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Chatbot Artificial Intelligence as Educational Tools in Science and Engineering Education: A Literature Review and Bibliometric Mapping Analysis with Its Advantages and Disadvantages

Dwi Fitria Al Husaeni[1], Nuria Haristiani[2], W. Wahyudin[1], R. Rasim[1]

[1] Pendidikan Ilmu Komputer, Universitas Pendidikan Indonesia, Indonesia
[2] Pendidikan Bahasa Jepang, Universitas Pendidikan Indonesia, Indonesia
*Correspondence: E-mail: dwifitriaalhusaeni@upi.edu

ABSTRACT

This research was conducted to analyze the application, utilization or use of AI chatbots in the education sector based on several previous studies. Bibliometric analysis is used to identify the current status of research and critical points in bibliometric data mapping can help predict future research trends. Data searches were carried out on the Scopus database with the keywords "Chatbot" AND "education" with a research year range of 2007-2024. There were 376 articles found. The research results show that research on chatbots, especially in the education sector, is increasingly in demand. In 2023 there will be a drastic increase in the number of studies regarding chatbots in the education sector compared to previous years. This is because chatbots are considered to be an interesting tool to use in education because they enable a more innovative teaching process in terms of improving learning processes and outcomes. There are 25 countries that have contributed to related research, with the United States, Australia, United Kingdom, China and Taiwan in the top five. This research also shows that there are 26 subject areas that have used chatbots in the education sector. The use of chatbots in the education sector has advantages and disadvantages. With the completion of this research, it is hoped that it can become material for consideration for related research.

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1. INTRODUCTION

Advances in information technology and its application have led to increased adoption of digitalization and automation in various aspects of industry. One form of progress in existing information technology is artificial intelligence (AI). AI has made steady progress in recent years and provided several functional benefits in various domains through its use (Sharma *et al*., 2023; Al-Khassawneh, 2023; Alimi *et al*., 2021; Agarry *et al*., 2022). One of the popular AI technologies is the Chatbot system. The introduction of AI technology has enabled the integration of Chatbot systems into various aspects of education (Okonkwo & Ade-Ibijola, 2021). Chatbot is an AI program that is able to imitate human conversation in the form of text or voice messages via messaging applications, websites or mobile applications (Adamopoulou & Moussiades, 2020; Haristiani & Rifa'I, 2020; Haristiani & Rifai, 2021; Haristiani *et al*., 2019). Specifically, conversation is one of the difficult points in learning language since it relates to the vocabulary and pronunciation, making it to be deeply researched (Husna & Febriyanto. 2022; Samita, 2022; Sudipa & Meilantari, 2022; Sesefanakh & Febriyanti, 2022; Maheswara *et al*., 2022; Nishfullayli *et al*., 2022; Mintarsih, 2023). Chatbots are considered a useful technology for facilitating learning in educational contexts. This can provide as media to learn and make students more understand. Indeed, media is important for increasing students understanding (Haristiani & Rifa'I, 2020; Winarni & Rasiban, 2021; Huwaidi *et al*., 2021; Millatina *et al*., 2022; Mulya *et al*., 2023; Zafrullah & Ramadhani, 2024; Suroto & Nandiyanto, 2021; Ramdhani & Nandiyanto, 2021; Anggraeni & Maryanti, 2021; Azizah *et al*., 2022; Maulidayani *et al*., 2022; Fahrannisa *et al*., 2022; Kasmana *et al*., 2021; Ariyanti & Maryanti, 2021; Buhori & Karnawati, 2022; Sutiyarti *et al*., 2019; Sukmana, 2021; Buhori & Karnawati, 2022; Ahmad & Bakar, 2023). Chatbot technology has the potential to provide fast, personalized service to everyone in education.

Chatbot is an AI technology that acts as a conversational agent that can provide instant responses to users (Mekni, 2021). Chatbots are widely used to increase student interaction in today's technological world where communication and other activities are highly dependent on online platforms. This can be used also for supporting distance learning (Mulyanti *et al*., 2020; Sangsawang, 2020; Escomes & Morbo, 2021; Onia & Ramadan, 2023; Soko *et al*., 2024; Riyanto *et al*., 2022; Hofifah & Sumiati, 2023; Azizah *et al*., 2022). Chatbots in the education sector can be used to develop learning media for students as presenters of interactive and interesting material and quizzes (Zulkarnain *et al*., 2020). Chatbot also can help writing ability. Writing ability relates to reading and literacy (Indrowaty, 2018; Nurjaleka, 2019; Andhini & Sakti, 2021; Putri *et al*., 2021; Ababil *et al*., 2021; Maryati *et al*., 2022; Hartati *et al*., 2023; Nafilah & Sakti, 2022; Alpapara, 2022; Viyana *et al*., 2023; Sidik & Masek, 2021; Agustin *et al*., 2022; Maryati *et al*., 2022; Ardiana *et al*., 2022; Nugraha *et al*., 2022; Kamila & Sakti, 2022; Sabila *et al*., 2021). It is important point in the teaching and learning in language, making many research on this subject reported (Aneros & Nerniwati, 2023; Widyastuti & Haristiani, 2023; Rusyani *et al*., 2021; Olowoyeye *et al*., 2023; Agustin *et al*., 2022; Nafilah & Sakti, 2022; Nandiyanto & Azizah, 2022). Chatbot systems can not only increase student engagement and support, but can also reduce the administrative workload of educators and teaching staff, allowing them to focus on curriculum development and research.

Currently, there has been a lot of research examining the application of AI chatbots in the educational sector, including the use of chatbots as an interesting and innovative media to support autonomous learning of the Japanese language (Haristiani and Riafa'i, 2020; Haristiani and Rifa'i, 2021), the use of media chatbot-based online learning through teacher training (Dewi and Jonathan, 2022), the application of AI chatbots to improve student learning

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in higher education (Liu *et al*., 2022), research on the impact of chatbot use on student learning experiences (Ait Baha *et al*., 2023), implementation of AI chatbots as English conversation partners (Yang *et al*., 2022) and many other studies that discuss the use of chatbots in the education sector (Viorennita *et al*., 2023; Munggaran *et al*., 2023; Kim, 2022; Essel *et al*., 2022).

Based on this, this research was conducted as a form of literature study which aims to analyze the application, utilization or use of AI chatbots in the education sector based on several previous studies. This research discusses the steps for implementing chatbots in the education sector, applications or chatbot development frameworks, and the benefits of chatbots in the education sector. It is hoped that this research can contribute to the use of technology, especially AI Chatbot technology in the field of education. This research also adds bibliometric analysis because it can describe the current research situation and trends in the field under study. Detailed information regarding previous research in the field of bibliometrics is shown in **Table 1**.

Table 1. Previous studies on bibliometric.

No	Author	Search Theme	Search Year
1.	Al Husaeni & Al Husaeni (2022)	Science and islam	2012-2022
2.	Al Husaeni & Munir (2023)	Philosophy of science and technology education	2018-2022
3.	Al Husaeni *et al*. (2024)	Education technology in Indonesia	2018-2023
4.	Maryanti *et al*. (2023)	Science Education	2017-2021
5.	Nandiyanto *et al*. (2023)	Introducing ASEAN journal of science and engineering	2021-2023
6.	Al Husaeni *et al*. (2023)	Special needs education	2017-2021
7.	Nandiyanto *et al*. (2024)	keyword water hyacinth and ecosystem	2000-2023
8.	Al Husaeni *et al*. (2024a)	Statistical significance test	2013-2023
9.	Al Husaeni and Nandiyanto (2022)	Mechanical engineering education	2012-2021
10.	Nandiyanto *et al*. (2023a)	Science and technology-related publications	2002-2023
11.	Al Husaeni and Rahmat (2023)	Islamic learning	2014-2023
12.	Al Husaeni and Wahyudin (2023)	Digital transformation in special needs education	1975-2023
13.	Al Husaeni (2023)	Sports science	2018-2022
14.	Hanief *et al*. (2021)	physical education in reputable international journals	2013-2020
15.	Supriyadi *et al*. (2023)	Augmented reality in mathematics education	2002-2022
16.	Ragadhita and Nandiyanto (2022)	techno-economic education	2017-2022
17.	Hofifah and Nandiyanto (2024)	Water hyacinth and education	2010-2023
18.	Nordin (2022)	Teaching science engineering	2012-2021
19.	Wirzal and Putra (2022)	Chemical engineering and special needs education	2018-2022
20.	Nugraha (2022)	Magnetite nanoparticle production	2017-2021
21.	Pramanik and Rahmanita (2023)	Community-based-tourism	1999-2023
22.	Wahyulistyo and Cahyonowati (2022)	Employee fraud	2011-2020
23.	Fardian & Dasari (2023)	Problem-based learning	2013-2023
24.	Santoso *et al*. (2022)	Management information systems	2018-2023
25.	Suherman *et al*. (2023)	Crystal structure education	2012-2022
26.	Nandiyanto *et al*. (2020)	Decreasing number of scientific publication	2014-2019
27.	Setiyo *et al*. (2021)	"B100", "performance", "emission"	2017-2021
28.	Soegoto *et al*. (2022)	Bioenergy Management	2017-2021

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2. METHOD

This research uses bibliometric analysis where the analysis uses statistics and mathematics to analyze, explain and visualize research subjects statistically. Bibliometric analysis is used to identify the current status of research and critical points in bibliometric data mapping can help predict future research trends (Nurramadhani *et al*., 2024). This research was carried out in four steps, namely (i) selecting keywords, (ii) data collection, (iii) data processing and analysis, and (iv) analysis of results and conclusions. **Figure 1** shows the steps of the bibliometric analysis research that we carried out. Detailed information on how to use bibliometrics is explained elsewhere (Al Husaeni & Nandiyanto, 2022a; Azizah *et al*., 2021).

Search for research data was carried out on the Scopus database. The keywords "Chatbot" AND "education" was used in the research data search process. The data search was carried out on February 23 2024. The search results for research studies covered the years 2007-2024 with a total of 376 related articles that met several of the analysis criteria for this research. The article criteria used in this research include the Scopus document type being an article, publication stage with final status. source type journal, the language used in the article is English. This research uses the VOSviewer application to help map search results. The results of the analysis are presented in the form of a visualization network that uses one term and another.

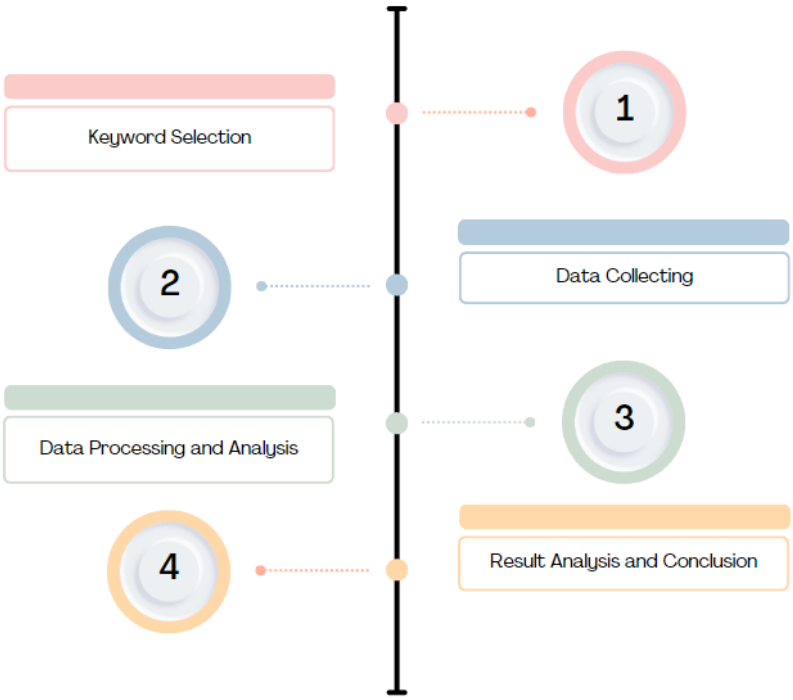

Figure 1. Research procedure.

3. RESULTS AND DISCUSSION

3.1. Chatbot Background

The term chatbot comes from two words, namely 'chat' and 'bot'. The latter comes from the word ‘robot’, a word derived from the Czech word ‘robota’ (labor) coined in 1920 by the Cubist painter Karel Čapek. After that, in 1994 Michael Mauldin coined the term 'chatterbot' (which was later shortened to 'chatbot'), which refers to a computer program or conversational agent designed to simulate an intelligent conversation with a human user by recognizing and reproducing written speech (Rudolph *et al*., 2023).

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Chatbot is a form of application of artificial intelligence (AI) which is able to interact with users through conversations where the chatbot is able to answer a series of questions and provide appropriate responses (Okonkwo & Ade-Ibijola, 2021). Chatbots are conversational agents that provide instant responses to users with AI technology principles (Suhaili *et al*., 2021). Chatbot is a computer program designed to simulate a conversation or interactive communication to users (humans) through text, sound, and/or visuals.

3.2. How Chatbot Work

In the process of creating chatbots, several AI technologies are used, one of which is the use of Machine Learning (ML), Natural Language Processing (NLP) and Natural Language Understanding (NLU) technology as well as Machine Reading Comprehension (MRC). Machine learning is a sub-field of artificial intelligence that allows machines to learn existing data and carry out certain tasks according to their knowledge (Shyam & Singh, 2021). Machine Learning allows chatbots to not only understand text, but also understand images and videos.

NLP and NLU are software whose ability can recognize the intent and purpose of even text, images or videos. NLP is able to evaluate AI's ability to understand questions, retrieve and utilize material to produce relevant answers (Jin *et al*., 2022). Then MRC is a technology with the ability to read and understand messages received and then be able to respond to those messages. ML, NLP, NLU, and MRC technology allows chatbots to be able to receive messages in various forms, including text, images, and videos, and process these messages so that the chatbot can respond in real time.

Meanwhile, according to Chakraborty *et al*. (2023) chatbots technology has 3 (three) types of operational systems or work patterns to reply to customer messages, namely:

(i) ***Pattern Matching,***
Chatbot works by scanning keywords entered by the user, then responding with answers that best match the selected keywords (can be the most similar word patterns).

(ii) ***Decision Tree-Based,***
One of the bot systems that is often found in bots that provides question options at the start of the conversation. Where users can only choose questions that have been provided by the system. This bot system has a low level of complexity and is faster, but the way this bot works is considered less user friendly.

(iii) ***Contextual,***
This method uses a Machine Learning artificial intelligence system so that Bots can respond using natural language. In this case, developers need strategic and targeted planning, namely designing a database that is large enough to cover all forms of user questions and requests.

3.3. Overview of Chatbot Technology Research for Education

Figure 2 shows search results in Scopus from 2007 to 2024 for the keywords "Chatbot" and "Education". The search results show that research on chatbots in the education sector is increasing every year, especially in 2023. In 2023 there will be a drastic increase in the number of research on chatbots in the education sector compared to previous years. Where in 2019 there were 15 publications, in 2020 there were 20 publications, in 2021 there were 39 publications, and in 2022 there were 58 studies in Scopus. Meanwhile, in 2023 there will be 205 studies regarding chatbots in the education sector found on Scopus.

These results show that research on chatbots, especially in the education sector, is increasingly in demand. This can happen because advances in artificial intelligence and

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natural language processing have enabled the development of chatbots that are more sophisticated and effective in interacting with users (Rifky, 2024). Thus, chatbots are considered to be an interesting tool to use in education. In addition, the use of chatbots makes it possible to encourage more innovative teaching processes in terms of improving learning processes and outcomes (Hwang & Chang, 2023).

The rapid development of civilization in the 21st century shows rapid advances in technology resulting in changes in the way of living, working and learning. Therefore, it is very important for educators to keep pace with change and prepare students with the skills they need, one of which is through the use of media and technological tools that can be used to hone students' 21st century skills. The use of chatbots is also considered to be one of the technologies used to support the learning process, so that students' 21st century skills can be better honed (Muhanditsah *et al*., 2023). Therefore, the research trend for Chatbots as a form of Artificial intelligent (AI) technology increases every year.

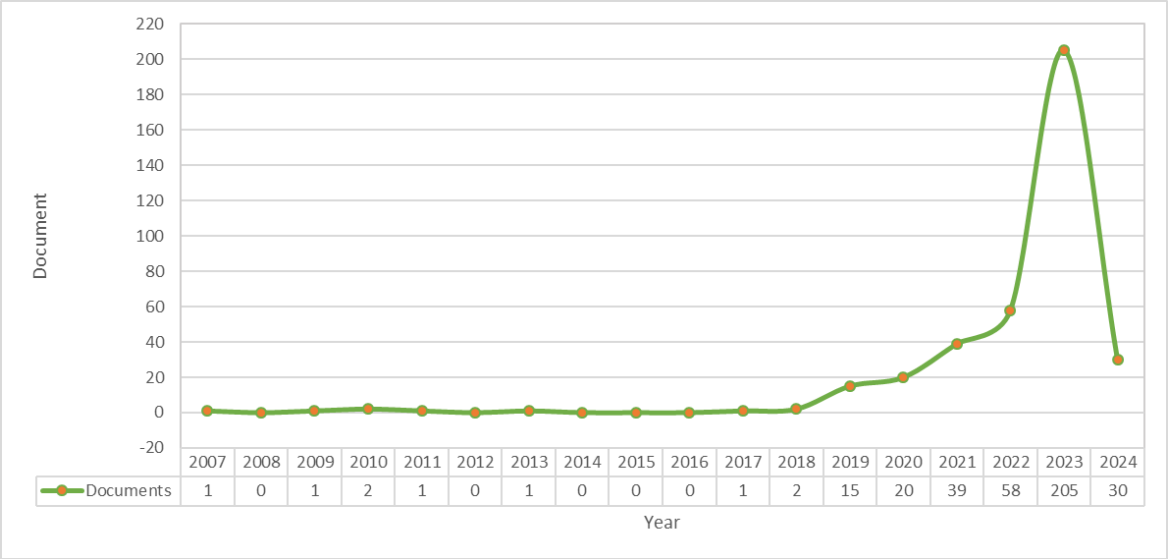

Figure 2. Development of chatbot technology research for education.

We also conducted an analysis of countries that have contributed to research on chatbots in the field of education. Analysis of authors are commonly used in current bibliometric reports (Nandiyanto *et al*., 2023; Al Husaeni *et al*., 2022; Nandiyanto *et al*., 2023b). **Figure 3** shows the distribution of countries' contributions in the world to research regarding the use of chatbot technology in the education sector. Based on the data shown in **Figure 3**, there are 25 countries that have contributed to related research, namely the United States, Australia, United Kingdom, China, Taiwan, South Korea, India, Spain, Saudi Arabia, Tukey, Hong Kong, Malaysia, Singapore, Canada, France, Thailand, Germany, South Africa, Netherlands, Greece, Egypt, Japan, Italy, Indonesia, and Brazil.

Form the 25 countries, the United States has the highest publication contribution with the number of publications regarding chatbots in the education sector in Scopus amounting to 96 publications. The other 4 countries that occupy the top five positions with the highest number of research contributions on related research themes are Australia with 23 publications, the United Kingdom with 21 publications, China with 20 publications, and Taiwan with 19 publications. Indonesia itself is in second place from the bottom or 24th position with a total publication of 6 articles on Scopus.

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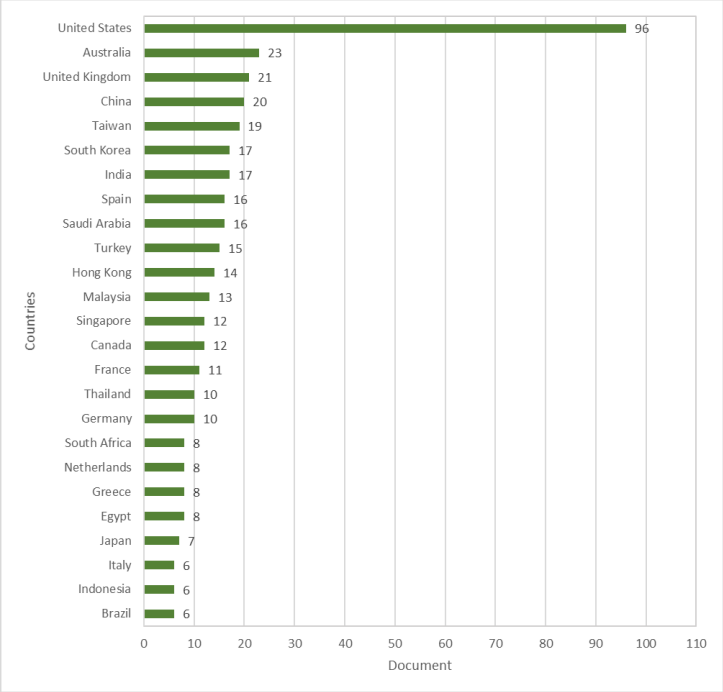

Figure 3. Distribution of country contributions to chatbot technology research for education.

3.4. Current Research in Chatbot in Education

Figure 4 shows the subject area for publications regarding chatbots in the education sector based on Scopus analysis. The results of Scopus analysis on subject areas show that there are 26 subject areas that have used chatbot technology, namely social science, computer science, medicine, engineering, business, management and accounting, health professions, psychology, nursing, materials science, mathematics, arts and astronomy, biochemistry, genetics and molecular biology, chemical engineering, environmental science, decision sciences, multidisciplinary, economics, econometrics and finance, energy, chemistry, pharmacology, toxicology and pharmaceutics, neuroscience, agricultural and biological sciences, dentistry, immunology and microbiology, and earth and planetary science. Chatbots are widely used in the subject areas of social sciences with 155 publications, computer science with 136 publications, and medicine with 115 publications.

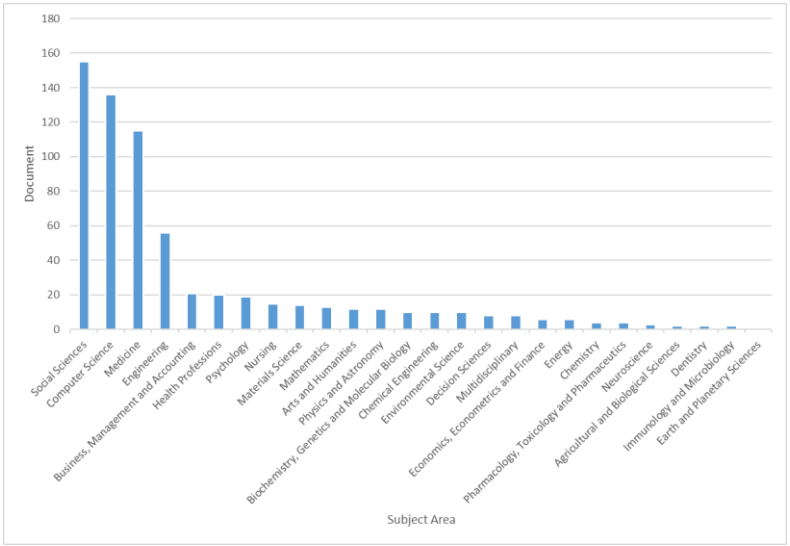

Figure 4. Distribution of research subject areas regarding chatbots in education.

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Previous studies that have used chatbots in the education sector include:

(i) Mathematics

Supriyadi and Kuncoro (2023) conducted research on a comprehensive picture of the future of mathematics teaching from the perspective of using AI chatbots in the form of ChatGPT. Supriyadi and Kuncoro (2023) in their research show that the integration of AI technology in the form of chatbots in mathematics learning can provide personalized learning experiences, blended learning environments, and computational thinking, data literacy and statistics.

Laksana & Fiangga (2022) show in their research that chatbots in the education sector can be developed to create interactive quizzes & automatic questions and answers, as well as as a medium that can provide information instantly according to what the user requests at any time and can be accessed via smartphone. or computer. Research by Laksana & Fiangga (2022) shows that chatbot media can attract students' interest in learning mathematics and is suitable for use in learning material on three-variable linear equation systems.

(ii) Physics

Riabko *et al*. (2023) in their research regarding the process of creating and testing physics problem solving algorithms implemented in chatbots that teach how to solve general physics problems. Riabko *et al*. (2023) shows that students who study physics and those who do not use chatbots have an insignificant difference in the level of problem-solving skills.

Additionally, Küchemann *et al*. (2023) used chatbot technology, namely ChatGPT, in the development of physics assignments by prospective teachers. The research results of Küchemann *et al*. (2023) showed no difference in task accuracy, but students who used the textbook achieved higher clarity and more often put their questions into a meaningful context. Meanwhile, students who used ChatGPT to pose problems rated the usability of the system as high but experienced difficulty with the quality of the output. These results provide insight into the opportunities and constraints of using large language models in education.

(iii) Chemistry

Mahroof *et al*. (2020) conducted research on the use of "Edubot" which acts as a solution to the research gap by providing an AI-based chatbot platform that can self-learn and self-evaluate for Ordinary Level students in the Chemistry domain. The findings of research conducted by Mahroof *et al*. (2020) show each Edubot has been implemented to support independent learning and self-evaluation, targeting ordinary level chemistry subjects.

Clark (2023) conducted research on the use of the artificial intelligence chatbot ChatGPT to answer questions from a final exam given on general chemistry material with closed and open response formats. Clark's (2023) research results show that chatbots are currently unable to provide reliable answers or explanations to students for many representative exam questions. However, there is potential for chatbots to be used to create assignments where students analyze and improve ChatGPT responses.

(iv) Language

Haristiani *et al*. (2019) regarding the development of a language learning application, namely Gengobot, which is integrated with the MIM LINE service. Gengobot is a chatbot-based grammar dictionary application that contains Level 5 and Level 4 (N5 and N4) Japanese Grammar Proficiency Tests as a database, accompanied by explanations and meanings in Japanese, Indonesian and English.

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In further research conducted by Haristiani & Rifai (2021) regarding the use of a chatbot-based Japanese grammar learning application, namely Gengobot, as an autonomous Japanese language learning medium. The research results of Haristiani & Rifai (2021) show that Gengobot as a chatbot-based Japanese grammar learning medium is an interesting and innovative medium to support autonomous learning of Japanese because students can decide how they learn to use this application to improve their Japanese grammar skills.

In language learning, chatbots have high potential to be used as a language learning medium, both as tutors in practicing languages, and as independent learning media (Haristiani, 2019). Apart from that, language learners are interested in using chatbots because they can be used anytime and anywhere, and are more confident in learning languages using chatbots compared to when dealing directly with human tutors (Haristiani, 2019).

(v) Computer Science

Ardimansyah and Widianto (2021) use Telegram chatbots as online learning media with case studies of programming courses. In research by Ardimansyah and Widianto (2021), it is possible for students to obtain learning by asking questions and answers about programming which can be accessed anytime and anywhere, without having to always be tied to educators. Ardimansyah and Widianto's (2021) research shows that the development of a Telegram chatbot can be an alternative as a learning medium.

Other research regarding the use of chatbots in the field of education in computer science was carried out by Daud *et al*. (2020) regarding the development of a virtual tutoring tool that provides support to students on JAVA programming language issues. This research shows that there is significant output produced by the e-JAVA chatbot (Daud *et al*., 2020). Research conducted by Daud *et al*. (2020) showed that E-JAVA Chatbot helps students understand topics they find difficult to understand by reducing the time needed to get help from a teacher in person and providing appropriate answers to their problems rather than similar code examples from the web.

3.5. Chatbot Applications in Education

Based on the site form https://gurubelajar.id/manfaat-chatbot-sebagai-media-pembelajaran-inovasi-baru-dunia-pendidikan/, there are several benefits of using chatbots in the education sector, including:.

(i) Chatbot as a Learning Media, the use of chatbots as a learning media makes it possible for the learning process to be carried out anytime and anywhere. The chatbot's ability to reply to chats automatically makes it possible for the chatbot to analyze student needs and provide teaching materials that are appropriate and specific to what we are learning.

(ii) Chatbots make it possible to save teachers' time, chatbots can help teachers in supporting the learning process. Chatbots can act as virtual assistants for teachers.

(iii) Chatbots can increase student activity, chatbots can make it easier for students to get material and ask questions when they encounter difficulties during the learning process. Chatbots can also simplify the learning and teaching process as well as communication between teacher and student interactions, student-to-student interactions, information on school and extracurricular activities.

(iv) Chatbots make administration easier, chatbot platforms can help administrative staff to convey information related to administrative matters and the student registration process.

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3.6. Advantages and Disadvantages of Chatbots in Education

Chatbot AI has been one of the effective strategies in the teaching and learning process. Many methods have been suggested to improve the process (Fauziah *et al*., 2021; Suherman *et al*., 2023; Al Husaeni *et al*., 2022). Several examples in the current strategies in teaching and learning are the following:

(i) Mathematics (Dallyono *et al*., 2020; Hashim *et al*., 2021; Ajenikoko & Ogunwuyi, 2022; Akinoso, 2023; Radiamoda, 2024; Husnah *et al*., 2021; Lathifah & Maryanti, 2021; Putri *et al*., 2022; Marasabessy, 2021; Maryati *et al*., 2022; Ogunjimi & gbadeyanka, 2023; Obafemi *et al*., 2023; Mitrayana & Nurlaelah, 2023; Camenda *et al*., 2021; Omolafe *et al*., 2021; Omolafe, 2021; Serra *et al*., 2021; Wijaya *et al*., 2022; Mirzabek, 2023; Awofala, 2023; Awofala *et al*., 2023; Obafemi *et al*., 2023; Awofala *et al*., 2024; Obafemi, 2024; Maryanti, 2021; Jose, 2022; Dermawan *et al*., 2022; Lagcao *et al*., 2023; Awofala & Olaniyi, 2023; Obafemi *et al*., 2024; Awofala & Agbolade, 2024; Padmore & Ali, 2024; Lasisi *et al*., 2024).

(ii) Engineering (Sambudi & Ramli, 2021; Bilad & Prayogi, 2021; Andika & Putra, 2022; Samsuri & Wan Osman, 2024; Harith, 2023; Suherman *et al*., 2023; Wagiran *et al*., 2023).

(iii) Chemistry (Barke & Harch, 2022; Francis & Baba, 2023; Putri *et al*., 2022; Wirzal & Halim, 2022; Barke & Buechter, 2023; Sombria *et al*., 2023; Swafiyah *et al*., 2023; Barke, 2023)

(iv) Biology (Glorifica, 2021; Olumorin *et al*., 2021; Bablola, 2022; Olumorin *et al*., 2022; Hofifah & Sumiati, 2023; Alhassan *et ali*., 2024; Tipmontiane & Williams, 2022; Abdussemiu, 2022; Babalola *et al*., 2023; Ala *et al*., 2022)

(v) Physics (Susilowati *et al*., 2023; Lestari *et al*., 2024; Abosede *et al*., 2024; Ibrahim, 2023; Al Husaeni, 2022)

(vi) Science, Technology, Engineering, and Mathematics (STEM) (Tipmontiane & Williams, 2022; Lestari *et al*., 2024)

(vii) Other Science Education (Al Husaeni & Al Husaeni, 2022; Effiong & Aya, 2022; Maryanti & Nandiyanto, 2021; Mirzabek, 2023; Maryanti *et al*., 2021; Maryanti & Asjjari, 2022; Nursaniah, 2023; Wahab *et al*., 2023; Juhanaini *et al*., 2022)

Different from other strategies, there are several advantages and disadvantages of using chatbots in the field of education.

Advantages from the use of chatbot AI are the following:

(i) 24/7 accessibility, chatbots can provide help and information at any time, allowing students to study outside of class hours.

(ii) Personalization of learning, chatbots can be tailored to individual needs, provide relevant material and support each student's level of understanding.

(iii) Interactive, chatbots can present learning material in an interactive way, through questions and answers, exercises, or games, which can increase student engagement.

(iv) Monitoring the learning process, chatbots can collect data on student interactions and provide insight into their learning progress, allowing teachers to provide additional help in areas where needed.

(v) Efficiency, chatbots can automate administrative tasks such as providing basic information, scheduling meetings, or providing feedback on assignments, freeing up teacher time to focus on more valuable aspects of learning.

Disadvantages from the use of chatbot AI are the following:

(i) Limited language understanding. Chatbots may have limitations in understanding natural language or certain language variations, which can limit effective interactions with users.

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(ii) Losing the human aspect, interactions with chatbots can lose important human aspects, such as empathy and appreciation of the social context, which may be necessary in certain learning situations.
(iii) Limited creativity, although chatbots can be designed to present material in an interactive manner, their ability to stimulate creativity or critical thinking may be limited.
(iv) Level of trust, students may not fully trust the accuracy or credibility of the information provided by the chatbot, especially if they experience errors or inconsistencies with their learning needs.
(v) Technology dependency, reliance on chatbots can reduce students' ability to develop interpersonal or problem-solving skills independently outside of a technological context.

4. CONCLUSION

Chatbots have many benefits in various sectors of life. One of them is that chatbots have several benefits in the education sector. The research results show that research on chatbots, especially in the education sector, is increasingly in demand. In 2023 there will be a drastic increase in the number of studies regarding chatbots in the education sector compared to previous years with a total of 205 publications in Scopus. Chatbots are considered to be an interesting tool to use in education. In addition, the use of chatbots makes it possible to encourage more innovative teaching processes in terms of improving learning processes and outcomes. The use of chatbots is considered to be one of the technologies used to support the learning process, so that students' 21st century skills can be better honed. There are 25 countries that have contributed to related research, with the United States, Australia, United Kingdom, China and Taiwan in the top five. This research also shows that there are 26 subject areas that have used chatbots in the education sector, including social science, computer science, medicine, engineering, business, management and accounting, health professions, psychology, etc.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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