

Original article

Studying Multiple Aspects and Impacts of Chatbots: A Systematic Mapping Study

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Abstract

The usage and deployment of chatbots are increasing in many sectors, such as education and healthcare systems. Those interactive systems are designed to provide automated responses to users 24 hours a day, and are capable of collecting data from users and helping in making decisions. With the stunning emergence of some chatbots recently, for instance, ChatGPT, many researchers have started studying chatbots from different perspectives. Some studies, for example, focus on the usage and deployments, while others investigate evaluation and classification. Despite the fame and great momentum that chatbots are having now, there are still many aspects that have not been studied well. For example, there is a lack of information about its correctness, impact, and best usage in some areas. In this paper, we remove the ambiguity and discover other impacts and characteristics of chatbots in different areas. To answer our research questions, we conducted a systematic mapping study using a search strategy on a well-known database, and then we discussed our mapping results. We identified a final number of 128 papers published between 2018 and September 2023. We observed some trends related to chatbots, like problems with correctness and reliability, besides successful usage and implementation in some areas and sectors. We also discovered some positive and negative influences of chatbots on humans. We believe that our results presented in this paper will be very useful and important where chatbots are being used, whether in the industry or in the scientific field. Overall, more efforts and research need to be conducted on chatbots.

Keywords. Bard, Chatbots, ChatGPT, Interactive Systems, Machine Learning.

Introduction

Conversational applications, such as Google Assistant and Amazon Alexa, are popular around the world due to their many benefits [1]. These applications allow users to interact with devices and services using natural language, which can be more convenient and efficient than traditional methods, and also respond to users with the most appropriate answers [2]. These applications are considered to be interactive applications and artificial intelligence models; they are supplied with the necessary knowledge and the capability to reply to and answer users' questions. Several studies reported successful adoption of chatbot systems in many fields, for instance, in the medical field, they are very helpful in providing users with healthcare suggestions and advice [3]. They are effective at being used to provide aids to patients to track their health, manage their conditions, and connect with healthcare providers [4]. Moreover, chatbots have shown great usage and efficiency when being deployed in learning and education. They can be used to provide educational content and support to students, regardless of their location or time zone [5]. In addition, the chatbot allows users to provide feedback during the learning process, which is immediately incorporated into the content. These results are in a more personalized and effective learning experience [6].

Despite the development of various AI-based chatbot models that aim to provide accurate answers to users, they still have many issues [7], such as understanding complex or nuanced questions and providing accurate and correct answers to questions that are outside of their training data. Besides, there is limited research on the effectiveness of using chatbots in some areas, for example, nursing education. Some studies have found that chatbots can be effective in improving student learning, but others have found no significant effects. More research is needed to determine the best way to use chatbots in nursing education or in any other field [8]. There is also a worry about chatbots' correctness and precision to answers due to some published articles and research arguing about their proficiency and correctness.

Hence, in our research, we conducted a systematic mapping study to limit the gaps in the literature, to try to unveil and remove the ambiguity attached with multiple aspects and impacts of chatbots. So, the primary contribution of this research is to give a comprehensive literature review on different usage and implementations of chatbots, which can be done by answering our research questions. To add more robustness and validity to our research, we added results of some test cases performed with well-known chatbots, which are discussed later in the discussion section.

The rest of this research is organized as follows. Section II presents the related work. Section III presents the overall goal of this paper and our research questions. Section IV shows how the systematic mapping protocol was conducted, whereas Section V presents the results, which are later discussed in Section VI. Finally, Section VII expresses the conclusion of the paper.

To the best of our knowledge, we found some systematic mapping studies done in the literature, but they differ in scope and objectives. Those studies focused on specific domains and topics, for instance, [9] conducted a systematic mapping study on SMS on the usability of chatbots, and work results were classified

based on four criteria: usability techniques, usability characteristics, research methods and type of chatbots. Another SMS research on usability [10], studied and analyzed the user experience evaluation of interactive and conversational systems, where evaluation technologies, such as methods, techniques, models, and others, were applied by researchers and experts to evaluate the usability and experience. The authors identified that chatbots were used to help people in their daily lives, and they also pointed out that conversational systems (CSs) can be used to improve accessibility for people with disabilities. This is because CSs can be designed to specifically address the needs of people with visual or hearing impairments, as well as the elderly and those with Alzheimer's disease.

Other SMS studies focused on the use and deployment of bots in software development. According to [11], based on previous studies, nine activities were identified where chatbots were used, seven benefits of using bots in software development, and seven challenges of using bots for software development. The most popular activities for bot applications in software development are project management, code analysis, debugging, and project onboarding. Another SMS study [12] reviewed 43 original research studies to understand the current state of the art in requirements specification and modeling and analyzed the methodologies, models, tools, and techniques that are used to specify and model requirements in real-world scenarios. The authors' results showed that most of the empirical studies on requirements engineering for artificial intelligence (AI) have focused on autonomous self-driving vehicles and managing data requirements. However, there is a need for further research in areas such as ethics, trust, and explainability. More studies like [13] performed an SMS on software assistants in software engineering. The authors investigated whether assistants like chatbots used by Amazon or Apple can be adopted and deployed in software engineering. They identified 112 research papers as their main samples of the study, and they have noticed a decline in the quantity of research papers presenting software assistants that are complete and immediately usable for tasks related to software design, development, and maintenance. Additionally, the assistants examined in our main studies do not closely match the workflows and preferred programming languages and development environments of software engineers.

Methods

This section presents the methods used to conduct this study. First, the Goals of the research is setup followed by the establishment of the research questions. Then, a systematic mapping protocol is used to develop the search strategy, select the studies, and extract data from the selected publications.

Goal and research questions

Researchers are cautious about chatbots' feedback and their side effects due to the lack of assessments about the impact of chatbots in different aspects. So, a lot of work and research is required to investigate more on chatbots and their usage. The main goal is to investigate multiple aspects of chatbots (correctness and accuracy, their usage in some areas, and their psychological effects). We have developed our research questions based on the main goal of the study.

RQ1. In what areas were chatbots mostly used and tested? This research aims discover and highlight which areas were used and implemented the most. We will try to make a comparison between those areas and discuss their success in some areas, besides why they are not yet deployed much in other areas.

RQ2. What is the impact of chatbots on future learning and education? Since many educational systems and institutions have started to use and deploy chatbots as a modern and low-cost effective way, it is worth studying their effects on learners, for example, on students and on the future of education.

RQ3. How beneficial is the use of chatbots in medicine? We will concentrate on the medical experiments and research where chatbots were part of the system. We will try to reach a conclusion based on what has been done so far in the literature regarding the advantages and effectiveness of chatbots in medicine.

RQ4. How correct and accurate are the answers of Chatbots? The focus here is on studying those CSs in terms of correctness and reliability. To what extent can we trust and rely on their given answers for some questions? We will add some test cases to enrich the answer to this question.

RQ5. Could chatbots have psychological effects on humans? Since dealing with CSs can be done textually or verbally in a clear human language in a conversational frame, there are effects of using them in our real lives. We will focus on what kinds of effects and detail the results of this question. Moreover, we will add some incidents involving people as psychological effects of using chatbots.

To address our research questions, we have conducted a SMS in the literature.

Systematic mapping protocol

A systematic mapping study is a type of secondary investigation that offers a systematic approach and framework for analyzing the research reports and outcomes that have been published, intending to address a specific research question [14,15]. This section presents how we conducted our systematic mapping study, starting from developing our search strategy until the process of data extraction that leads to the research results and answers to the research questions.

Search Strategy

To identify the most relevant search strings and keywords, we first read some initial articles. This gave us a basic understanding of the topic and helped us identify some keywords. Based on this information, we selected the search string that we believed would be most effective. We opted for the following search string: ("chatbot" OR "ChatGPT"). We adopted our search on a well-known database for scientific research (Web of Science Core Collection), and the search string was applied to titles, abstracts, and keywords.

Study Selection

Our study comprised papers published in the period from 2018 until September 2023. The study's Inclusion Criterion (IC) and Exclusion Criteria (ECs) to filter the studies are presented in (Table 1).

Table 1. Inclusion and Exclusion Criteria

Criteria	Description
IC1	Include chatbot or ChatGPT in the title, keywords, or abstract
EC1	Not written in English
EC2	Just mentioning chatbot or ChatGPT as an example, but does not satisfactorily describe any usage or effectiveness
EC3	Do not answer the research's question topic or are not related to them

The Web of Science search yielded 400 studies in total. Initially, we assessed the title and abstract of all potential studies using specific criteria, eliminating those that were only loosely relevant to the topic. Subsequently, we further evaluated the full text of the remaining papers and narrowed them down to our seed set, which consisted of 128 studies.

C. Data Extraction

Information extracted from each paper included standard publication details (such as publication year and authors), responses to specific research questions, and the documented pros and cons associated with certain practices. The data extraction form, presented in (Table 2), outlines the specific details that were collected.

Table 2. Data Extraction Form

Information	Description
Study metadata	Name, abstract, year of publication, Publisher
Learning and education	True or false
Benefits in medicine	True or false
Correctness and effectiveness	True or false
Psychology	True or false

We have created an Excel file to save all the necessary data about the collected studies, and we used it to extract the needed information to answer our research questions. For instance, we classified the papers in the Excel file based on their research area and the research question for which they will answer.

At the end of this section, we try to further clarify our mapping protocol by presenting each step using (Figure 1).

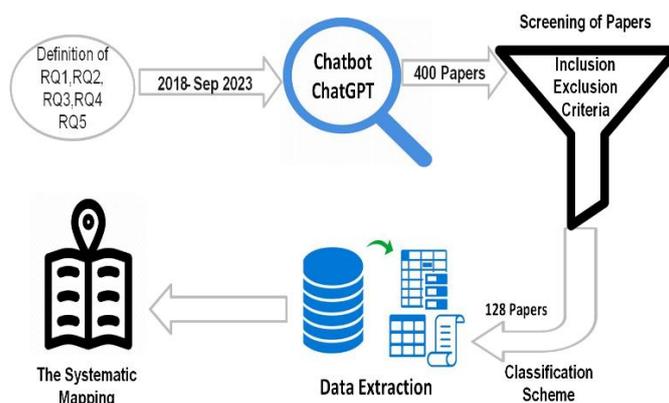


Figure 1. How Systematic Mapping Methodology is Conducted.

Results

In this section, we respond to our research questions derived from the information gathered from the 128 chosen papers, which were selected as part of our mapping study. The list of selected papers is in Appendix A. As mentioned before, the selection process returned papers published from 2018 to September 2023. There has been a concentration of research on this topic in recent years.

RQ1. In what areas were chatbots mostly used and tested?

Fig 2 demonstrates the distribution of research areas reported in the selected papers. As shown in (Figure 2), education and learning research lead with 70 papers, followed by medicine with 45 papers, followed by effectiveness and correctness with 33 papers, followed by psychology with 28 papers. Finally, the least value of the number of papers goes to the business research area. It is important to note that a few papers were classified to more than one area (overlapping), for instance, one was classified in the area of education and medicine as well, because the research involved both teaching and usage in medicine.

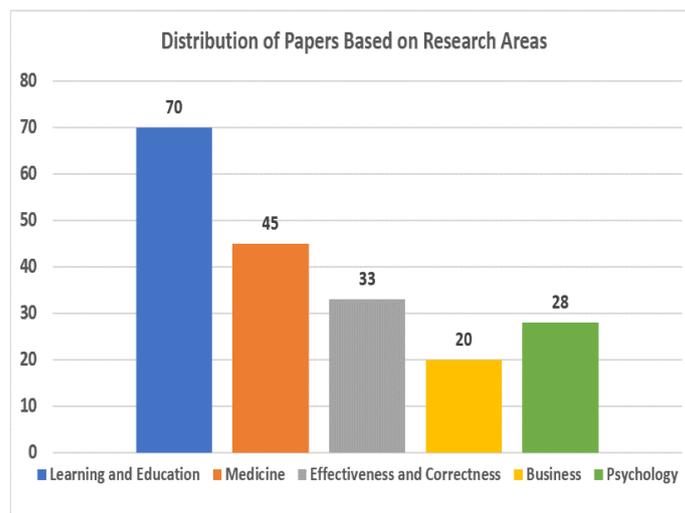


Figure 2. Distribution of Papers Based on Research Areas.

RQ2. What is the impact of chatbots on future learning and education?

A total of 43 out of 70 collected papers discussed learning and education aspects remains after applying the exclusion criteria. Surprisingly, all the selected research papers' results indicated the successful implementation of chatbots in learning and education. The studies ranged from developing new chatbots for the purpose of education, testing them to measure their efficiency, like papers [20,24,33]. To other studies making experiments and comparisons between students' achievements and improvements in learning using chatbots and without, like papers [35,37]. Several outcomes from other studies proved that using CSs in learning is effective, as in the paper [43], where results indicated that participants' writing skills were improved after dealing with a chatbot during an experiment. One more study [47] also recorded that students' learning progress in Chinese language evolved after using a chatbot in the study, [142] conducted an experiment and a survey and showed that ChatGPT can be a helpful and supportive tool in education and research work. [143] discussed using chatbots in teaching and education by using ChatGPT as a case study. The study showed some advantages like the ease of access to information, facilitating complex topics for learners, and reducing the teaching workload. The study demonstrated some pitfalls, such as the lack of wide comprehension, the difficulty of measuring the quality, and the absence of higher-order reasoning skills. (Figure 3) shows the number of research on chatbots for education and learning over the last 6 years.

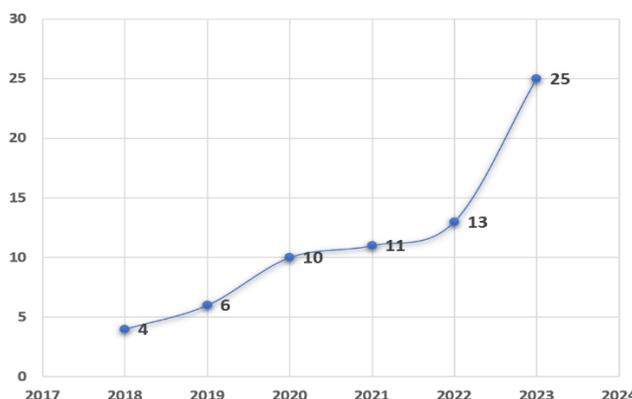


Figure 3. Number of Research on Chatbots for Education in the Last Six Years.

RQ3. How beneficial is the use of chatbots in medicine? 45 papers of ours were concerned with the use of chatbots in medicine. They were mostly experimental studies that test the capabilities of chatbots, for instance, collecting data from patients and providing consultations to both patients and medical staff. Some studies [25,29] tested the usability of chatbots in the medical atmosphere, examined the chatbot responses, and collected feedback from users. Their results showed that implementing CSs in the health sector was beneficial, and the success rate in some studies was about 80 percent. For instance, the results in paper [70] showed that 73.3% of the experiment participants found that the chatbot can help understand multiple health issues and provide a good conversation. The results of papers related to chatbot deployment in the health sector were mostly positive in terms of the ability of chatbots to provide good services and contributions, with potential for expanded capabilities in the medical domain. But other studies, like [139], mentioned some shortcomings regarding the use of this program in the medical field. The study mentioned that despite being informative, the chatbot's limitations include the inability to offer personalized feedback or engage in real-time conversations with patients. As a result, the learning process may be constrained, and surgical patients might face challenges in comprehending concepts or seeking clarification.

RQ4. How correct and accurate are the answers of Chatbots?

A total of 33 collected papers focused on measuring the effectiveness and accuracy of chatbots. Referring to those papers, more specifically paper [26], we elicited that there are major criteria for evaluating CSs: text processing, semantic understanding, and response generation. We also discovered that there are evaluation methods that can be implemented to test CS's correctness and accuracy. Those evaluation methods are categorized into three categories as shown in (Table 3).

Table 3. Categories of Evaluation Methods

Category	Description
Content evaluation	Focuses on the response context from the chatbot,
User satisfaction	A popular method because chatbots are a complex system with no single correct answer
Functional aspect	Any additional method that does not fall into the first and second categories, for example, assisting users in a definite list of tasks like buying a ticket

Other studies like [27] proposed a novel approach for evaluating chatbots using machine learning algorithms to test the quality of chatbots' responses, and it produced very good results. Another study [31] proposed another methodology that connects neuroscientific methods, text mining, and machine learning. The studies in the literature vary and differ from one to another, searching for an optimal solution or methodology for evaluating CSs. Later in the discussion section, we try to expand more by adding some test cases done with chatbots.

RQ5. Could chatbots have psychological effects on humans?

Only 28 papers were related to the psychological impact of chatbots on humans. Research in the literature varied in its approach for measuring emotional effects. Some papers used surveys and experiments to collect the users' feedback, while other studies relied on chatbots themselves to analyze users' responses and produce the results. Regardless of the methodologies used in papers, the results from all papers confirmed that there are influences or effects on humans. Paper [21], examined the influence of three kinds of empathic expression, sympathy, cognitive empathy, and affective empathy, on individuals' perceptions of the service and the CS. The authors discovered that giving priority to demonstrating sympathy and empathy is preferred over offering advice without emotional involvement.

We also noticed in the literature that there are what are called social chatbots; these kinds of chatbots were developed for social purposes only. These types of chatbots integrate enhanced linguistic features that resemble human characteristics. For instance, paper [34] authors proposed a smart social therapeutic CS that distributes the words into emotion labels, and they could discern the emotional state of the current users, such as stress or depression, by resolving and analyzing the chat data of users.

In study [48], the authors developed a social CS and examined its ability in relieving panic symptoms; they ran controlled experiments on participants for a period around four weeks. Their results showed that using a chatbot led to a noticeable decrease in the social phobia score and a significant increase in the control helplessness score. Another study [87,89] studied the possibility of establishing a relationship between chatbots and humans, and they analyzed the human behaviors towards CSs after a specific period and recorded the impact.

Discussion

In this section, we summarize the obtained results, discuss the answers to our questions, and add some case studies to extend and enrich the knowledge about our findings. Through a systematic mapping process, a total of 128 studies related to chatbots published between 2018 and September 2023 were identified. To

address our research questions, we examined these studies, specifically exploring the implementation of chatbots in the domains of education and learning, psychology, medicine, accuracy, and correctness. Additionally, we analyzed the various research areas covered in the collected papers.

By looking at (Figure 1), we can clearly notice that deploying chatbots in the learning and education area has the maximum number of 70 studies among the 128 collected papers. This may refer to the need for such CSs in the educational sector, especially when many studies and experiments in the literature reported successful results and positive indications towards adopting such systems in education. Chatbots worked well in some educational jobs, such as teaching some courses and advising students. Moreover, the willingness to transfer into modern electronic digitized systems for educational institutions. However, substantial work remains to be done for integrating chatbots into their systems. This can also be seen in (Figure 3), which represents the increase in numbers of research studies since 2018 until 2022, which can be considered as a trend towards the use of such systems in learning and education.

The number of research papers related to correctness and effectiveness is 33 papers. Since CSs have recently been used in many areas, the number of evaluation studies is increasing to test their efficiency and correctness. The studies we found in the literature, for example [16,51,76], tested chatbots' effectiveness in experiments where authors recorded CSs impacts and influence. We can say that CSs effectiveness stems from their ability to automate and streamline interactions, enhance customer service, and improve operational efficiency. Regarding CSs correctness, some studies showed an acceptable accuracy rate, like in paper [76]. But the correctness of answers of chatbots is still up for debate. To enrich our discussion and knowledge about the correctness issue, we added two test cases happened with the famous chatbot ChatGPT. In the first test case, we asked ChatGPT a technical question about 6G antennas and also asked for the reference of the answer, as shown in (Figure 4). As you can see, the CS answered the question and summarized the answer into well-organized points and finished its reply with references we requested, as shown in (Figure 5). When we tried to validate the whole answer, we discovered that ChatGPT was pointing to non-existing references (reference 1 and reference 2), while reference 3 exists. We searched everywhere, but there was no matching data at all. Simply, ChatGPT generated two fabricated references, it generated them and included them in the answer to our question. The system was simply hallucinating and generating random data.

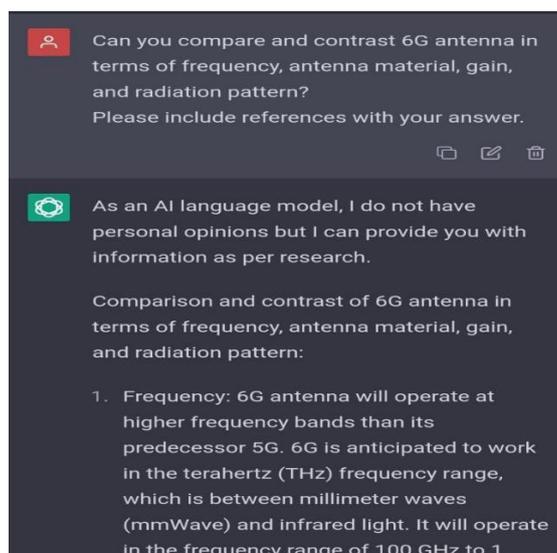


Figure 4. Asking ChatGPT a Question and Part of its Answer.

Another example of chatbots' false answers is the question asked to ChatGPT by journalists of the New York Times magazine: "When did the New York Times first report on artificial intelligence?". The ChatGPT replied with the correct date, but it invented the title of the article as it did with the two references in the previous example. As for the use of chatbots in medicine, most papers reported successful experiments of deploying such an artificial intelligence system in medicine. CSs could achieve a good level of providing health care services, such as being available 24 hours, responding to patients' inquiries, and collecting data. But, till much work to be done, especially on their correctness.

Regarding the psychological impact of chatbots, the 28 collected papers varied and differed in their experiments to measure the emotional effects of CSs. Regardless of the experiment type, it was proven in the literature that chatbots could have impacts on people's behaviors and attitudes. For instance, paper [51] conducted an experiment to motivate smokers to quit and the results were positive.

But the impact is not always positive and does not always have a good result. A case study we use here in our discussion, according Euronews channel on its website, reported that a Belgian man decided to end his life after having conversations with a chatbot named Eliza. It kept telling him more about the end of this planet, making him more upset, which led him into a severe depression in the end.

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Figure 5. The Generated References from ChatGPT.

Conclusion

We gathered data from our chosen papers that focused on various aspects of chatbots, including their accuracy and evaluation, applications in medicine, influence on education and learning, and the psychological effects they have on individuals. Additionally, we examined the specific research areas covered in these papers. Our results show that most papers presented the successful use of chatbots in education and learning; they were mostly about developing CSs and integrating them into educational systems and learning applications. Studies on correctness and evaluation focus more on the usability of CSs and provide a number of methodologies to measure the effectiveness and accuracy, but without paying much attention to the randomly generated data by CSs in some cases, which affects correctness. Another finding is that there are fewer scientific studies on CSs in business or industry. We also found that deploying CSs in medicine field was beneficial, especially when they were used to provide medical services. Many studies in their future works suggest more improvements for CSs to have advanced functionalities. Finally, we noticed that most research studied the psychological impacts on people, but only discussed the positive side of those impacts without referring to their downsides. Chatbot knowledge is limited to the data used during training. It may lack access to the latest information and may not offer a complete grasp of a topic since it relies on data from human-generated texts that are not promptly updated.

Conflicts of Interest

The authors declare no conflicts of interest

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