THE DIFFERENCE IN ACADEMIC PERFORMANCE OF SENIOR SECONDARY SCHOOL BIOLOGY STUDENTS EXPOSED TO CHATBOT AI OR EXPOSITORY METHOD BASED ON THEIR GENDER

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ABSTRACT

The study assessed the difference in academic performance of senior secondary school biology students exposed to Chatbot AI and those exposed to expository method based on their gender. This study adopted a quasi-experimental pretest post-test non randomize control group design. This research will be conducted in Akwa Ibom State. The population of this study consisted of 30,985 Senior Secondary School two students offering Biology as a subject in 227 Secondary schools in AkwaIbom State, Nigeria. A total number of 600 senior secondary school three male and female in sciences offering biology as a subject (280 males and 320 females) were divided into control and treatment groups. The researcher developed instrument called Biology Performance Test (BPT). They validation was done through content, and face validity. The researcher then incorporated all corrections into the work. Kuder-Richardson formula 21. test-retest method was used to accessed the reliability at 0.05 level of reliability. Descriptive Statistics of Mean and Standard Deviation was used to present data for answering research questions.The findings of the study showed that students taught Biology using ChatBot AI outperformed those taught with traditional expository method. The study also revealed that revealed that male and female students performed equally high when exposed to Chatbot AI. The study concluded that Utilization of Chartbot AI in teaching and learning Biology concepts is more effective than the use oftradional expository method because chatbot AI engages students in interactive conversations, provide immediate feedback and reinforce Biology knowledge which can encourage critical thinking in the students thereby improving their academic performance in Biology. The study recommended that Curriculum planners and designers should integrate Chatbot AI into the educational system in AkwaIbom State to support student learning and retention.
Keywords: Academic Performance, Senior Secondary School, Biology Students, Chatbot AI, Expository Method and Gender

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Introduction

In today's rapidly advancing technological era, the integration of Artificial Intelligence (AI) into educational settings has gained significant attention. One area that has witnessed notable advancements is the use of Chatbot AI in enhancing the learning experience and academic outcome of students (Kooli, 2023). According to Kooli (2023), The integration of Artificial Intelligence (AI) and Chatbots into education and research completely revolutionized the educational sector specifically as from the end of 2022. John McCarthy in 1956 first coined the term "Artificial Intelligence" (AI) for an intelligent machine system at the Dartmouth Conference (Xu, Liu, Cao, and Huang, et al. 2023) and today it is a worldwide name. ELIZA, developed by Joseph Weizenbaum at Massachusetts Institute of Technology (MIT) in 1966, was the world's first Chatbot. Today, Chatbots are used across a wide range of platforms and applications, such as websites, mobile apps and social media platforms.

The one- way communication from teacher to students in expository teaching method is not doing students any good, it leads to passive learning, limited engagement and encourages memorization in the place of retention. The advantages of using Chatbot AI include low cost, less time in obtaining answers, better interaction, personalized and creative learning, engagement and motivation, and improved efficiency when using in instruction (Llic and Markovic, 2016; Bii, 2013). Chatbot AI have significant educational potential and positive impact on student learning and satisfaction through its personalized learning support (Winkler and Söllner, 2018). It can offer immediate, interactive and continuous support service to students, serving as a virtual tutor or study partner.

Chatbot's potential impact on Biology and other fields is immense as it can answer life biological science questions, become a useful learning tool but its effectiveness may depend on how it is integrated into the curriculum and the support students receive from teachers. According to Hassoun, Jefferson, Shi, et al (2022). Chatbot AI for Biology will be the cross-cutting technology that will enhance our ability to do biological research at every scale. Biologist expect Chatbot AI to revolutionize Biology in the 21st century much like statistics transformed Biology in the 20th century. Chatbot AI can reinforce biological concepts by providing concise explanations and examples which can enable students to review and revise key topics by posing questions to the Chatbot. It can break biological terminologies into bits, create a more interactive and immersive learning environment, which can help students better understand the concept. It can also offer additional information or prompt students to think critically about the subject matter, consolidating their understanding (Cunningham-Nelson et al 2019).

However, it is important to consider gender factors when developing and implementing Chatbot AI systems in education, to ensure equal utilization and an optimal learning experience for students of all gender. Researches have suggested gender differences in confidence levels may impact the utilization of Chatbot AI. According to a research study by Franken, Mauritz and Wattenberg (2020) on self-awareness test, women had lower understanding of AI than men. Females, in general, may be less likely to engage with technology or express confidence in their abilities to solve problems. This may lead to varying levels of utilization based on gender. Also, there is a clear gender gap in academic performance between male and female students, with boys lagging behind girls in terms of subject grades, secondary school graduation, and tertiary level enrolment and completion. The utilization of Chatbot AI systems however, may inadvertently reflect gender biases due to the data used to train them. If the training data contains gender

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stereotypes or biases, the Chatbot's responses may perpetuate those biases, leading to potential disparities in the learning experience unless the Chatbot was trained with contents that are unbiased and inclusive to provide supports for users of all gender..

Statement of Problem

Most Biology instructors face difficulties in comprehending and teaching complex Biology concepts, while most of them want their students to go beyond memorization to think critically, reason scientifically, and solving problems. Though, their delivery method do not stimulate the students enough to sustain retention especially in some educational settings (in rural areas) where access to comprehensive Biology resources, subject matter experts, or labouratory materials may be limited. Moreover, studies have shown high entries and poor results of students in internal and external Biology examination. The problem of this study is to find out if there is difference in retention and academic performance in Biology of Senior Secondary School students exposed to Chatbot AI and those taught with expository methods?

Research questions

1. What is the difference in academic performance in Biology of Senior Secondary School students exposed to Chatbot AI and those taught with expository method?
2. What is the difference in academic performance in Biology of Senior Secondary School students exposed to Chatbot AI and those taught with expository method based on their gender?

Research Objectives

1. There is no significant difference in academic performance in Biology of Senior Secondary School students exposed to Chatbot AI and those exposed to expository method.
2. There is no significant difference in the academic performance in Biology of Senior Secondary School students exposed to Chatbot AI and those exposed to expository method based on gender.

CONCEPTUAL REVIEW

Chatbot AI in Education

In April 2016, Bill Gates told a large audience of educational technology entrepreneurs and investors that "we really haven't changed (student) outcomes" with Educational Technology, but he held out the promise that "we can surprise people by really making education better both here in the United States and around the world" (Molnar 2016). Chatbot AI emerges as a promising solution to effectively address some educational issues. Some educational institutions are increasingly turning to Chatbot AI, recognizing their relevance, while others are more cautious and do not rush to adopt them in modern educational settings.

Chatbots are now used across various sectors, including education. Chatbot AI have been applied for both instruction and learning within the education sector. Chatbots strategized for educational purposes are described as educational Chatbots. Chatbots in the education industry is an AI-powered (Chatbot AI) virtual assistant designed to interact with students, teachers, and other stakeholders in the educational ecosystem. Using advanced Conversational AI and Generative AI technologies, Chatbots can engage in natural language conversations, providing personalized support and delivering relevant information on various educational topics. Chatbot AI specialize in personalized tutoring, homework help, concept learning, standardized test preparation, discussion and collaboration, and mental health support. Some of the most popular Chatbots AI

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tools used in education are: Bard, introduced in 2022 capable of generating text, language translation, producing various types of creative content, and providing informative responses to questions. (Rudolph et al., 2023). ChatGPT, launched in 2022 by OpenAI, is a large language model chatbot that can generate text, produce diverse creative content, and deliver informative answers to questions (Dergaa et al., 2023; Rudolph et al., 2023). Ada Chatbot, a Chatbot AI platform that is designed to be a friend and companion for students. It can listen to students' problems, offer advice, and help them feel less alone (Pentina et al., 2023; Xie and Pentina, 2022)

Another Chatbot named Habitica, was launched in 2013, used to help students develop good study habits. It gamifies the learning process, making it more fun and engaging for students. Students can use Habitica to manage their academic tasks, assignments, and study schedules. By turning their to-do list into a game-like experience, students are motivated to complete their tasks and build productive habits (Sales and Antunes, 2021; Zhang, 2023). However, the gamified nature of Habitica could inadvertently introduce distractions, especially for students who are easily drawn into the gaming aspect rather than focusing on their actual academic responsibilities and those with Attention Deficit Hyperactive Disorder. Another Chatbot Piazza, was launched in 2009, and is used to facilitate discussion and collaboration in educational settings, particularly in classrooms and academic institutions. It provides a space for students and instructors to engage in discussions, ask questions, and share information related to course content and assignments (Ruthotto et al., 2020). Because discussions on Piazza are user-generated, the quality and accuracy of responses can vary. This variability may result in situations where students do not receive accurate and helpful information and that may alternate their learning experience. There might likely be even more widespread development and adoption of Chatbots in education in the years to come as technology advances further, because Chatbots have enormous potential to improve teaching and learning.

Chatbot AI and Academic Performance

Ogunwale (1989) identified two types of factors capable of influencing students' academic achievement as phenotypic and organismic factors. According to him, the phenotypic factors are mainly social which include the home, the school, and parental influence, the interactive effects of the students and materials as well as socioeconomic status of parents. In recent times, educators in Nigeria have been increasingly concerned about the need to improve on the academic achievement of students. In the same vein, Akubuiro, 2008 asserted that parents, teachers and society in general are worried and apprehensive about the best way to improve academic standards, achievement and performances,and that is where the utilization of recent technologies like Chatbot AI come in.The results of the study conducted by Wu, and Yu (2023) indicates that AI Chatbots had a large effect on students' learning outcomes. Moreso, AI Chatbots had a greater effect on students in higher education, compared to those in primary education and secondary education. In addition, short term interventions were found to have a stronger effect on students' learning outcomes than long term interventions. It could be explained by the argument that the novelty effects of AI Chatbots could improve learning outcomes in short interventions, but it has worn off in the long interventions. Beyond academic performance, AI Chatbots have also been instrumental in building relationships with students. As universities engage more students, Chatbots become smarter and better at fostering connections. These relationships play a critical role in driving student retention, reducing summer melt, and improving graduation rates when implemented effectively.

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According to researchers, in the fall of 2018, California State University System (CSUN) opted to test CSUNny by allowing half of all first-time freshmen access to the Chatbot and measuring their success against a control group that did not use CSUNny. Three years later, in the fall of 2021, students who were given access to CSUNny were "significantly more likely" to still be enrolled at the university and were more likely to have already graduated (5.6 percent) than their control group counterparts (3.6 percent). Similar success was found by Georgia State University, one of the first institutions to use a Chatbot with the stated goal of reducing summer melt by staying in contact with students when they were away from campus. Pounce, Georgia State's Chatbot, reduced summer melt by 22 percent and has continued to evolve since then. In 2021, Pounce was offered to a group of political science students to remind them of upcoming exams, assignment deadlines and more. Students who used the Chatbot received better grades and were more likely to pass than those who did not. There is significant and diverse literature on what drives student success in the classroom. Scholars have looked at such factors as the impact of different types of instructors (Miskolczi and Rakovics 2018). The utilization of the Chatbot AI has been observed to have a positive impact on academic performance by enhancing learning motivation. Effective and ethical employment of Chatbot AI plays a significant role in promoting educational progress and enhancing academic achievement among students. Researches have shown that active engagement in Chatbot AI can improve students' critical thinking skills and promote their problem-solving abilities thereby contributing to a better academic performance.

Chatbox AI and Gender

A study by Kuhail, Thomas, Alramlawi and Shah (2022) assessed whether gender plays a role in students' perception of the personality-imbued Chatbots. Their findings showed a positive impact of Chatbot personality on perceived Catbot authenticity and intended engagement, while student gender did not play a significant role in the students' perception of Chatbots. According to an article published by Pew Research Centre in 2022, women in the U.S. are less likely than men to say that technology has had a mostly positive effect on society (42% vs. 54%) and more likely to say technology has had equally positive and negative impacts (45% vs. 37%). In addition, women are less likely than men to say they feel more excited than concerned about the increased use of AI computer programs in daily life (13% vs. 22%). Gender remains a factor in views about AI and technology's impact when accounting for other variables, such as respondents' political partisanship, education and race and ethnicity.

According to Baxter et al (2018), there have been many studies that show how gender affects human perceptions of a conversational agent. However, there is limited research on the effect of gender when applied to a Chatbot system. Gulz and colleagues 2007 study controlled the measure of femininity of female virtual characters through visual cues. Nass, Moon and Green's seminal study (1997) tested whether computers would trigger the same social scripts, expectations, and attributions associated with male and female gender stereotypes. They concluded that ''the tendency to gender-stereotype is not only deeply ingrained but can be triggered by minimal gender cues, even when those cues are disembodied". One character was developed to have more stereo-typically feminine features whereas the other character had less stereotypically feminine traits. Asides from visual cues, all aspects of both characters were identical as to their professions as medical doctors, their voice outputs and their lecturing content. The visual cues to the level of femininity complied with gender stereotypes and influenced he user's evaluation of the characters and the content of their lectures. (Nass, Moon and Green, 1997). Recent studies highlight that

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gender stereotyping is commonplace in HCI and brings with it both positive and negative results. (Rhim, Kim, Kim, and Yim, 2014). Subtle cues of visual stereotypes in pedagogical agents can have an impact on a user's learning experience and the way they absorb content in a digital environment. although Chatbots have garnered glowing reviews from various angles for the benefits they bring towards improving productivity and profit-making, the frequent anthropomorphisation of them as female, merits close scrutiny because of the impact on perceptions of women, as well as existing socio-cultural expectations, stereotypes and demands regarding how women are expected to act in society.

In a UNESCO report titled "I'd blush if I Could" (UNESCO, 2019), UNESCO detailed the potential negative impacts of Chatbots or voice-based conversational agents on societal perceptions of gender. According to the report, the proliferation of female-gendered conversational agents was primarily driven by customer preference and a non-critical examination of the product development decisions by product teams, which could entrench and perpetuate biases about women today. According to Nowak and Fox (2018), when avatars are gendered, they elicit gender stereotypes and people may then expect the avatars to have gendered knowledge. This might be due to the general stereotyping of women and men. Such attribution of (gendered) knowledge and stereotypes to Chatbots may be partly explained by the Computers Are Social Actors framework (CASA) stating that people respond to media agents mindlessly and therefore interact with them using the same script as one would use for human-to-human interactions (Nass and Moon 2000). People tend to expect the qualities of women to be linked with commonality; they should be warm, helpful to others and nurturing, while men's stereotypical domain refers to their agency, their competence and authority (Ellemers 2018). These stereotypical responses and expectations could in theory be applied to Chatbots as social agents. Gambino et al. (2020) suggest that although the social scripts we apply when talking human to human might not necessarily always apply directly to media agents (such as Chatbots), given that these media agents are now so common, we as humans might have developed scripts that we use in interaction with them. These human-machine scripts may be, similarly to human-human scripts, applied mindlessly (Gambino et al. 2020). When it comes to gender, different streams of research on conversational agents suggest that a female voice is deemed as more helpful regardless of the gender of the individual who interacts with an agent. This might be linked to females in general being perceived as more friendly (warm) and more helpful (De Angeli and Brahnam 2006). However, we do not know enough about the extent to which the usage of gender cues within text-only Chatbots especially its language style or assigned identity may elicit social gender stereotypes and how those stereotypes affect how Chatbots are perceived in terms of their knowledge and helpfulness.

Methodology

This study adopted a quasi-experimental pretest post-test non randomize control group design. This research will be conducted in AkwaIbom State. The population of this study consisted of 30,985 Senior Secondary School two students offering Biology as a subject in 227 Secondary schools in AkwaIbom State, Nigeria. A total number of 600 senior secondary school three male and female in sciences offering biology as a subject (280 males and 320 females) were divided into control and treatment groups. The researcher developed instrument called Biology Performance Test (BPT). They validation was done through content, and face validity. The

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researcher then incorporated all corrections into the work. Kuder-Richardson formula 21. test-retest method was used to accessed the reliability at 0.05 level of reliability. Descriptive Statistics of Mean and Standard Deviation was used to present data for answering research questions.

RESULTS AND DISCUSSION

Result of Descriptive Analysis and Answer to Research Questions:

In this section, the research questions are answered using mean and standard deviation.

Research Question one: What is the difference in academic performance in Biology of Senior Secondary School students exposed to Chatbot AI and those taught with expository method?

Table 1. Descriptive Statistics of the academic performance in Biology of Senior Secondary School students exposed to Chatbot AI and those taught with expository method

Group	Pre-Test Mean ($\overline{X}$)	SD	Post-Test Mean ($\underline{X}$)	SD	N	Mean Gain
ChatBot AI	51.25	3.166	72.85	7.42	359	21.60
Expository	51.22	3.155	54.77	6.23	241	3.55

Source: Field data (2024)

Data presented in Table 1 indicated that students in experimental group had pre-test mean score of 51.25 with 3.17 standard deviation and those in the control group had pre-test mean score of 51.22 with 5.156 standard deviation, indicating that both groups had almost similar scores in performance. In posttest, students exposed to Chatbot AI had a mean performance score of 72.85 and a standard deviation of 7.42. While those taught Biology with expository method had a mean performance score of 54.77 and a standard deviation of 6.23. The mean gained for the experimental group was 21.60 while the mean gained for the control group was 3.55. This indicated that students exposed to Chatbot AI performed higher than students taught Biology with expository method. This study agrees with the findings of Garrison and Kanuka (2014) who found out that the use of ChatBot AI provide students with a dynamic learning experience where content is delivered interactively, fostering deeper understanding through engagement rather than passive reception of information as in expository method, thereby enhancing students academic performance.

Research Question Two: What is the difference in academic performance in Biology of Senior Secondary School students exposed to Chatbot AI and those taught with expository method based on their gender?

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Table 2: Descriptive Statistics of the academic performance in Biology of Senior Secondary School students exposed to Chatbot AI and those taught with expository method based on their gender

Gender	Pre-test Mean (X)	SD	Post-test Mean (X)	SD	N	Mean Gain
Male	51.31	3.180	72.93	7.41	172	21.62
Female	51.18	3.160	72.78	7.44	187	21.60

Source: Field data (2024).

Data presented in Table 2 shows that male students had pre-test mean score of 51.31 with standard deviation of 3.18 and their female counterpart had pre-test mean score of 51.18 with standard deviation of 3.16, indicating that male and female performed at the same rate before treatment. In Posttest, male students who were exposed to Chatbot AI had a mean performance score of 72.93 and a standard deviation of 7.41. On the other hand, female students exposed to Chatbot AI had a mean performance score of 72.78 and a standard deviation of 7.44. The mean gained for the male group was 21.62 while the mean gained for the female group was 21.60. This is an indication that male and female students performed equally high when exposed to Chatbot AI. This result align with previous research on gender differences in technology-mediated learning environments by Vekiri and Chronaki (2018) who suggest that in digital learning contexts, gender disparities in academic performance tend to diminish or become negligible.

In this section, the hypotheses formulated to guide the study are tested.

Hypothesis One: There is no significant difference in academic performance in Biology of Senior Secondary School students exposed to Chatbot AI and those exposed to expository method.

Table 3: ANCOVA analysis of the academic performance in Biology of Senior Secondary School students exposed to Chatbot AI and those exposed to expository method

Source	Type III Sum of Squares	df	Mean Square	F	Sig. @p<.05	Decision
Corrected Model	47153.093[a]	2	23576.546	485.65	.00	**
Intercept	38609.055	1	38609.055	795.31	.00	**
Pre-test	13.576	1	13.576	.28	.60	S
Group	47143.616	1	47143.616	971.11	.01	S
Error	28982.047	597	48.546			
Total	2657364.000	600				
Corrected Total	76135.140	599				

a. R Squared = .619 (Adjusted R Squared = .618)

b. Source: Field data

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Table 3 shows that the Analysis of Covariance (ANCOVA) of mean performance scores of students exposed to Chatbot AI and those taught Biology using expository method. The result showed that F-Cal value of 971.11 was found to be significant in .01 which is less than 0.05 (P<0.05) at 0.05 level of significant set for the study. The null hypothesis one is therefore rejected indicating that there is significant difference in academic performance in Biology of Senior Secondary School students exposed to Chatbot AI and those exposed to expository method.

Hypothesis Two: There is no significant difference in the academic performance in Biology of Senior Secondary School students exposed to Chatbot AI based on gender.

Table 4: ANCOVA analysis of the academic performance in Biology of Senior Secondary School students exposed to Chatbot AI and those exposed to expository method based on gender

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Decision
Corrected Model	2.002[a]	2	1.001	.018	.98	NS
Intercept	31305.147	1	31305.147	565.913	.00	**
Pre-test	7.987	1	7.987	.000	.99	NS
Gender	2.002	1	2.002	.036	.85	NS
Error	19693.173	356	55.318			
Total	1925076.000	359				
Corrected Total	19695.175	358				

a. R Squared = .000 (Adjusted R Squared = -.006)

b. Source: Field data

Table 4 shows that the Analysis of Covariance (ANCOVA) of mean performance scores of students exposed to Chatbot AI based on gender. The result showed that F-Cal value of .036 was found to be not significant in .85 which is greater than 0.05 (P<0.05) at 0.05 level of significant set for the study. The null hypothesis two was therefore retained indicating that there is no significant difference in the academic performance in Biology of Senior Secondary School students exposed to Chatbot AI based on gender.

Conclusion

The study concluded that Utilization of Chartbot AI in teaching and learning Biology concepts is more effective than the use of tradional expository method because chatbot AI engages students in interactive conversations, provide immediate feedback and reinforce Biology knowledge which can encourage critical thinking in the students thereby improving their academic performance in Biology. Gender does not significantly affect the performance of student exposed to Chatbot AI because the decision to learn does not depend on gender, secondary Chatbot AI is designed to overcome the challenge of gender disparity. Moreover Chatbot AI provides personalized learning tailored to individual students irrespective of gender.The findings showed

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that students taught Biology using ChatBot AI outperformed those taught with traditional expository method. The study also revealed that revealed that male and female students performed equally high when exposed to Chatbot AI.

Recommendations

1) Curriculum planners and designers should integrate Chatbot AI into the educational system in AkwaIbom State to support student learning and retention.
2) AkwaIbom State governments should sponsor the partnership with technology providers to develop and implement Chatbot AI platforms tailored to specific needs of senior secondary school students and potentially improve academic performance and retention.

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