



Effect of Artificial Intelligence Technology Using Chatbots-Video Instruction on Achievement in Statistics among Secondary School Students in Ogidi Educational Zone, Anambra State, Nigeria

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Abstract

This study investigated the effect of Artificial Intelligence (AI) Chatbots-video instruction on students' achievement in statistics among secondary school students in Anambra State. 18,500 JSS1 Students formed the population. The sample comprises of 53 students drawn from the population using purposive and simple random techniques. Instrument used for data collection was teacher made Statistics Achievement Test (SAT). The test items covered 50 objective questions from Statistics. The 50 objectives questions were constructed and validated by experts from mathematics education and measurement and evaluation. The reliability coefficient of the instrument was 0.78 obtained using kuder Richardson (K-R-20). Two research questions were posed and answered using mean and standard deviation while two null hypotheses developed were tested at 0.05 level of significance using Analysis of Covariance. The result showed that students who were taught Statistics using Artificial Intelligence (ai) chatbots-video instruction performed better than their counterparts who were taught using the conventional method. There was difference though not significant in the mean achievement scores of male and female students in mathematics when taught using Artificial Intelligence (AI) Chatbots-video instruction. The female students slightly performed better than their male counterparts in achievement. Based on the result, it was recommended among others that teachers should adopt the use of Artificial Intelligence (AI) Chatbots-Video Instruction in teaching since it has been found to enhance achievement in Statistics.

Keywords: artificial intelligence (AI), chatbots, achievement, statistics, video instruction.

Introduction

Mathematics is often described as the universal language, used across cultures to communicate ideas about number, space, and logic (Dehaene, 2020). Mathematics is an indispensable tool in virtually all human endeavors and there is hardly any field where mathematics is not useful (Uka, 2020). Mathematics as a science-based discipline is known as the queen of all subjects. It is a basic tool in the development of science, technology, commerce and industry. Mathematics education plays a very unique role in the making of any student in his field of study. It is a unique subject which encourages the acquisition of skills and knowledge, which explains the natural phenomena of life in society (Uka, 2024). In Nigeria, Mathematics remains a core subject at all levels of the educational system, yet the performance of students, especially in external examinations such as the West African Senior School Certificate Examination (WASSCE) and the National Examination Council (NECO), has continued to be a source of concern to educators, policymakers, and parents alike (WAEC Chief Examiner's Report, 2025). Mathematics performance among Secondary School Students has persisted over the years [West African Examinations Council (WAEC), 2025]. The West African Examinations Council (WAEC) Chief Examiners' Reports (2023-2025) consistently highlight widespread candidate weaknesses in core mathematical areas such as algebra, word problems, and geometry, indicating a systemic failure to grasp fundamental concepts. This trend is not merely statistical but has profound implications for the individual and the nation. Students who perform poorly in mathematics are often limited in their pursuit of Science, Technology, Engineering, and Mathematics (STEM)-related fields in tertiary



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institutions, thereby constraining the pipeline of critically needed technical skills for national development (Okigbo & Okeke, 2021). The root causes of this underperformance are multifaceted and deeply entrenched. Researchers attribute them to a confluence of factors, including but not limited to: overcrowded classrooms, a shortage of qualified mathematics teachers, and the prevalence of abstract, teacher-centered instructional methods (Uka, 2024). Also, Studies in Nigeria have identified a number of factors impeding educational quality, including lack of qualified teachers, inadequate instructional materials, overcrowded classrooms, and the frequent reliance on teacher-centred instructional methods, (Tata, Abba & Sadiq, 2021; Akaba & Audu, 2023). The dominant pedagogical approach in many Nigerian classrooms, often termed the "Conventional Teaching Method," is predominantly chalk-and-talk, characterized by rote memorization and procedural learning. In this model, the teacher acts as the sole knowledge transmitter, while students assume a passive, receptive role (Akinbolola & Ikitde, 2021). This method offers little room for interactive engagement, critical thinking, or the personalized addressing of learning gaps. Consequently, it fails to cater to the diverse learning paces and styles within a classroom, leaving many students behind and fostering math anxiety and disinterest (Nworgu & Onwuakpa, 2023). The persistence of this conventional method, despite its documented inadequacies, forms the core problem that necessitates the investigation of innovative, student-centered, and technologically-enhanced instructional strategies in Anambra State. Artificial Intelligence Chatbots is one of such technologically-enhanced instructional strategies. Artificial Intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions. AI systems are designed to perceive their environment, learn from data, reason, solve problems, and make decisions, often performing tasks that traditionally require human intelligence.

Artificial Intelligence (AI) Chatbots are sophisticated software applications powered by Natural Language Processing (NLP) and Machine Learning (ML) algorithms, designed to simulate human-like conversations and provide interactive, personalized learning experiences (Winkler & Söllner, 2018). It is a computer program that simulates human conversation through voice commands, text chats, or both. In the context of this study, an Artificial Intelligence (AI) Chatbot refers to a dialog-based intelligent tutoring system with its core functions as Natural language interaction, personalized learning pathways, Adaptive feedback and Scaffolding. It serves as an intelligent tutor, offering real time assistance, answering students' queries, guiding learners through problem solving processes and mimics human intelligence by learning, reasoning, and making decisions (Haenlein & Kaplan, 2019). In Nigeria, the use of AI chatbots is gradually gaining ground. Eze and Olawale (2024) found that students exposed to chatbot-based Mathematics lessons demonstrated better retention of algebraic concepts compared to those taught through traditional lectures. The researchers attributed this to the interactive question-answer format that maintains students' attention and curiosity. This shows that chatbot integration can bridge the feedback gap in resource-constrained classrooms. In Nigeria, although this integration is still emerging, preliminary studies by Okoye and Adebayo (2025) indicate that combining AI chatbots with instructional videos improved students' participation and comprehension in secondary school Mathematics. The researchers noted that the multimodal combination appeals to visual and interactive learners simultaneously, thus reducing math anxiety and promoting conceptual learning. It promotes personalized, self-paced, and engaging education, aligning with the 21st-century learning demands of critical thinking, collaboration, and technology fluency. Thus, for this study, video instruction is conceptualized as a structured digital teaching tool that enhances mathematics learning by offering clear demonstrations and flexible access to content, especially when combined with AI chatbot interactions for further clarification and practice. This Video is embedded in the application - Khan Academy. For this Study, Khan Academy and Gemini AI (Google's Multimodal AI Chatbot) was used. Khan Academy is an educational platform where the students can subscribe to by signing up with their email addresses. It is free. They watch the uploaded lessons after which they interact with the Gemini AI by asking unclear terms taught. Gemini can process not just text, but also images and diagrams. This is beneficial for topics like graphs, tables, or geometric data in statistics. Khan Academy has the features of Interactive and Adaptive Creative Problem Solving Ease of Access via Android and Chrome. Literature reviewed revealed very few studies like Mohammed and Bello (2024), who carried out a study on the effects of video-based learning in flipped and flipped collaborative classroom settings on senior secondary school students' performance and retention in mathematics. The result indicated a significant improvement in the post-test scores of students in the experimental groups compared to the control group, demonstrating that video-based instruction combined with collaborative and flipped classroom strategies enhanced students' understanding, retention and



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overall achievement in mathematics more than the conventional method. Wu (2024) showed that when video lessons are supplemented with chatbot interaction, learners demonstrate improved conceptual understanding, problem-solving accuracy, and sustained engagement compared to traditional instructional formats. Thompson and Garcia (2023), who carried out a study on gender and AI revealed that in using Artificial Intelligence (AI) Chatbots-Video Instruction, female students fostered a deeper and more confident understanding of mathematical concepts. There is a scarcity of empirical studies in Nigeria, and indeed across Africa, that investigate the integrated effects of an "AI Chatbots-Video Instruction" package. The work of Eze and Adeyemi (2023), on Differential Effectiveness of Collaborative and Technology-Integrated Strategies on Mathematics Achievement of Senior Secondary Students by Gender found that Male students demonstrated their highest achievement in the AI Chatbot-Video Instruction condition when compared to their female counterparts. Nilsson and Berg (2024) carried research titled "Bridging the Gap: A Comparative Study of AI Chatbots and Video Instruction on Calculus Achievement and Gender Differences. "The findings revealed a statistically significant difference in the post-test scores, with the AI Chatbot group outperforming both the Video Instruction and control groups, gender was reported not significant. The present study seeks to see if the result will be different in Anambra State.

Statement of the Problem

Despite numerous reforms and instructional strategies introduced to improve mathematics performance, students in secondary schools across Nigeria, including those in Anambra State, continue to record poor results. Conventional teaching methods, often teacher-centered, may not adequately engage students or cater to their diverse learning needs. With the increasing accessibility of digital tools and the emphasis on learner-centered approaches, the use of Artificial Intelligence (AI) Chatbots-Video Instruction could offer promising alternatives. Yet, the effectiveness of these methods - either independently or in combination, on students' achievement in mathematics has not been adequately explored in this context. This study seeks to investigate the Effect of Artificial Intelligence (AI) Chatbots-Video Instruction on Mathematics achievement among State Secondary School Students.

Objectives of The Study

The purpose of this study is to investigate the Effect of Artificial Intelligence (AI) Chatbots-Video Instruction on the Mathematics achievement of Secondary School Students in Ogidi Educational Zone of Anambra State. Specifically, this study seeks to:

1. Determine the mean achievement scores of students taught Statistics using Artificial Intelligence (AI) Chatbots-Video Instruction and those taught using Conventional Teaching method
2. Find the mean achievement scores of male and female students taught Statistics using Artificial Intelligence (AI) Chatbots-Video Instruction

Research Questions

1. What are the mean achievement scores of students taught Statistics using Artificial Intelligence (AI) Chatbots-Video Instruction and those taught using Conventional Teaching method?
2. What are the mean achievement scores of male and female students, taught Statistics using Artificial Intelligence (AI) Chatbots-Video Instruction?

HYPOTHESES

The following null hypotheses (H_0) are formulated to guide the study and are to be tested at 0.05 level of significance:

H_{01} : There is no significant difference in the mean achievement scores of students taught Statistics using Artificial Intelligence (AI) Chatbots-Video Instruction and those exposed to Conventional Teaching method,

H_{02} : There is no significant difference in the mean achievement scores of male and female students, taught Statistics using Artificial Intelligence (AI) Chatbots-Video Instruction,

Methodology

This study adopted a quasi-experimental research design because of different extraneous variables the researcher may control at the course of this study. Specifically, the pretest-posttest control group design was used. The population of the study was all the Junior Secondary School One (JSS1) students in Ogidi Educational Zone of Anambra State totaling 18,500 JSS1 Students in 132 Secondary Schools (Zonal Inspector of Education, Ogidi Educational and Zone, July, 2025).



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The sample for this study was drawn using a multi-stage sampling technique, purposive sampling techniques and simple random sampling techniques were employed at various stages. A sample of 53 JS 1 students made of two intact classes was used. The instrument used for data collection was researchers' developed achievement test which was validated by three experts from department of science education, Michael Okpara University of Agriculture Umudike. Data collected were analyzed using mean and standard deviation for research questions and analysis of covariance (ANCOVA) for hypotheses at 0.05 level of significance.

Presentation of Results

The data were analyzed and the result presented according to research questions and hypotheses.

RESEARCH QUESTION 1: What are the mean achievement scores of students taught Statistics using Artificial Intelligence (AI) Chatbots-Video Instruction and those taught using Conventional Teaching method?

Table 1: Mean achievement scores and standard deviations of students taught Statistics using Artificial Intelligence (AI) Chatbots-Video Instruction and those taught using Conventional Teaching method

Variable Methods	N	Pre-test		Post-test		Achievement mean difference
		X	SD	X	SD	
AI	27	18.67	5.11	57.34	7.48	38.67
LECTURE	26	19.88	6.90	29.38	5.42	9.50

Where N=Number of students, X=mean, SD = Standard deviation

Table 1 presents the mean achievement scores of students taught Statistics using Artificial Intelligence (AI) Chatbots-Video Instruction and the Conventional Teaching method. The table shows that students taught using Artificial Intelligence (AI) Chatbots-Video Instruction had a pretest mean score of $X = 18.67$ ($SD = 5.11$) and a posttest mean score of $X = 57.34$ ($SD = 7.48$), resulting in a mean difference of 38.67, which suggests substantial improvement in achievement. Similarly, students taught using the Conventional Teaching method had a pretest mean score of $X = 19.88$ ($SD = 6.90$) and a posttest mean score of $X = 29.38$ ($SD = 5.42$), yielding a mean difference of 9.50, which reflects comparatively lower improvement. The relatively similar pretest mean scores of the two groups suggest that the students were at comparable achievement levels before the experiment, while the posttest mean scores indicate that students taught using Artificial Intelligence Chatbots-Video Instruction performed better than those taught using the Conventional Teaching method. The standard deviations across groups are relatively low and comparable, indicating limited variability in students' scores around the mean.

Hypothesis 1

There is no significant difference in the mean achievement scores of students taught Statistics using Artificial Intelligence (AI) Chatbots-Video Instruction, Jigsaw Strategy and Conventional Teaching method.

Table 2: Analysis of Covariance (ANCOVA) of students mean achievement scores when taught using Artificial Intelligence (AI) Chatbots-Video Instruction and Conventional Teaching method.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	10376.948 ^a	2	5188.474	151.070	.000	
Intercept	8335.702	1	8335.702	242.706	.000	
Pretest	3.210	1	3.210	.093	.761	
Methods	10302.959	1	10302.959	299.986	.000	S
Error	1717.240	50	34.345			
Total	113037.000	53				
Corrected Total	12094.189	52				

a. R Squared = .858 (Adjusted R Squared = .852)

The result in table 2 showed F-ratio of 299.986 for groups with P value of .000 which is less than the alpha value of .05 ($p < 0.05$). The null hypothesis of no significant difference is therefore rejected which implies that there is a significant difference in the mean achievement scores of students taught Statistics using Artificial Intelligence (AI) Chatbots-Video Instruction and Conventional Teaching method in favour of Artificial Intelligence (AI) Chatbots-Video Instruction.



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Research Question 2:

What are the mean achievement scores of male and female students, taught Statistics using Artificial Intelligence (AI) Chatbots-Video Instruction?

Table 3: Mean achievement scores and standard deviation of male and female students taught Statistics using Artificial Intelligence (AI) Chatbots-Video Instruction.

Variable	N	Pre-test		Post-test		Achievement Mean difference
		X	SD	X	SD	
Male	13	20.00	4.24	58.62	6.70	38.62
Female	14	17.43	5.68	56.21	5.10	38.78

Table 3 showed the mean achievement scores and standard deviation of male and female students taught Statistics using Artificial Intelligence (AI) Chatbots-Video Instruction. Male students had pretest score of 20.00 with standard deviation of 4.24 and a post test score of 58.62 with standard deviation of 6.70 and an achievement gain of 38.62 while female students had a pretest mean score of 17.43 with standard deviation of 5.68 and a posttest mean score of 56.21 with standard deviation of 5.10 and an achievement gain of 38.78. This indicates that female students taught Statistics using Artificial Intelligence (AI) Chatbots-Video Instruction achieved slightly more than their male counterparts taught Statistics using Artificial Intelligence (AI) Chatbots-Video Instruction. The standard deviations across groups are relatively low and comparable, indicating limited variability in students' scores around the mean.

Hypothesis 2:

There is no significant difference in the mean achievement scores of male and female students, taught Statistics using Artificial Intelligence (AI) Chatbots-Video Instruction.

Table 4: Analysis of covariance on the mean achievement scores of male and female students, taught Statistics using Artificial Intelligence (AI) Chatbots-Video Instruction.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Decision
Corrected Model	41.870 ^a	2	20.935	.355	.705	
Intercept	5355.343	1	5355.343	90.869	.000	
Pretest	3.007	1	3.007	.051	.823	
Gender	31.161	1	31.161	.529	.474	NS
Error	1414.427	24	58.934			
Total	90323.000	27				
Corrected Total	1456.296	26				

a. R Squared = .029 (Adjusted R Squared = -.052)

The result in table 4 showed F-ratio of .529 for groups with P-value of .474 which is greater than the significant value of .05. (P>.05). The null hypothesis of no significant difference is therefore not rejected which indicates that there is no significant difference between the mean achievement scores of male and female students taught Statistics using Artificial Intelligence (AI) Chatbots-Video Instruction.

Discussion of Findings

The findings of the study revealed that students who were taught statistics using Artificial Intelligence (AI) Chatbots-Video Instruction performed better than students who were taught using conventional method. The female students performed slightly better than their male counterpart when taught Statistics using Artificial Intelligence (AI) Chatbots-Video Instruction. The study showed that there is a significant difference between the mean achievement scores of students taught statistics using Artificial Intelligence (AI) Chatbots-Video Instruction and those taught using conventional method. This is in agreement with the opinions of Mohammed and Bello (2024), Nilsson and Berg (2024) whose research works indicated that students who learnt through video-based multimedia instruction and AI Chatbots performed significantly better than their counterparts in mathematics. The result is also in tandem with Wu (2024) whose study showed that when video lessons are supplemented with chatbot interaction, learners demonstrate improved conceptual understanding, problem-solving accuracy, and sustained engagement compared to traditional instructional formats. Findings also showed that



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there is no significant difference between the mean achievement scores of male and female students taught Statistics using Artificial Intelligence (AI) Chatbots-Video Instruction though the female students slightly performed better than their male counterparts but not statistically significant. This is in agreement with the findings by Thompson and Garcia (2023), whose work revealed that in using Artificial Intelligence (AI) Chatbots-Video Instruction female students fostered a deeper and more confident understanding of mathematical concepts. This study disagreed with the work of Eze and Adeyemi (2023), on Differential Effectiveness of Collaborative and Technology-Integrated Strategies on Mathematics Achievement of Senior Secondary Students by Gender where Male students, conversely, demonstrated their highest achievement in the AI Chatbot-Video Instruction condition.

Conclusion

From the results obtained in the study, it was found that students taught statistics using Artificial Intelligence (AI) Chatbots-Video Instruction performed better than their counterparts taught using conventional method. Female students performed better than male students though not statistically significant.

Recommendations

Based on the findings of this study, the following recommendations are proffered

1. Teachers should adopt the use of Artificial Intelligence (AI) Chatbots-Video Instruction in teaching since it has been found to enhance achievement in Statistics.
2. Workshops, seminars, and conferences should be organized for teachers by state and federal government, NGOs, Associations like Mathematical Association of Nigeria (MAN) and Science Teachers Association of Nigeria (STAN). This is because Artificial Intelligence (AI) Chatbots-Video Instruction is barely new and some teachers may not be aware of how best to employ or implement it in the classroom.
3. Modules on AI-based instruction should be included in Teacher training programmes so that teachers can acquire the necessary skills to implement chatbot-assisted learning effectively
4. Since gender does not significantly affect learning outcomes in this instructional approach, teachers should provide equal learning opportunities for both male and female students when using Artificial Intelligence (AI) Chatbots-Video Instruction.

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