria used to determine the rigor and validity of a study. On application of Briggs checklist, aspects such as study design, participant selection, data collection and analysis of the articles were analyzed. The 14 identified articles were assessed for their methodological quality. The included studies were examined through a critical and independent review using an eleven-point checklist developed by Aromataris and Munn (Aromataris & Munn, 2020).

To ensure an unbiased assessment, a masked review of the checklist was conducted by two independent researchers, unrelated to the study. This measure was implemented to avoid any assessment bias on the part of the researchers. The selected studies had to meet at least four of the checklist criteria. The checklist used covered the following assessment criteria:

- Is the purpose of the research clearly specified?
- Does it address the use and impact of ChatGPT in education?
- Are the data extraction instruments appropriate?
- Are the results obtained useful to the research community?
- Are the authors' conclusions supported by the data analyzed?
- Are recommendations made for future research?

Some of the studies were excluded based on the quality issues raised in the checklist, as they did not meet at least four of the criteria provided above.

Selection of Studies

A total of 154 records were identified in the three electronic databases analyzed. After removing duplicate records (n = 73), studies were reviewed by title and abstracts to assess eligibility (n = 81). A total of 67 studies were excluded as they did not meet the established inclusion and exclusion criteria. Subsequently, the remaining 14 studies were assessed for methodological quality, eliminating 2 studies. Finally, a total of 12 studies were eligible for inclusion in the review. Figure 1 shows the flow chart of the record selection process based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page, McKenzie, Bossuyt, Boutron, Hoffmann, Mulrow, Shamseer, Tetzlaff, & Brennan, 2020).

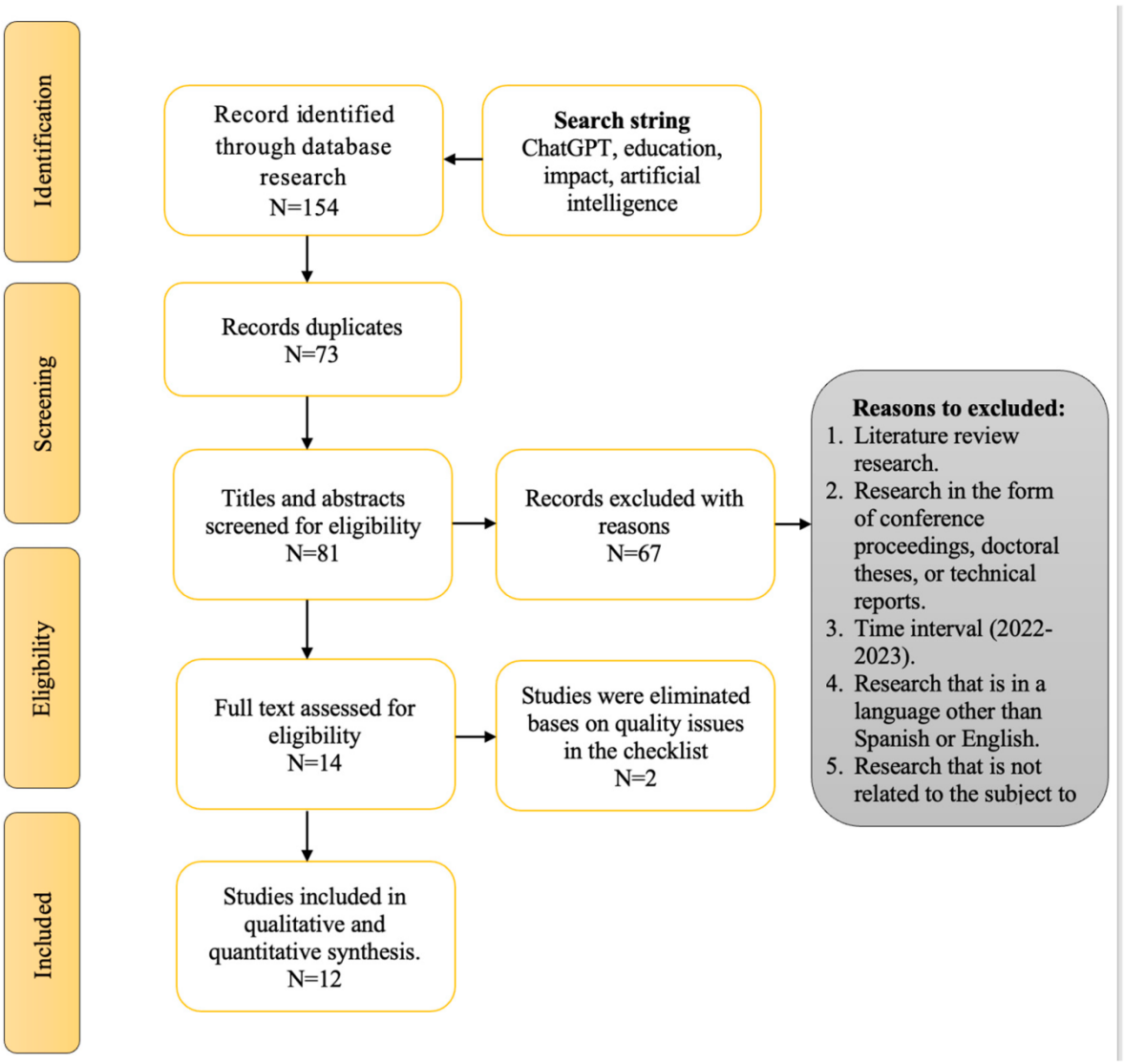


Figure 1. Flow chart of the study selection process.

Data Extraction and Analysis

In order to address the research questions posed, we carried out a content analysis combining qualitative and quantitative approaches to the 12 research studies obtained. The quantitative analysis allowed us to visualize and understand general aspects of the topic through descriptive graphs. For the qualitative analysis, we used the VOS viewer 1.6.15 tool to

identify the main trends and scientific impact of the research field (Nandiyanto & Husaeni, 2021).

Each of these clusters has a different number of elements, colour, and size. The size is determined by the frequency of occurrence. The larger the circle, the more frequently that keyword is used in the studies (Mulyawati & Ramadhan, 2021). The main characteristics of the studies included in the review related to ChatGPT in education are provided in **Table 3**.

Table 3. Characteristics of the studies included in the review.

Authors/Year	Methodology	Country/Continent	Findings	
			Advantages	Disadvantages
Diego Olite et al. (2023)	Theoretical	Cuba, America	• Strategy that will bring about changes in the way of thinking and educating (educational process).	• Lack of training.
García Peñalvo (2023)]	Theoretical	Spain, Europe	• Promotes the development of critical thinking.	• Provides training for both teachers and students to encourage appropriate and ethical use.
Sánchez García (2023)	Theoretical	Mexico, America		• Educational institutions should take into account the concerns expressed by students when using artificial intelligence.
Halaweh (2023)	Theoretical	United Arab Emirates, Asia	• It offers numerous opportunities for teachers and lecturers to develop ideas.	• Provides teacher training on the functions of artificial intelligence tools, as well as how to evaluate and use it correctly.
Rahman and Watanobe (2023)	Quantitative	Bangladesh, Asia	• Very useful as a support for educational work.	• Lack of training. • Lack of common sense in its use. • Difficulties in complex reasoning.
Ausat et al. (2023)	Quantitative	Malaysia, Asia	• Offers improvements in learning.	• It does not completely replace the role of the teacher. Therefore, a teacher's digital competence is necessary to integrate it effectively and appropriately.
Rincón Castillo et al.	Qualitative	Indonesia, Asia	• ChatGPT significantly impacts	• Many students use ChatGPT to manage

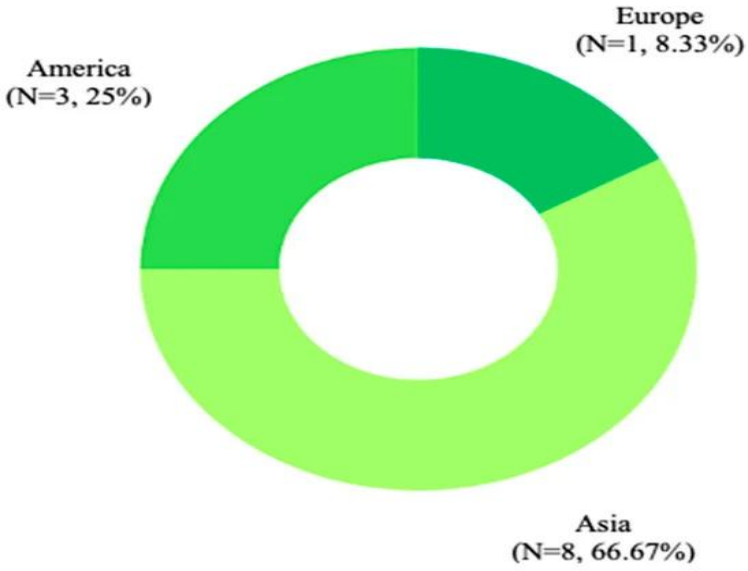
Authors/Year	Methodology	Country/Continent	Findings	
			Advantages	**Disadvantages**
(2023)			the teaching–learning process.	and deliver their work without learning anything.
Javaid et al. (2023)	Theoretical	Mexico, America	• Both students and faculty can benefit from this tool. • Faculty can save time on numerous tasks by using these technologies. • Students can use it as a support tool.	• Lack of training.
Qadir (2023)	Theoretical	India, Asia	• It offers numerous benefits in the teaching–learning process.	• It is important to use these tools with caution, as they can be misleading. • Provides equitable access to advanced technology, especially for marginalised communities, so as not to exacerbate existing inequalities.
Firat (2023)	Qualitative	Qatar, Asia	• This tool can increase student engagement and satisfaction. • It can enhance learning experiences and transform the role of educators.	• Need to improve the training of teachers and students.
Fauzi (2023)	Qualitative	Turkey, Asia	• It offers learners the chance to improve their language skills. • Facilitates collaboration. • Increases time efficiency and effectiveness. • Provides support and motivation.	• Lack of training.
Strzelecki	Quantitative	Indonesia, Asia	• Tool	• Lack of

Authors/Year	Methodology	Country/Continent	Findings	
			Advantages	Disadvantages
(2023)			accepted by university students. • Increases students' performances. • Increases students' motivation.	training.

RESULTS

A total of 12 relevant articles were selected for this systematic review. When observing the distribution of the collected research according to the year of publication, it is evident that all the articles found belong to the year 2023. This is due to the fact that the implementation of ChatGPT in education was implemented at the end of 2022, which did not allow enough time for studies to be conducted and articles on its impact to be published until the following year.

Looking at the distribution of the studies according to the place of publication, research from the Asian continent predominates with 66.67% of the research collected, coming from countries such as the United Arab Emirates, Qatar, Indonesia, Turkey, India and Bangladesh. However, we also found research from the Americas (25%) and Europe (8.33%) to a lesser extent. Some of these countries are Spain, Mexico, Poland and Cuba**. No articles were found from the African or** Oceanic continent (**Figure 2**).



Regarding the methodology used in the selected articles, it is worth noting that most of the research published on the impact of ChatGPT in the educational field has been carried out through a theoretical approach (50%), with the aim of understanding the potential and challenges of this tool. To a lesser extent, there are other studies that have chosen to approach the study from both a qualitative and quantitative methodology (25%) (**Figure 3**),

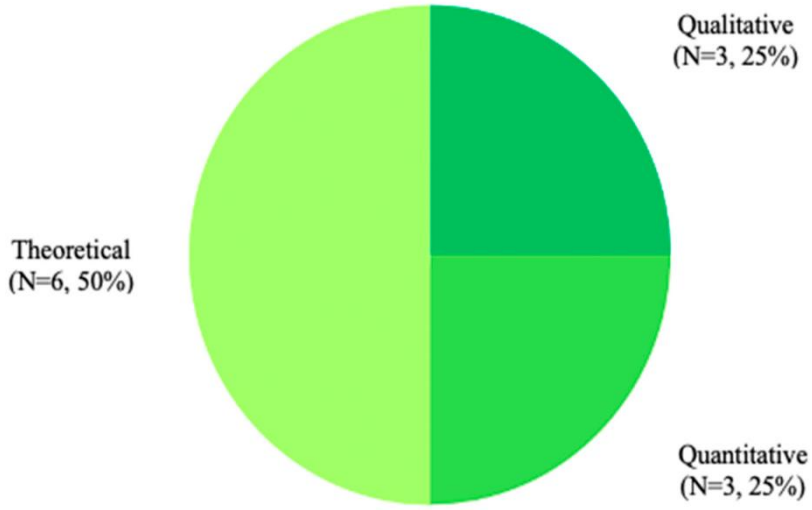


Figure 3. Distribution of studies by methodology used.

Considering the main findings that were found after reading the selected articles, Figure 4 shows that the main result obtained was that the use of ChatGPT in education is a great educational support in the teaching and learning process for both students and teachers (82%). This is closely linked to the improvement of performance, motivation, organization and efficient time management, as well as the promotion of a more effective and collaborative learning environment.

At the same time, there is a lack of teacher training regarding the use of ChatGPT for its subsequent application and use in educational classrooms (58%), as many teachers do not have the necessary skills to apply it efficiently. However, it is necessary that all educational agents know how to use this tool in a responsible way, following ethical guidelines, since inappropriate use could be an obstacle in the learning process of students (52%). On the other hand, and closely related to the previous finding, a large part of the research collected in their articles shows the great changes at the educational level that the use of ChatGPT can create by generating a strong impact on the way of teaching and carrying out tasks (46%). Lastly, the articles reflect a concern for the clear need for student training (32%) and the possible problems in the educational system that can be generated after prolonged use of this application (28%).

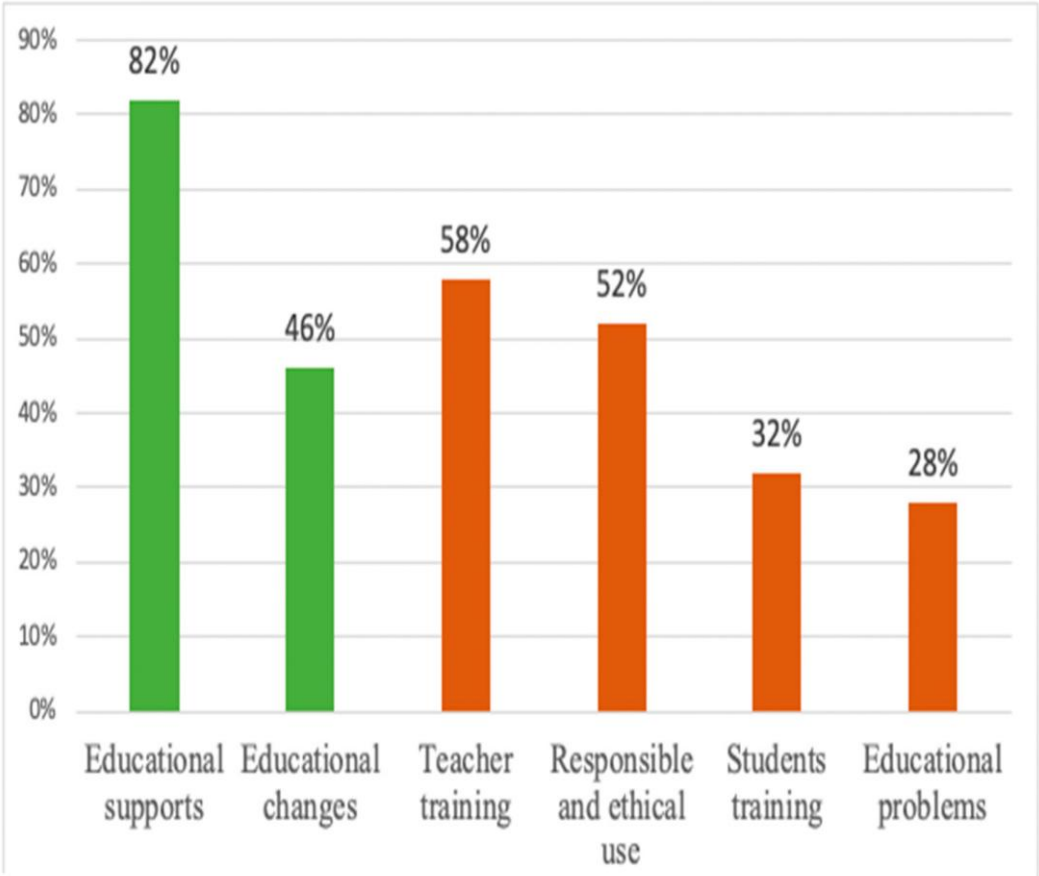


Figure 4. Main findings of the analyzed studies.

Finally, to find out the lines of research in this field, three clusters were obtained from the mapping of VOS viewer. The three clusters obtained are (**Figure 5**):

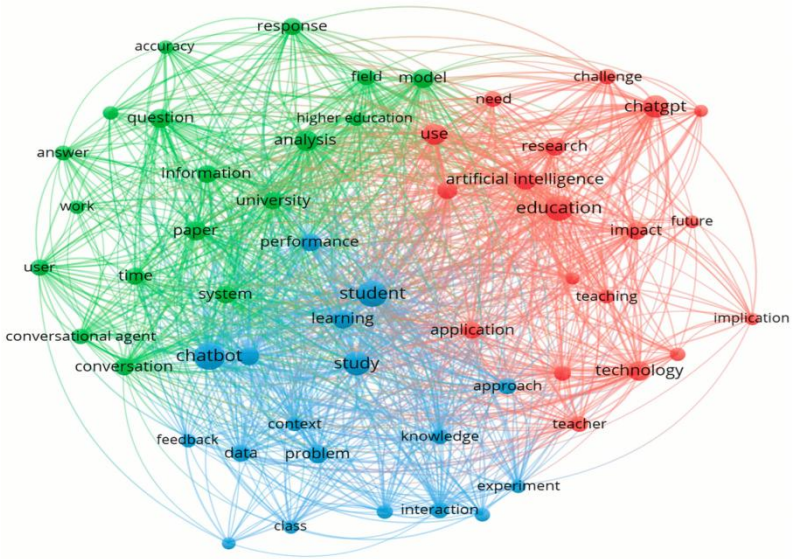


Figure 5. Labelled bibliometric map.

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Cluster 1 (red). The cluster marked in red has 19 items, including application, artificial intelligence, challenge, ChatGPT, critical thinking, education, future, impact, implication, limitation, need, opportunity, research, strategy, teacher, teaching, technology, tool and use. This cluster is therefore linked to research on the role of the teacher in an educational environment driven by artificial intelligence, including their training, the impact of using artificial intelligence tools and their adaptation to changes in their pedagogical practice.

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Cluster 2 (blue). The cluster marked in blue has 18 items, including approach, chatbot, chatbot technology, class, context, data, development, experiment, feedback, interaction, knowledge, learning, participant, performance, problem, skills, student and study. This cluster is related to the line of research on the use of chatbots in education, including their impact on students.

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Cluster 3 (green). The cluster marked in green has 18 items, including accuracy, analysis, answer, conversation, conversational agent, field, higher education, information, model, order, paper, question, response, system, time, university, user and work. This cluster is related to research on the impact of the chatbot on teaching and learning processes, including factors such as the socioeconomic, cultural, institutional and technological environment in which it is developed.

DISCUSSION

To address the research questions, the findings obtained through the qualitative and quantitative content analysis conducted in the 12 selected research were explored.

Q1: What is the general state of scientific research on the use of ChatGPT in education?

The general state of scientific research on the use of ChatGPT in education is limited due to the recent implementation of this application in the educational setting, being still in its initial stages. A total of 12 relevant articles were collected for a systematic review, all published in the year 2023. This is because the use of ChatGPT in the educational setting is a relatively new practice, since its launch occurred at the end of 2022, so there has not been enough time to conduct long-term studies and collect meaningful data on the impact on education until the first months of the following year (Alonso & Cordero, 2023).

In terms of geographic focus, a greater representation of studies belonging to the Asian continent was observed. The predominance of research from Asian countries may be related to the early adoption of technology in these regions and their focus on educational research. Other factors such as the availability of research funds and collaboration between university institutions may also influence these data. It should also be noted that in different countries, the use of this tool has been banned in educational centres (Strzelecki, 2023).

In relation to the methodology used in the selected articles on the impact of ChatGPT in education, a high predominance of theoretical articles stands out, as opposed to qualitative and/or quantitative studies. This may be possible because the development and implementation of artificial intelligence technologies in education, such as ChatGPT, are still at a relatively early stage, so the exploration of the possibilities and challenges presents a mainly theoretical approach before conducting empirical research (García, 2023).

Q2: **What are the benefits and challenges of implementing ChatGPT in the classroom?**

In an ever-changing society, technological advancement has taken on a fundamental role in our existence and, naturally, it has left its mark on the field of education. OpenAI's

innovative creation, known as ChatGPT, is revolutionizing the way educators and students approach the learning process in the classroom. The implementation of ChatGPT in schools brings a number of benefits and challenges that educational agents need to be aware of in order to improve the quality of education in the classroom.

Its use in the classroom is offered as a promising tool that offers multiple benefits for learning. This tool allows content and activities to be customized to the specific needs of each student, improving the effectiveness of teaching and learning. In other words, it allows students to adapt to their learning pace and provides constant support in their knowledge acquisition process.

All of these results in having more individualized and personalised learning, which leads to an improvement in motivation and commitment on the part of students, being considered as a fundamental educational support for the improvement of the teaching and learning process (García, 2023). At the same time, ChatGPT promotes collaboration by allowing students to work together to research topics and develop communication and teamwork skills, leveraging this tool to support the educational process. ChatGPT is also an easy-to-use and accessible tool for teachers and students, allowing for quick integration into the classroom. Finally, by providing support in the generation of content and activities, ChatGPT allows teachers to focus on more important aspects of teaching, such as personalised interaction and feedback.

However, for an effective implementation of this tool, the importance of providing training appropriate to the current context is highlighted. Teachers must be provided with the necessary technological knowledge to be able to use this tool effectively in the educational environment, preventing teachers themselves from being an obstacle in the implementation of this tool. In this sense, teachers must not only learn how to use the technology itself but also understand its possibilities and limitations, as well as address the associated ethical and pedagogical challenges (García, 2023). Along these lines, the implementation of this tool should be approached in a reflective manner to ensure a responsible classroom environment. Its use in the education system must be carefully evaluated to ensure that it is not used to that it is not used to replace these important skills (Alonso & Quinde, 2023).

However, there is a need to consider the academic misuse of ChatGPT that may be implied by using text generation technology for dishonest or unethical purposes in academia (Rahman & Watanobe, 2023). In addition, ChatGPT's knowledge is still limited and has not yet been updated with information beyond 2021 (Gilson, Safranek, Huang, Socrates, Taylor & Chartash, 2023). Therefore, its answers may not always be accurate or reliable, especially on specialized topics and recent events. In addition, ChatGPT may generate incorrect or even inaccurate information (Megahed, Chen, Ferris, Knoth & Jones, 2023).

This situation can pose a challenge for students who rely on ChatGPT for information during their learning process. In this context, one of these specific limitations is the phenomenon known as "hallucinations". In the context of chatbots such as ChatGPT, hallucinations refer to responses that sound plausible but are incorrect or nonsensical. That is, the chatbot may generate responses that appear to be well-written and coherent but are actually erroneous or unsubstantiated information. This phenomenon can be problematic in the educational context since students could receive incorrect or confusing information, which would negatively affect their learning and understanding of the topics. This is why it is important to take these limitations into account and carefully evaluate the accuracy and reliability of the chatbot before using it as an educational tool (Rudolph & Shannon, 2023).

Q3: **What are the future trends and emerging research areas in the use of ChatGPT in education?**

After conducting an analysis using the VOS viewer software, a bibliometric analysis was performed to visualise research trends in relation to the use of ChatGPT in education. This analysis revealed three clusters grouping the keywords present in the titles and abstracts of the studies found in the databases, allowing us to identify three main emerging research areas and the directions that the research in this field is taking.

The first is focused entirely on the role of the teacher in the educational setting driven by the use of artificial intelligence. The role of the teacher in the context of the use of artificial intelligence is crucial for improving educational practice and fostering new teaching methodologies (Firat, 2023). ChatGPT is a valuable tool for trainers, providing them with a starting point for designing curricula, teaching materials and assessment activities.

The second line of research in the field of education focuses on the impact and use of artificial intelligence (AI) in the classroom, which has aroused great interest among educators and pedagogical experts. The incorporation of artificial intelligence as a complementary tool in the teaching–learning process has shown promise and has generated a variety of research (Ausat, Massang, Efendi, Nofirman & Riady, 2023). In this context, artificial intelligence, and in particular ChatGPT, has been highlighted for its ability to improve a student's academic performance and foster the development of critical thinking. By providing quick and accurate answers to specific questions, ChatGPT facilitates access to relevant and up-to-date information, which can be particularly beneficial for students in their process of inquiry and understanding of different topics (Javaid, Haleem, Singh & Kahn, 2023). In addition, artificial intelligence adapts to each student's individual learning pace, allowing them to progress at their own pace and receive personalised support based on their needs. This not only improves student motivation and engagement but also frees up time for educators to focus on more interactive and creative tasks, such as one-to-one tutoring and constructive feedback (Castillo, Silva, Arocutipa, Berríos, Rodríguez, Reyes, López, Reves, Rivera & González, 2023).

However, it is also important to bear in mind some challenges and ethical considerations when incorporating artificial intelligence in the classroom. For example, it is essential to ensure the privacy and security of student data, as well as to assess the accuracy and reliability of the answers provided by AI to avoid the spread of erroneous or biased information (Ausat, Massang, Efendi, Nofirman & Riady, 2023).

The last line is closely related to the impact of artificial intelligence on teaching and learning processes, including factors such as the socioeconomic, cultural, institutional and technological environment (Rahman& Watanobe, 2023). In summary, AI technologies such as ChatGPT can help educational institutions achieve intelligent management and allocation of learning resources, improve the utilisation and effectiveness of educational resources, greatly change the shape of education quality and efficiency, provide better learning services to students and help them to better adapt to the development needs of future society.

CONCLUSIONS

The systematic literature review has shown that scientific research on the use of the ChatGPT tool in education is still scarce, as it turns out to be a novel tool launched in late 2022. The use of ChatGPT in education has emerged as an innovative and promising tool that seeks to enhance the learning experience and foster greater interaction between students and teachers. As its possibilities are investigated and understood, the use of ChatGPT in education reveals

a significant potential to transform teaching and learning methods. In this sense, this artificial intelligence tool proves to be a motivating tool for students, by having to apply Information and Communication Technologies, and significantly improves students' academic performances, if it is used appropriately. However, it is essential to bear in mind that its use presents a series of challenges, which teachers must be aware of to avoid incorrect use. Along these lines, proper training of teachers and students can be effective to know how to use the application and avoid its misuse in the academic environment. With ethical implementation and proper supervision, this technology can open new educational possibilities and enrich the teaching and learning process.

In this sense, although artificial intelligence is not something new, the emergence of ChatGPT has generated debate in education, questioning aspects such as traditional tasks, methodology and evaluation. Therefore, it is important to continue researching the potential of these tools and their impact, considering didactic and scientific aspects, and promoting an ethical and responsible integration of artificial intelligence in education.

The main limitation of this review lies in the limited amount of literature included in the analysis. This is because, so far, not enough studies that address the specific use of ChatGPT in higher education institutions have been conducted. Educational technology, such as ChatGPT, is a constantly developing and evolving field, and its implementation in higher education may be relatively new and therefore less researched compared to other levels of education. Despite this limitation, the review provides an overview of how ChatGPT has influenced the university level. As more research is conducted and knowledge about the use of ChatGPT in higher education expands, it will be useful to expand the study to gain a more complete understanding of its impact and benefits at this specific educational level. In future studies, other databases such as ERIC or Dialnet, among others, could be included to ensure an exhaustive and comprehensive search for relevant studies.

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