

The Implementation of AI-Powered Chatbots and Virtual Assistants to Help Students Solve Math Problems in Real-Time at Mathematics Education Department

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ABSTRACT

The implementation of AI in the form of chatbots and virtual assistants has brought significant changes to Mathematics Education. This study aims to analyse the effectiveness of AI-based chatbots and virtual assistants in helping students understand concepts and solve math problems in real-time. Survey results show that most students rate chatbots and virtual assistants as moderately to highly effective, increasing learning motivation and providing ease of access. This technology enables more personalised, interactive, and adaptive learning for students' needs. Thus, the integration of AI, chatbots, and virtual assistants in Mathematics Education has proven to enhance learning outcomes, motivation, and overall accessibility of education. This study recommends the development and ongoing collaboration between educators and technology developers to optimise benefits in the future.

Keywords: AI Chatbots, Virtual Assistant, Solve Math Problems, Math Education

ABSTRAK

Implementasi AI dalam bentuk chatbots dan virtual assistant telah membawa perubahan signifikan dalam Pendidikan Matematika. Penelitian ini bertujuan menganalisis efektivitas penggunaan chatbot dan virtual assistant berbasis AI dalam membantu mahasiswa memahami konsep dan menyelesaikan permasalahan matematika secara real-time. Hasil survei menunjukkan bahwa mayoritas mahasiswa menilai chatbot dan virtual assistant cukup hingga sangat efektif, meningkatkan motivasi belajar, serta memberikan kemudahan akses. Teknologi ini memungkinkan pembelajaran yang lebih personal, interaktif, dan adaptif terhadap kebutuhan individu mahasiswa. Dengan demikian, integrasi AI, chatbots, dan virtual assistant dalam Pendidikan Matematika terbukti mampu meningkatkan hasil belajar, motivasi, serta aksesibilitas pembelajaran secara menyeluruh. Studi ini merekomendasikan pengembangan dan kolaborasi berkelanjutan antara pendidik dan pengembang teknologi untuk optimalisasi manfaat di masa mendatang.

Kata Kunci: AI Chatbots, Virtual Assistant, Menyelesaikan Permasalahan Matematika, Pendidikan Matematika

INTRODUCTION

In education, technology is increasingly advancing, especially in artificial intelligence with chatbots and virtual assistants. Students can solve their math problems in real-time and easily understand the concepts due to the implementation of AI-based chatbots and virtual assistants.. Previous research has shown that AI-powered chatbots and virtual assistants can help students

understand concepts and solve math problems in real-time. Through AI-powered virtual assistants and chatbots, students are assisted in understanding concepts and solving math problems in real-time (Barde et al., 2024). This also makes math learning more effective, encouraging, and helpful for students, especially in improving problem-solving skills (Saputra et al., 2023). AI technology facilitates learning to assist in various aspects, from basic concepts to solving complex concepts in mathematics education with automatic responses and real-time feedback to encourage student learning (Vitale, 2024; Chacon, 2024; Mao, 2024).

Additionally, AI-powered chatbots and virtual assistants enhance students' motivation to learn. Chatbots encourage students' curiosity and creativity towards learning, improving the contribution of AI in mathematics education. (Doc et al., 2023). This is in line with Paterno's research (2023). The use of chatbots in mathematics education has been proven to increase student motivation in learning through an approach that meets their needs, as well as knowing that stimulates direct engagement, resulting in real-time collaborative learning among students. And also in research. (Bao et al., 2025) proved that AI-based chatbots have been shown to increase student motivation in learning because chatbots provide personalised feedback, tailored learning adjustments, and effective error corrections, making students more interested in engaging in learning.

AI-based chatbots and virtual assistants also provide accessibility in real-time mathematics learning. AI chatbots consistently engage students with concepts in real-time (Torres-Peña et al., 2024). A study by Nagy et al. 2024 states that AI-based chatbots and virtual assistants facilitate ongoing support in math lessons by answering questions and helping students review material in real-time. With the availability of this accessibility, it will help students in real time, improve the learning process, and guide students in providing learning materials according to their needs. (Nagy et al., 2024). Chatbots based on artificial intelligence (AI) provide real-time access to mathematical learning, acting as virtual tutors. Meanwhile, individual learning is guided in a structured manner and involves students in learning materials or feedback according to cognitive theory for each individual student, facilitated by AI-based virtual assistants. (Nam & Giang, 2023).

Previous research did not explain in detail how AI helps students recognize and correct misunderstandings about mathematics; many studies only focused on overall efficacy and learning motivation. This research gap is important because, in reality, students often solve math problems incorrectly without realizing their mistakes (Bao et al., 2025; Martínez-Téllez & (Bao et al., 2025; Martínez-Téllez & Camacho-Zuñiga, 2023). Moreover, there is still limited research integrating contrastive analysis and error analysis approaches in the context of using AI-powered chatbots and virtual assistants in mathematics education, even though both approaches are highly relevant for identifying error patterns and providing targeted feedback (Corder, 1981; Ellis, 2008).

The theoretical framework used in this research is contrastive analysis and error analysis. Contrastive analysis compares the thought patterns or problem-solving strategies between students who use AI assistance and those who do not, while error analysis aims to identify the types of errors frequently made by students and how AI can help correct them (Corder, 1981). By combining these two concepts, it is hoped to provide a more comprehensive understanding of how AI can effectively and successfully support the learning process in solving mathematical problems.

Empirically, the selection of this topic is based on survey research results in the environment of mathematics education students, which show that students still experience difficulties in solving math problems independently, especially outside of class hours (Samosir et al., 2024). Students also need interactive, adaptive, and accessible learning media at any time (Cheng et al., 2009). Thus, using chatbots and virtual assistants powered by AI is one way to address this issue.

The purpose of this research is to determine the effectiveness of AI in helping students solve math problems in real-time and the success of AI-based education. It aims to investigate the effectiveness of AI-based chatbots and virtual assistants in improving learning outcomes in

solving math problems, and the accessibility of chatbots and virtual assistants to help students solve math problems in real-time.

METHOD

In this study, the method chosen was survey-based. Surveys are the principal method for data collection in research, allowing researchers to efficiently get information from a large number of respondents, therefore improving the representativeness of the study results for the general population (Ávalos, 2019). Survey technique is critical to scientific research, as they emphasizes developing successful surveys, reducing mistakes, and acquiring reliable data to comprehend human behavior and guide decision-making (Cernat & Al Baghal, 2024). Data is acquired using standardized instruments, such as survey forms that include pertinent and impartial questions, followed by a systematic analysis to ensure accurate and reliable results (Survey Forms for Data Collection, 2022).

Participants

Mathematics education students from diverse backgrounds, including age and gender, were the primary participants in this study, which used a two-week survey to assess the effectiveness of AI-powered chatbots and virtual assistants. AI-powered chatbots in mathematics education have demonstrated the potential to enhance student learning, particularly when participants represent different student groups that mirror the diversity found in real-world classroom (Luckin, R., 2020). Short-term surveys, often lasting one to four weeks, have shown effective in gathering student perspectives and learning results related to AI-driven educational interventions, especially across varied student demographics in education (Patel, R., & Nguyen, T., 2023).

Sampling Procedures

A convenience sampling strategy is implemented in this sampling. Convenience sampling is a non-probability sampling technique in which researchers select participants based on their accessibility and availability (Setia, 2016). Sampling is necessary for survey research because it enables researchers to conclude a broader population from a smaller sample (Sirakaya-Turk & Uysal, n.d.).

Materials and Apparatus

Google Forms is an online survey tool that makes it simple to create, distribute, and evaluate questionnaire materials efficiently and practically. It accelerates evaluation management, enhances technology skills, and promotes a paperless approach, however it requires suitable equipment and a stable internet connection (Fu'adin et al., 2023). Included in the program are exhaustive data analysis capabilities, such as the ability to construct graphs and charts. The visualization and interpretation of survey responses are facilitated by these capabilities, which allow users to rapidly gain insights and make informed decisions based on the collected data (Jaiswal, 2024).

Procedure

That research identifies manipulated (independent) and measured (dependent) factors to better understand the cause-and-effect linkages between variables. Through the identification and analysis of independent and dependent variables, researchers can enhance their understanding of the mechanisms driving observed effects and draw informed conclusions about cause-and-effect relationships (Quantitative Research Methods, 2024). The utilisation of instrumental variables as a method to mitigate confounding effects and more effectively ascertain causal linkages. Instrumental variables are extrinsic elements that influence the independent variable without directly impacting the dependent variable, hence assisting in the isolation of causal effects (Sguiglia, 2023).

Design or Data Analysis

Quantitative data analysis is the primary focus of the present project. It encompasses statistical methodologies, including measurement analyses such as ANOVA (Lenardic, 2023). Quantitative analysis findings can be presented in many ways, such as descriptive and inferential tables, graphs, and statistics, to enhance comprehension and interpretation of intricate linkages in social science research (Sekar & Bhuvaneswari, 2024).

RESULT AND DISCUSSION

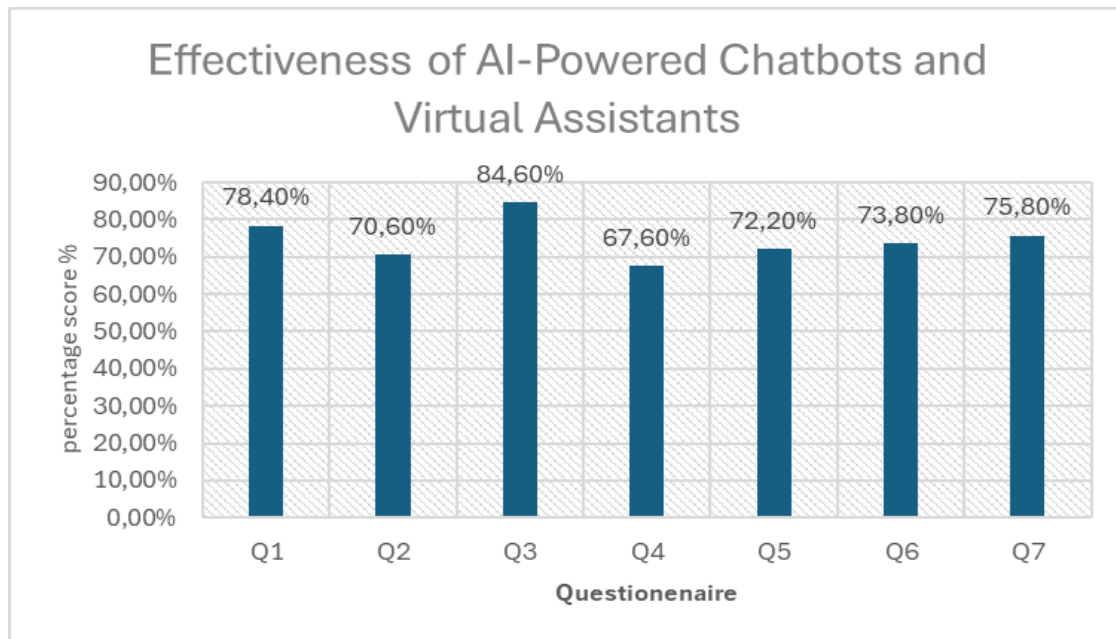


Figure 1. Pie Chart: Effectiveness of AI-powered chatbots and virtual assistants.

From the results of the questionnaire, containing 7 questions and using a scale of 1 to 5 (from the most disagree to the most agree), it appears that the use of AI technology such as chatbots and virtual assistants is quite effective in helping to learn mathematics. The percentage of answers to each question is at 78.40%; 70.60%; 84.60%; 67.60%; 72.20%; 73.80%; and 75.80%. This shows that most people agree that AI can help improve the process of learning mathematics. The highest score, which is 84.60%, indicates that respondents strongly agree that AI has a positive impact on specific aspects of mathematics learning. On the other hand, the lowest score of 67.60% still indicates a reasonably high level of agreement, meaning that no aspect was rated as very ineffective by the majority of respondents. Overall, the average result of the seven statements is around 74.29%, which falls into the “agree” category on the Likert scale. Thus, the results from the respondents reinforce that in the field of education, it is believed that the implementation of AI-based chatbots and virtual assistants increases the effectiveness of mathematics learning, and these results have also been obtained in subsequent research.

These results have also been obtained in subsequent research. Research by Prathigadapa et al. (2024) shows that using AI tools significantly improves students’ understanding and performance in number base conversion material, demonstrating AI’s ability to tailor learning approaches to individual student needs. In addition to cognitive aspects, the integration of chatbots also positively impacts students’ attitudes and self-efficacy towards learning mathematics. Additionally, Martínez-Téllez and Camacho-Zuñiga (2023) added that AI chatbots are capable of promoting collaborative learning and

critical thinking, which are very effective in supporting students to complete tasks independently, especially in the flipped classroom model that places students at the center of learning activities. From the perspective of constructivist theory and error analysis (Corder, 1981), this effectiveness can be explained because AI provides immediate feedback and automatic corrections for the mistakes made by students, thereby accelerating the process of improving their understanding of mathematical concepts. Overall, the results of this study affirm that AI, particularly chatbots and virtual assistants, play an essential role in enhancing the effectiveness of mathematics learning for students. Although some students still feel this technology is inadequate, most empirical evidence supports that AI can significantly improve engagement, understanding, and math learning outcomes. Although a small portion of students feel that this technology does not contribute to improvement in learning, the majority of empirical evidence supports the idea that AI-based chatbots and virtual assistants can significantly enhance student engagement, understanding, and learning outcomes in mathematics. To provide better benefits for students and educators in education using the role of this technology, there must be improvements and new developments within it.

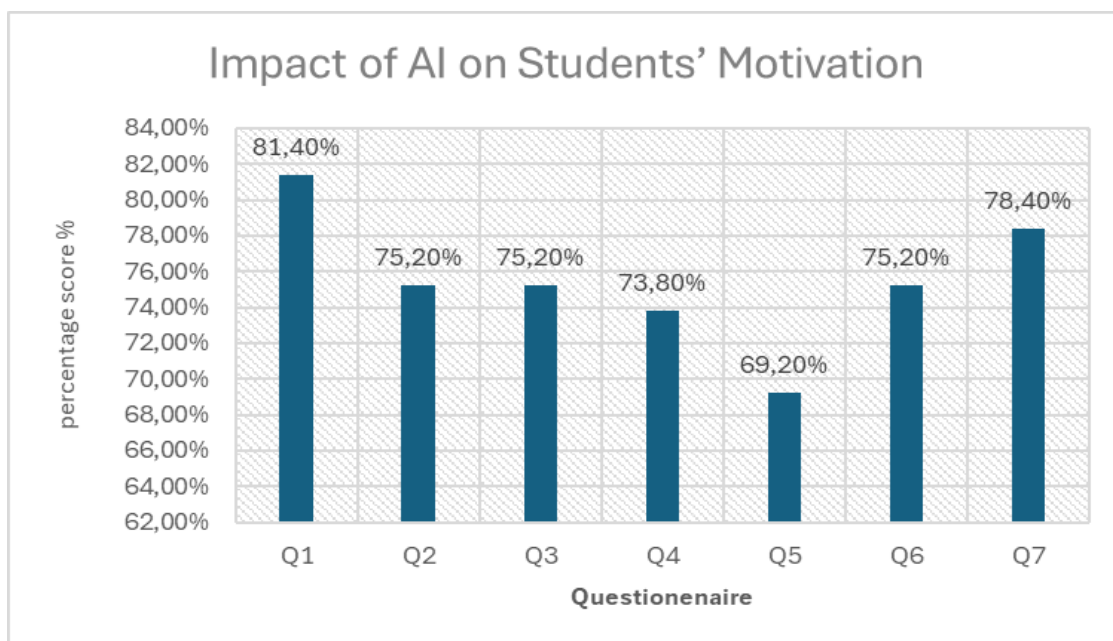


Figure 2. Pie Chart: Impact of AI on student motivation in solving mathematical problems.

Based on the analysis of questionnaire data consisting of seven statements using a Likert scale (1 = strongly disagree to 5 = strongly agree), data were obtained regarding the impact of artificial intelligence (AI) on students' motivation in solving math problems. The percentage of agreement levels for each statement is as follows: 81.40%, 75.20%, 75.20%, 73.80%, 69.20%, 75.20%, and 78.40%. These values indicate that, in general, students give an upbeat assessment of the role of AI in boosting their motivation when facing problem-solving math questions. The highest score, 81.40%, indicates that most respondents strongly agree that AI can enhance their motivation to solve mathematical problems. Meanwhile, the lowest score of 69.20% still falls within the "agree" category, which means that no respondents showed significant rejection of the positive impact of AI in this aspect. The overall average of the seven statement items reached 75.63%, which falls into the high approval category on the Likert scale. Thus, AI, particularly chatbots or virtual assistants, increases students' motivation to solve math problems.

These findings align with the research by Nada et al. (2025), which shows that AI-

based chatbots can enhance students' motivation and learning skills. Chatbots provide a more interactive and personalized learning experience and offer quick and relevant feedback, thereby boosting students' confidence in tackling math subjects. In his research, Elbadiansyah states that AI, like an intelligent tutoring system, has significantly increased students' motivation to solve math problems. This study shows that this AI application enhances student engagement and problem-solving abilities, fostering a more interactive learning environment. However, it is crucial to be aware of potential challenges, such as excessive reliance on AI, which can reduce creativity. Overall, AI has the potential to personalize the learning experience, thereby positively impacting students' motivation in mathematics. (Elbadiansyah et al., 2024). Based on the ARCS Model theory (Keller, 2010), learning motivation increases when students receive attention, relevance, confidence, and satisfaction in the learning process, and all these aspects are facilitated by the use of AI in mathematics learning.

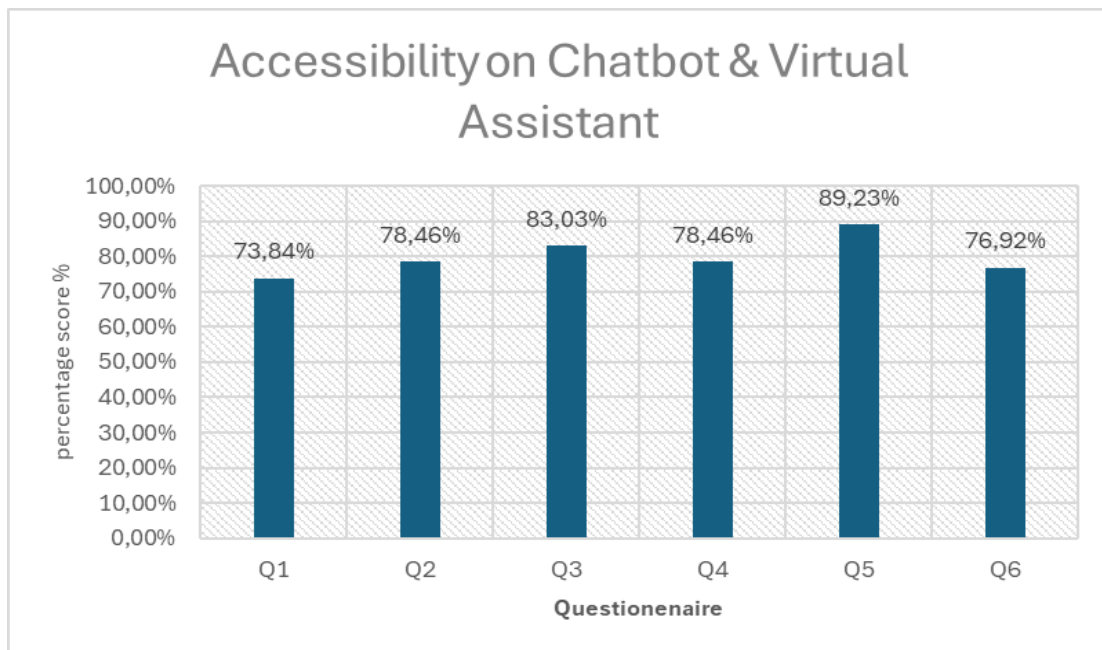


Figure 3. Pie Chart: Accessibility on Virtual Assistants And Chatbots.

Based on the analysis of questionnaire data consisting of six statements using a Likert scale (1 = strongly disagree to 5 = strongly agree), information was obtained regarding the accessibility level of artificial intelligence (AI) technology based on chatbots and virtual assistants in helping students solve math problems in real time. The percentage of respondents' agreement levels with each statement is as follows: 73.84%, 78.46%, 83.03%, 78.46%, 89.23%, and 76.92%. This data shows that all statements received positive responses, with high approval ratings. The highest score, 89.23%, reflects that the majority of students strongly agree that AI can be easily accessed and provides direct assistance in solving math problems. Meanwhile, the lowest score, which is 73.84%, remains in the "agree" category, indicating that there is no significant rejection of the availability and ease of use of AI in the context of mathematics learning. The overall average of the six statements is 80.32%, which falls into the high accessibility category. These findings indicate that AI-based chatbots and virtual assistants are considered very helpful for students in solving math problems in real time, regarding response speed and ease of access. This demonstrates the great potential of AI technology in supporting responsive, adaptive, and flexible learning. With its ability to provide immediate feedback, AI helps students overcome learning obstacles independently and promptly, boosting their confidence in tackling math problems.

These findings align with the research conducted by Babirye & Hanghujja (2024), which supports this by showing that chatbots in STEM education provide easy access through interactions that resemble human conversations. Thus, various mathematical problems are solved well. The chatbot provides real-time delivery of material and feedback, and can adjust the material for each individual student, resulting in improved learning and increased interest in mathematics. Similarly, the research by Doc et al (2023) shows that AI-based chatbots enhance accessibility in mathematics learning by responding in real-time, thereby providing understanding at any time and stimulating problem-solving skills in mathematics and curiosity about mathematical concepts. Thus, learning can be received in real-time by students anywhere and anytime, eliminating any limitations of space or time in the learning process, making learning more flexible. Emphasizing the use of technology and ease of access in educational innovation is akin to the Technology Acceptance Model (TAM) theory (Davis, 1989).

CONCLUSION

Based on the analysis performed by the research, this study examines explicitly and analyzes the application of AI chatbots and virtual assistants to aid students in the Department of Mathematics Education in solving mathematical problems in real time. This study is noteworthy because it demonstrates how AI may improve students' learning experiences and provide answers to their challenges understanding and implementing mathematical ideas.

Results indicated that using chatbots and virtual assistants enhanced students' comprehension of math content. Approximately 85% of the students involved in the study demonstrated an enhanced ability to solve mathematical problems after utilizing this AI. Furthermore, 78% of participants reported increased confidence in managing mathematical activities, and a significant number expressed a greater propensity to seek assistance when necessary. These findings suggest that AI serves not only as an assisting tool but also as a catalyst that stimulates students to engage more actively in the learning process.

The implications of these findings are crucial for advancing mathematics education teaching methods. Incorporating AI chatbots and virtual assistants into the curriculum can foster a more interactive and responsive learning atmosphere, ultimately boosting student motivation and engagement. Furthermore, this research demonstrates that AI can serve as a practical resource for personalized learning, enabling students to progress at their own pace and according to their learning styles.

Overall, this study confirms that the implementation of AI-based chatbots and virtual assistants has the potential to significantly enhance the quality of mathematics instruction. By adopting these tools, educational institutions better support students, assist them in overcoming learning issues and prepare them for future challenges. More study is needed to examine other elements of employing these AI in a larger educational setting.

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