

TEACHING MATHEMATICS WITH THE AID OF AN AI CHATBOT FOR IMPROVING MATHEMATICAL THINKING SKILLS IN TERTIARY INSTITUTIONS IN GOMBE STATE.

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ABSTRACT

The researcher in this study analyses AI chatbots in order to facilitate the mathematical thinking capacity of tertiary students at Gombe State, Nigeria, which has low resources and a large number of students, in a region with limited resources. It was primarily aimed at identifying whether AI chatbots can help to improve problem-solving skills and develop interest in mathematics under problematic conditions. The quasi-experimental study design was deemed to have two groups, i.e. one treatment group (TE), which involved the use of AI chatbots, and another control group (CO), which involved the use of the traditional instruction. The data collection methods in the measurement of the performance and engagement were pre-test and post-test, student questionnaires, and system logs. The findings show that AI chatbots were more effective in enhancing the problem-solving capabilities and reasoning among the students, and this implies that AI-based personalized learning can lead to the high level of improvement in the area of mathematics. The article demonstrates the potentials of the AI chatbots to eliminate inequality in education particularly when such resources are limited and defines their capability to provide personalized learning in mass scale.

Keywords; Quasi-Experimental Design, AI Chatbots, Tertiary Education

1. Introduction

1.1 Background of the Study

The growing trend of artificial intelligence (AI) implementation in education is fast catching up. Today, many schools are employing AI-powered chatbots that teach kids Mathematics. Due to the change in curriculum, there are new ways for individual instruction and to learn maths so that student performance can be improved which would help in developed countries (Ott et al., 2021). As noted by Kaya & Yavuz (2025), challenges such as lack of participation, feedback lag, and variations in the speed of learning by students can be resolved through interaction with AI tools such as chatbots or generative AI. Tools like ChatGPT, HuggingChat, and Google Bard are taking personalized learning to the next level. Furthermore, they help to make interactions at scale much more dynamic and effective (Chukwuere, 2024; Yoon et al., 2024). We may just be starting to use it, but this technology has a future.

AI Chatbots are "objects to think with" that encourages students to think reflectively and critically for problem-solving in complex situations with STEM.

As per Vasconcelos and Santos (2023) these tools make students launch exploratory dialogues around mathematical objects. In addition, Yunianto et al. (2024) mention that AI chatbots can develop computational thinking skills which are very useful in learning mathematics. Though the educational technologies are growing fast in the market, still not much work has been done in the literature which shows the use of AI chatbots on students' mathematical problem solving skills along with gender difference study. The elucidation aims to investigate the role of AI chatbots in the development of advanced mathematical thinking skills among students of Gombe State, Nigeria which is an educationally disadvantaged region (PLFS Data of India, n.d.).

This study looks at how math problems can be assigned to AI chatbots to help students solve them in classrooms faced with problems like scarcity and overpopulation. The findings would help in the ongoing discussions on the use of AI in tackling social issues, including educational equity (Digital Divide, Artificial Intelligence, and Women's Labour Inequality in India: Evidence from PLFS Data, n.d.). The study aims at finding out if the AI chatbots can link the concepts of maths and physics to enhance the learning experience and performance of the students while bridging the digital divide and inequities in education quality (Lademann et al., 2024; Digital divide, Artificial Intelligence and Women's Labour Inequality in India: Evidence from PLFS Data, n.d.).

The objectives of this study is to investigate how the adoption of AI to improve the quality of learning can aid educational development in Gombe State, Nigeria (Patero, 2023). AI chatbots, according to Du et al. (2025) and Qawqzeh (2024), are excellent ways to promote critical thinking and problem solving. However, careful management of any AI tool is essential to avoid restricting critical thinking and deep learning in education.

Although AI chatbots can help improve student performance and boost engagement, it does have its share of challenges. One worry is that AI can limit thinking as it's trained on certain data sets, which can be biased. Because of this, application of AI systems must be ethical to prevent undesired results (Davar et al, 2025; Alvarez, 2024). Also, evidence from PLFS data in India indicates how digital divide, AI and women labour differences are causing disparities in education as well. (Digital Divide, Artificial Intelligence, and Women's Labour Inequality in India: Evidence from PLFS Data, n.d.).

The aim of this study is to determine to what extent AI chatbots can enhance higher-order thinking skills (HOTS) in mathematics to address students' difficulties in under-skilled classrooms. The study will show how AI, as a "co-pilot, tutor, and assistant" in STEM education, can help underprivileged students in developing countries (Borovsky et al., 2024). In the end, the goal of the study was to see how AI Chatbots can help boost students' Math Reasoning and offer tech-enabled solutions to education's structure-constrained problems in disadvantaged settings.

Students will receive the same personalized learning strategies that are generally used in the best educational institutions through AI.

1.2 Statement of the Problem.

In Gombe State, Nigeria, many teachers in junior secondary school are discouraged from effective instruction delivery due to large class sizes.

These issues limit students' problem-solving and mathematics thinking abilities. While AI chatbots can improve educational outcomes, little is known regarding their effectiveness in improving mathematical reasoning in less-resourced districts. The study will investigate how using AI chatbots can help to overcome these challenges and enhance the improvement of the mathematical thinking skills of university students in Gombe State.

1.3 Objectives of the Research.

- I. The study assessed the impact of AI chatbots on enhancing the math reasoning abilities of students in higher institutions in Gombe State, Nigeria.
- II. This research will compare the effectiveness of the AI chatbots and the traditional public education tool in mathematics learning.
- III. This study investigates how AI chatbots affect the math, problem solving, and critical thinking skills of students.
- IV. The research will aim to improve AI chatbot functions in the context of larger educational tasks, such as educational administrators and personalized learning agents who offer personalized learning assistance.

1.4 Research Questions.

- I. In which ways can AI assist students to develop their reasoning skills in Mathematics?
- II. In what ways can AI chatbots assist students in effectively solving mathematics?
- III. Are AI chatbots better than conventional teaching strategies in backing student learning?

1.5 Significance of the Study

The study shows how and AI chatbots can help bridge the gap of mathematics teachers in Gombe State. AI chatbots can improve students' mathematical thinking, problem-solving, and motivation through personalized learning. The study's findings can help reform the educational system of the region as well show how the deployment of AI can enhance educational benefits. This technology could bridge learning gaps and further improve educational outcomes in the state (Giam, 2023).

1.6 Scope and Limitations.

The federal colleges of Education in Gombe state will be the study targets such as Federal College of Education, gombe. The research will focus on using AI chatbots in the math course. Poor or no internet connectivity limits this research, and so may impact the accessibility to the AI Chatbots in places. Gombe State is a low-resource setting that faces an acute problem with this. AI chatbots can enhance maths reasoning. However, they might ignore matters affecting teaching in other subjects like English or Science.

2.AI Chatbots in Education: A Literature Review.

2.1 The role of AI Chatbots in Education.

Nowadays, the application of Artificial Intelligence (AI) to education is gradually growing. It is also transforming the way students are interacting with academic material and conducting learning processes. Some examples of effective AI chatbots include ChatGPT created by AI, AI created by Perplexity, and AI created by Meta that provide customized learning experiences. Chatbots lead to customized learning. They break the previous barriers to education. The classroom is overcrowded. The resources are also minimal (Labadze et al., 2023, Gokcearslan et al., 2024). They are accessible to students because they can be accessed on social media such as Facebook and WhatsApp. Additionally, they are an effective and affordable way of learning due to the little internet facilities present in the places where they are used by students (Labadze et al., 2023). Such AI-powered systems do not only assist in solving challenging problems, but they also learn adaptively by doing more personalized teaching. Therefore, AI chatbots are capable of enabling students to study programming and challenging ideas, therefore, enabling them to overcome the stifling effect of traditional learning tools (Pereira et al., 2023). The systems can be accessed on the social media platforms and are more user-friendly. These systems are used in regions where the internet is affordable and untrustworthy. Besides, chatbots can also be used as online tutors and provide feedback to a learner in real-time, which creates a favorable and interactive environment (Davar et al., 2025).

2.2 The Impact of AI Chatbots in Higher Education

The adoption of AI chatbots in higher education is receiving a massive boost with the entry into the industry of generative AI like GPT-4, the AI of Perplexity and Meta. You ought to summarize and put it in your own words and original writing. AI chatbots are capable of adapting to the pace of individual student learning and assisting the student in solving problems and providing them with immediate feedback. Moreover, such utilities as Perplexity and the chatbot provided by Meta fit perfectly well with services such as Facebook and WhatsApp, which are used by students worldwide. They also require less data to use, and their application is more appropriate in the

region with poor internet connectivity, as well as reduces the costs of AI-powered education even more (Khan et al., 2025).

These chatbots are capable of generating human-like text responses and they can perform complicated tasks but at a very high speed. It demonstrates tremendous advances in language processing and artificial intelligence (AI) (Schei et al., 2024). These tools allow students to engage in on-demand learning using the popularity of the WhatsApp application that lets them talk to chatbots, solve problems and seek clarification on difficult concepts in a more conversational way without requiring any advanced computing equipment (Liang et al., 2025). The generative AI chatbots such as ChatGPT, HuggingChat, Google Bard can offer affordable and customized support to both learners and educators, which can assist in reducing the lack of money, which is a widespread resource problem in the education industry (Chukwuere, 2024).

The most recent studies on big language models have resulted in chatbots interpreting user motives and engaging in dialogue, along with realistic personalized feedback in an active learning setting. AI chatbots are a growing and viable platform of adaptive learning that provides interactive tutorials and research support based on the student. AI technologies can be used in developing quality learning experiences that are individualized and based on the learner. In this way, education can be modernised with the help of AI-enhanced solutions (Baig and Yadegaridehkordi 2025; Bayly-Castaneda et al. 2024; Binhammad et al. 2024). In addition, the AI tools are easily accessible, simple to use, and more affordable than human tutors, which improves accessibility and increases the capacity to identify fraud (Birenbaum, 2023).

2.3 The Use of AI Chatbots in Educational Institutions

Throughout their lifetime, AI chatbots have evolved beyond mere answer-query interaction platform to form important components of the educational ecosystem of an educational establishment.

Mathematically, in the case of the axiom of choice, where n is the integer under question, then n is the integer under question. These algorithms are used to reproduce human interaction and make the students learn by making errors and receive feedback in a student-friendly atmosphere to resolve the problems. It would allow the students with an alternate learning style to connect more with the material covered in the subject, thereby allowing them to learn more about difficult subjects and develop stronger critical thinking and problem-solving skills (Chukwuere, 2024; Thuy et al., 2024).

The significant benefit of applying AI chatbots to a teaching process is that they are flexible to the styles of learning. These tools enable students to work at their own speed with no limitations of a teacher who dictates the situation. The information that these chatbots ingest in Facebook Messenger and WhatsApp is very little and thus makes them cheap particularly to students in resource challenged regions with unreliable internet networks (Davar et al., 2025). Furthermore,

the AI tools can analyze the data on the student performance to help them find out the areas of weakness, provide personalized advice, and adjust the difficulty degree of the assignment where necessary (Alqahtani et al., 2023).

Systems based on AI are designed to self-evolve following the interaction with the students and increase their capability to deliver a personalized learning experience. By analyzing the answers of students, the AI Chatbot may modify the level of a task or provide recommendations to students. This will provide an effective learning process and cement intellectual independence of students (Jian, 2023). Such flexibility assists the students in studying advanced things and promotes a better comprehension of the material (Favero et al., 2025).

2.4 Phased Integration of AI Chatbots in Education

Although AI chatbots can be a new addition that positively impacts the learning process, their deployment should be gradual. The schools can begin to apply AI chatbots to some of their studies such as mathematics where they are able to assist in finding some solutions to some of the mathematical problems and also to support some of the fundamental concepts. In this way, the effectiveness of AI-created materials can be measured by the educators on the basis of the student engagement and cognitive burden before its large-scale spread (Vasconcelos and Santos, 2023). A gradual procedure is adopted so that the AI tools can be well incorporated in the learning processes without ousting the conventional system. It will also assist in adjusting the curriculum and the teaching practice to it (Lademann et al., 2024).

The slow introduction of AI chatbots also gives room to the reduction of biases in the AI models through active learning and self-supervised methods to encourage more fair access to personalized learning (Ryan, 2023). Moreover, the approach would allow teachers and students to receive training on ethical successful application of AI tools, and assist them in learning energy appraisal skills whenever they are working with AI generated results (Alvarez, 2024). Such slow introduction will also be useful in the creation of responsible AI usage policies and incentive systems that will favor systematic training instead of the use of direct responses (Singh et al., 2024).

Since AI chatbots are increasingly being implemented in educational institutions, digital literacy should be paid attention to. The effective use of AI tools should be trained to the teachers. They should be in a position to make good use of AI chatbots in their instruction. As Pereira et al. (2023) note, AI tools give instant feedback to the students, with their help, students are taken through the reasoning processes that are critical, and they develop their reasoning and critical thinking skills. The use of AI chatbots will develop a more analytical form of learning in the students that will help them to overcome future academic and employment challenges. Chatbots can also explain challenging ideas that also enhance cognition and knowledge building in blended learning classrooms (FILIZ et al., 2025)

Additionally, chatbots consume minimal information in WhatsApp, therefore, they can be used by individuals in poor nations. Since they are inexpensive, readily available and tailored to suit the needs of an individual, they are a good material to sustain mathematical cognition and other scholarly proficiencies especially in the developing world. However, the issue of academic honesty, data security, and critical thinking should also be considered since AI is actively implemented in education (Pitts et al., 2025; KARAKUS et al., 2025). Even though such devices may be quite helpful, the utilization beyond regulation can imply that the children might just finish their tasks with the assistance of a chatbot that can likely be helpful yet will not develop them since it is not advised by pedagogy principles (Kestin et al., 2025).

To guarantee the presence of AI that will benefit academic performance and reduce bias and data privacy in algorithms, we should develop powerful policies (Al-Zahrani, 2024; Naeem and Hanif, 2025). The use of artificial intelligence should be practiced together with the credibility and truthfulness of information with maximum utilisation of the educational benefit (Vasconcelos and Santos, 2023).

3. Methodology

3.1 Research Design.

The researcher employed a quasi-experimental design to determine whether the AI Chatbot could be useful to enhance the mathematical reasoning of students. The study respondents will include the students of the universities, as well as poly-techniques and colleges of education in Gombe State. The treatment group students who attend such institutions will learn using AI chatbots as the control group will continue with the traditional teaching strategies. The performance of both groups will be compared to check how effective the AI chatbots are in solving maths problems by the student.

3.2 Data Collection Tools And Techniques.

The respondents were the students who responded to the open-ended and closed-ended questionnaire designed by the researcher. The questionnaire assessed several factors.

How frequently did the students use AI chatbot?

Student justifications for chatbot interactions included studying learning activities, problem-solving, and seeking information.

How AI chatbots impacted students' perceptions toward mathematical thinking and academic performance.

Pretest and posttest were conducted along with Questionnaire in this study will to investigate the change of students' mathematical reasoning in interaction with AI chatbot.

3.3 Data Analysis Methods.

The percentage and frequency distribution will help to identify the distribution of students using AI Chatbots and with respect to academic performance. Researchers used descriptive statistics to summarize their data. They then undertook comparative analysis for the treatment and control groups. A t-test was also done to see if the differences in students' perceptions and performances of two groups was significant. It showed how effective chatbots can be in improving the mathematical thinking of students.

4.RESULT AND DISCUSSION.

Category	Institution Name
Public Universities	Federal University, of Kashere (FUK)
	Gombe State University (GSU)
Public Polytechnics	Federal Polytechnic Kaltungo.
	Gombe State Polytechnic.
Public Colleges of Education	Federal College of Education (Technical), Gombe.
	College of Education, Billiri.
	Gombe State College of Education and Legal Studies, Nafada.
Public Health and Specialized Institutions	Gombe State College of Health Sciences and Technology, Kaltungo.
	Gombe State College of Nursing and Midwifery
	Gombe State College of Legal Studies, Nafada
Private Universities	North-Eastern University (formerly PenResource University)
	Jewel University
Private Colleges of Education	AGZ College of Education
	Christian College of Education
	Jibwis College of Education
	Mus'ab bn Umair Community College of Education
	Zagada College of Education
Private Health and Specialized Institutions	Umma College of Health Sciences and Technology
	Garkuwa College of Health Sciences and Technology
	Dukku International College of Health Sciences and Technology

Category	Institution Name
	Haruna Rasheed College of Health Sciences and Technology
	Ilimi College of Health Sciences and Technology

Table 1: Frequency of AI Chatbot Use Among Students

This table shows how frequently students in Gombe State's tertiary institutions use AI chatbots for learning mathematics.

Frequency of Use	Mean Score
Several times a day	3.18
Twice a day	2.65
Once a day	2.10
Once in two days	1.85
Once a week	1.73
Occasionally	1.51
Don't use at all	1.40
Grand Mean Score	2.02

The average of 3.18 indicates that the largest group of AI chatbots users visit the chatbots multiple times per day; therefore, this group regards the chatbots as the useful tool to improve their learning. Students that use these chatbots twice a day achieve an average of 2.65, students who use the chatbots once a day achieve an average of 2.10, thus showing that they are considered to be beneficial, although not excessively so. However, although those numbers do not vary significantly when compared to the mean (1.87) of those who use the chatbots every two days, once a week (1.73), and only once-in-a-while (1.51) have slightly lower email ratings, not everybody is wholly integrated into the technology. The overall Grand Mean Score of 2.02 indicates that on average students do not use the chatbot very frequently and, therefore, the average engagement with the tool is relatively low.

Table 2: Challenges Faced by Students in Using AI Chatbots

This table outlines the key challenges faced by students in using AI chatbots for academic purposes.

Challenge	Mean Score
The AI chatbot is time-consuming and difficult to integrate.	3.45
Lack of technical skills among students to use AI chatbots.	3.12
Limited access to necessary technology (e.g., internet, devices).	3.33

Challenge	Mean Score
Lack of personalized support when encountering chatbot issues.	2.98
Poor interaction quality due to AI limitations (non-human interaction).	3.20
Grand Mean Score	3.22

Integrating AI chatbots was the biggest obstacle to their application (M: 3.45), implying that students believe they are useful, but that getting the time investment that the technology needs could be a key deterrent. The challenging factors also relate to lack of technical abilities (means = 3.12) and inaccessibility to technology (means = 3.33) both with references to the issues with the appliances and connectivity. The lack of individual assistance (mean: 2.98) shows that, as helpful as it is, the chatbot does not offer real-time assistance and one-on-one feedback. The overall Grand Mean Score is 3.22, which means that students face relatively low or moderate rates of problems in using AI chatbots and especially face technical and access issues.

Table 3: Impact of AI Chatbots on Learning

This table presents the perceived impact of AI chatbots on students' learning outcomes, particularly in improving mathematical thinking.

Impact of Use	Mean Score
The AI chatbot helps me better understand complex concepts.	3.55
Using the chatbot makes me feel more engaged with the material.	3.23
The AI chatbot allows me to practice more efficiently.	3.15
I depend on the AI chatbot for immediate feedback.	3.30
The chatbot reduces the need for face-to-face interactions.	2.75
Using the AI chatbot positively impacts my academic performance.	3.00
Grand Mean Score	3.15

Impacts of AI chatbots on students' learning The mean score of the highest influence, 3.55, suggests that the AI chatbots significantly improve students' comprehension of complex mathematics by simplifying difficult subjects. Furthermore, the chatbot is a source that stimulates learning with content (3.23) and enhances learning practice outside class (3.15). Peer feedback (mean = 3.57) and immediate feedback (mean = 3.30) also had a positive impact, indicating students appreciate being able to receive immediate corrections and corrective feedback. However, a rating of 2.75 implies that the chatbot could minimize the face-to-face sessions, but learners appreciate meeting with their instructors. The influence on the learning outcome is noticed in a positive manner (3.00), however the effect is rather nuanced, indicating that the chatbot is contributing to the learning outcomes rather than driving them on its own.

Table 4: Perceptions of AI Chatbots in Academic Use.

This table reflects students' overall perceptions of the usefulness of AI chatbots for academic purposes.

Statement	Mean Score
It would be convenient and beneficial to use AI chatbots for academic purposes.	3.42
The chatbot can be effectively used by lecturers to teach and share information.	3.28
I feel comfortable using AI chatbots for academic support.	3.15
I believe that AI chatbots can replace traditional learning methods.	2.98
I am concerned that using AI chatbots may invade my privacy.	2.53
The use of AI chatbots in learning is an innovative approach.	3.44
Grand Mean Score	3.20

Most students have positive judgments towards AI chatbots for academic uses; the mean value is 3.42, students find them convenient and useful for learning. Students also have the highest level of agreement that AI chatbots can aid their academic journey ($M = 3.28$). Overall, they feel quite comfortable with the technology (mean value of 3.15). Nevertheless, respondents are ambivalent about displacing traditional instructional techniques, reflected by a mean of 2.98 suggesting a strong desire for face-to-face education. Privacy issues is the lowest perception, with an average score of 2.53.

Table 5: T-test Statistical Comparison Between Public and Private Institutions. Purpose: This table compares the responses from students in public and private institutions to see if there is a significant difference in the impact of AI chatbots.

Group	Mean Score	Standard Deviation	T-value	P-value
Public Institutions	3.20	0.60	0.03	0.96
Private Institutions	3.19	0.58	-	-

The data from this research are verified by using t-test analysis. This t-test analysis shows that there is no significant difference among the respondents of both the public and private schools, where $p\text{-value}=0.96$ exceeds more than is significant $=0.05$. (See Table 11), head public ave.469 4.3 Public and 4.2 Private; difference very small which shows that there is no significant difference in the perception of both AI chat bots. The t-value of 0.03 proves that both means are insignificantly different, GDP Both groups had the general intention towards improvement of mathematical thinking skills in the help of AI chatbots. Finally, we see that the value of the same standard deviation (0.60 in case of public and 0.58 in case of private) does not show much evidence of variation in responses. Thus, it supports the understanding that students of both the public and the private institutions share similar views on the use of AI chatbots.

5. CONCLUSION

The discovery indicates that the chat robot has the ability to enhance the mathematical thinking and learning of the Gombe state tertiary institutions.

The tool is not considered very useful as a pedagogical tool in this sense. Even if the use is low, the perception by the student and by the device as a pedagogical tool is high. Even though the AI chatbots are beneficial, their widespread use is held back by impediments from time involvement, non-technical skills and access to technology. Still, students feel good and their attitude towards AI chatbots is a positive one. They think that chatbots should be a supplement and not a substitute to the traditional method of teaching and learning. Also, their effectiveness does not statistically differ (18,19) which means that AI intervention with chatbots should be an effective technology to implement in both public and private schools. The findings reveal that much more effort is required to solve the technical problems, privacy to the students and faculty and the technical capacity. Future research may be directed towards the resolution to these challenges as well as long-term implications of deployment of AI tools on schools.

5.1 Summary.

The present study examined artificial intelligence chatbots meant to help learners' learning and mathematical reasoning at tertiary level in Gombe state. Although AI chatbots could make studying higher Mathematics classes easier and more enjoyable, they have not taken off yet. Those students who were using the chatbot have always stated that they found it useful to learn the difficult material and train and receive immediate feedback. Because they did not have the required technology, that had stopped them from taking advantage of the digital technology scheme as well as lack of time. The top topics included the insufficient privacy settings and the worry of the man in A.I that the chatbot can be accepted as a learning aid among the students. According to the analysis, students attending a private university and students attending a public university do not differ significantly in their attitude towards AI chatboxes.

5.2 Recommendations.

I. We need to do more to use high-tech tools. Helping students and teachers learn how to use the opportunities of ai chatbots also plays a part. It will help to offer digital literacy and technology skills.

II. AI chatbots must be used in our everyday lives just as course books were used in yester years health co-existing and health academics routine.

III. As per the law, students' privacy will not be compromised. Further research will determine the long-run effect of AI tools on academic performance. The use of these tools on campuses is only increasing

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