THE IMPACT OF GENERATIVE AI ON PERSONALIZED LEARNING: A MULTI-PHASE STUDY ON STUDENT ENGAGEMENT AND LEARNING OUTCOMES IN SECONDARY SCHOOLS IN EBONYI STATE

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Abstract

This study explores the potential of generative AI to revolutionize education. Through a mixed-methods approach, including surveys and a controlled experiment, it examines students' and teachers' perceptions of personalized learning and the role of technology. Findings indicate a strong desire for hands-on learning and tailored instruction. The intervention group, exposed to generative AI, demonstrated higher post-test scores and reduced score variability compared to the control group. However, challenges such as data collection limitations and the need for comprehensive teacher training surfaced. The research emphasizes the importance of a holistic approach to AI integration, considering ethical implications, user experience, and ongoing evaluation to maximize its benefits for student learning and achievement.

Keywords: *Generative AI, Personalized Learning, Student Engagement, Learning outcomes, multi-phase study.*

Introduction

Nigeria's educational landscape has been characterized by a persistent gap between the needs of diverse learners and the provision of adequate support. The prevailing one-size-fits-all approach to education has been criticized for its failure to accommodate individual learning styles and paces (Adedoyin & Adelabu, 2013). This rigid system, often prioritizing rote memorization and standardized testing, has resulted in disengagement and underachievement among many students. Compounding the issue is the problem of overcrowded classrooms, a persistent challenge that has limited teachers' capacity to provide individualized attention (Armstrong, 2010). UNICEF's 2021 report underscores the severity of this problem, highlighting its negative impact on the quality of education. Furthermore, the curriculum in many Nigerian schools has been criticized for its inadequate preparation of students for the demands of the 21st-century job market (World Economic Forum, 2020). A skills gap, characterized by deficiencies in critical thinking, problem-solving, and digital literacy, has emerged as a consequence.

In response to these challenges, personalized learning has emerged as a promising approach to education. By tailoring instruction to the unique needs, interests, and abilities of each student, this method aims to enhance engagement, improve learning outcomes, and promote equity (Ferguson, 2013). Research has consistently demonstrated the positive impact of personalized learning on student achievement (Guskey, 2007). Recent advancements in artificial intelligence (AI) have opened new possibilities for personalized learning. AI-powered tools and platforms can analyze student data to identify strengths, weaknesses, and learning preferences. This information can be used to create customized learning paths, provide targeted feedback, and offer individualized support.

Studies have explored the potential of AI to enhance education in various ways. Abulibdeh, Zaidan, and Abulibdez (2024) investigated the alignment of AI tools with sustainability principles in general

education. Devy and Rroy (2023) focused on AI's application in sustainable teaching within higher education. Klasnja-Milicevic and Ivanovic (2021) identified areas within e-learning systems where AI can contribute to a more sustainable approach.

The emergence of generative AI, exemplified by ChatGPT, has sparked significant interest in its educational applications. Researchers like Grassini (2023) and Qadir (2023) have examined the potential of generative AI to transform teaching and learning. Lee, Jung, Jeon, Sohn, Hwang, Moon, and Kim (2023) explored the use of generative AI for creating practice questions, while Jauhianen and Guerra (2023) investigated its application in personalizing reading materials.

While the potential benefits of AI in education are evident, research on its impact on student engagement and learning outcomes, particularly in the Nigerian context, is limited. This study aims to contribute to this emerging field by investigating the effectiveness of generative AI in enhancing student engagement and achievement in secondary schools in Ebonyi State.

Statement of Problem

Secondary schools in Ebonyi State face significant challenges in delivering effective education due to resource limitations and class size constraints. Overcrowded classrooms, characterized by disproportionate student-teacher ratios hinder personalized learning approaches. This is further compounded by a lack of qualified and motivated teachers, potentially due to inadequate training opportunities (Achilike& Achilike,2016).

Secondly, research examining traditional secondary school classrooms from the perspective of personalized learning suggests that the instructional practices that are typically used in classrooms may lack certain other conditions that enhance personalized learning experience. Most secondary school students in Ebonyi state still spend the majority of their classroom time doing individual seat work or listening to lectures, and while these activities may present significant challenges in which the students can apply their skills, they tend not to be very involving for students (Shernoff, Csikszentmihalyi, Schneider, & Steele- Shernof 2003).

Furthermore, the absence of robust technological infrastructure constitutes a major impediment to the integration of innovative educational tools. This situation creates a critical need for solutions that can personalize learning experiences for students despite these limitations. Generative AI, with its potential to provide tailored instruction, support, and content, offers a promising avenue for addressing these challenges. However, the impact of generative AI on student engagement and learning outcomes in this specific context remains unexplored.

Purpose of the Study

The general purpose of this study is to investigate the impact of generative AI on personalized learning in secondary schools, to explore how generative AI can improve student engagement and learning outcomes, and to conclusively contribute to the growing body of research on the potential of AI in education, particularly within resource-constrained contexts. Specifically, this research aims:

To assess the effectiveness of generative AI tools in promoting personalized learning experiences for students in Ebonyi State's secondary schools, considering the challenges of large class sizes, limited teacher training, and lack of technological infrastructure. To evaluate the impact of generative AI on student engagement and learning outcomes within this specific educational environment.

Research Questions

Phase 1: Needs Assessment and Pilot Study

- What are the perceptions, attitudes, and challenges related to personalized learning and generative AI among students, teachers, and administrators in Ebonyi State's secondary schools?
- To what extent is the implementation of generative AI tools feasible for personalized learning in Ebonyi State's secondary school context?
- What are the initial impacts of generative AI tools on student engagement and perceptions in a pilot setting?

Phase 2: Intervention and Evaluation

- Does the use of generative AI tools enhance student engagement compared to traditional teaching methods in Ebonyi State's secondary schools?
- How do students perceive the utility and usability of generative AI tools for learning?

- Does the implementation of generative AI tools for personalized learning improve student outcomes, considering variations in learning styles?

Methodology

This multi-phase study investigated the impact of generative AI on personalized learning experiences, student engagement, and learning outcomes in secondary schools within Ebonyi State, Nigeria.To gain a more comprehensive understanding of the research topic, the researchers employed a mixed methods approach, which combines both qualitative and quantitative data collection and analysis (Jonker & Pennink, 2010; Creswell, 2013). This approach acknowledges the limitations of relying solely on one type of research method (Creswell, 2013). By merging the findings from both methods, we were able to strengthen the overall quality of the study through triangulation (Kaplan & Duchon, 1988; Denzin, 2012). We believe this mixed methods approach was the most suitable choice because it allowed us to leverage the strengths of both qualitative and quantitative data to effectively address all the research questions (Creswell, 2002). The target population of the study was100 senior secondary school two students (SS2) students, 15 teachers, and 9 school administrators from 12 public and private schools in Ebonyi state selected via purposive random sampling. A total of 15 laptops and 4 palmtops were utilized by the researchers and research assistants to cater to the technological infrastructural deficit.

The detailed phase-by-phase strategies were outlined as follows:

Phase 1: Needs Assessment and Pilot Study
Main Focus:

Assessed the current understanding and perceptions of personalized learning and generative AI among students, teachers, and administrators. Identified potential challenges and opportunities for integrating generative AI tools into personalized learning practices within Ebonyi State's secondary schools. Conducted a pilot study to evaluate the feasibility and initial impact of using generative AI tools in the classroom setting.

Methods:
Needs Assessment Survey: A structured questionnaire was administered to students, teachers, and administrators to gather information on their understanding, attitudes, and perceived challenges related to personalized learning and generative AI.
Focus Groups: Focused group discussions were conducted with teachers and administrators to gain deeper insights into their perspectives and experiences with personalized learning approaches.
Pilot Study: A small group of classrooms was selected for a pilot implementation of generative AI tools for personalized learning. Data on student engagement and initial perceptions was collected.

Phase 2: Intervention and Evaluation
Main Focus From results of Phase 1:
Evaluate the effectiveness of generative AI tools in promoting student engagement with learning materials.
Assess the impact of generative AI on student learning outcomes compared to traditional learning methods.

Methods:
Quasi-Experimental Design: Two groups of students were recruited. One group (100) students randomly selected (intervention) received instruction with the integration of generative AI tools, while the other group (control) another set of 100 students received traditional instruction.
Pre-Test and Post-Test: Standardized achievement tests or subject-specific assessments were administered to both groups before and after the intervention period.
Engagement Measures: Data on student engagement were collected through surveys, observations, and classroom activity tracking tools.

Considerations for Addressing Resource Constraints:
The researchers: explored open-source or low-cost generative AI tools specifically designed for educational purposes such as Gemini, mathway, DreamBox, Quillbot, Khan Academy, Quizlet, Socratic by Google,and chatGPT. Focused on integrating generative AI tools into existing curriculum materials or learning activities to

maximize efficiency. Conducted teacher training workshops on basic functionalities and best practices for using generative AI tools in the classroom. Consider a phased implementation plan, starting with a small group of schools and expanding based on success.

Results

Phase 1:

The themes from the interviews cum Focus Group Discussions with the students, teachers, and School administrators were categorized into the following broad themes: Perceptions of GAI and personalized learning, current practices, technology integration, attitudes towards GAI, infrastructure, and support, envisioning AI-powered learning and summary. Some of the important responses in line with the themes were randomly captured and encapsulated thus:

Student 1: "I learn best by doing, so I love hands-on activities and group projects. Sometimes lectures can be a bit boring for me."

Teacher1:" We primarily use textbooks and sometimes improvised real-life objects for personalized learning. We group students based on their abilities" on the perception of AI, 'AI sounds like something complex and only for experts but I am excited about the possibility of AI providing personalized feedback to students"

School Administrator 1: "Our school is committed to personalized learning, but we face challenges in implementing it, we need to improve digital literacy among teachers." On the perception of AI, AI has the potential to revolutionize education it can be a valuable tool for identifying students who needs extra support, but we need to proceed cautiously"

All Students: (Generally positive about using technology in learning) "Technology can make learning more engaging and interactive. On-line simulations and games can be a fun way to learn new concepts but the possibility of using it in our classes is a mirage."

Perceptions of Personalized Learning:

Student 1: "I haven't really experienced personalized learning in class. It would be nice if teachers could adjust the pace of the lesson based on how everyone is doing which I think will be tedious for teachers considering the number of students in class"

Student 2: "I think it would be helpful to have learning materials that are tailored to my strengths and weaknesses. For example, if I'm struggling with math, I could get more practice problems on that specific topic."

Student 3: "Maybe personalized learning could help me stay more focused. Sometimes I get lost in class if the material is too easy or too hard for me."

Teacher 2: "I can see some challenges. It might be difficult for teachers to personalize learning for everyone in a large class. Like in my class, I have over 45 students"

Attitudes Towards Generative AI:

Student 1: "I've heard of AI like its application in driving cars, but I'm not sure how it can be used for learning."

Teacher 2: "AI could create personalized quizzes and assignments that help students understand the material better."

Student 3: "It would be nice if AI could summarize complex topics and break them down into smaller, easier-to-understand bits."

School Administrator 4: "I'm a little worried that AI might replace teachers. I think teachers are important because they can explain things and answer questions in real time. Again, AI cannot counselstudents or help them when they are emotionally down"

Envisioning AI-powered Learning:

Student 1: "An AI tutor that could explain things in different ways and answer my questions on the spot would be amazing."

Student 2: "I'd like an AI tool that suggests learning resources based on my interests and learning style. Maybe it could recommend educational videos or articles."

Student 3: "AI could be really helpful for subjects like science or history, where there's a lot of information to learn. It could create personalized flashcards or study guides with key points."

Wrap-up:
Teacher1: "I think AI has a lot of potential to personalize learning and make it more engaging. I'm excited to see how it develops."
SchoolAdministrator 2: "It's important that AI tools are user-friendly and don't feel overwhelming. They should be designed to help teachers, not replace them."
Teacher 2: "I think the most important thing is to have a good balance between technology and traditional learning methods. Technology can be a great tool, but it shouldn't replace human interaction in the classroom."
Teacher 3: "Overall, I don't know much about AI application in education, but I'm open to using AI in learning as long as it helps me teach more effectively.".

Phase 2:Intervention and Evaluation
Table 1: Mean and Standard deviation score for the intervention and control groups

Intervention Group	(AI instruction)	Control group (traditional instruction)
Pre-test score (average)	72.5	71.8
Post-test score (average)	81.2	77.4
Pre-test score (SD)	10.4	9.7
Post-test Score (SD)	8.3	11.2
Engagement survey Score (average)	8.7	7.9
Number of observations	85	92
Time spent on activities(average)	42	38

The data shows that the intervention group (students who received instruction with generative AI tools) had a higher average post-test score (81.2) than the control group (students who received traditional instruction; 77.4). However, it is important to note that the pre-test scores were also slightly higher for the intervention group (72.5) compared to the control group (71.8). It is also important to consider the standard deviations of the pre-test and post-test scores. The standard deviation for the intervention group's post-test scores (8.3) is lower than the standard deviation for the control group's post-test scores (11.2), suggesting that the intervention may have been more effective in reducing variability in achievement scores.

The data on engagement is also interesting. The intervention group had a slightly higher average engagement survey score (8.7) than the control group (7.9). However, the control group had a higher number of observations (engagement data) collected (92) compared to the intervention group (85). This could be due to several factors, such as the fact that the intervention group was more engaged in the learning activities and therefore required less observation from the teacher.

Discussion of Findings

From the responses and the themes in the first phase, it was inferred that Students preferred hands-on learning and found traditional lectures boring. Teachers utilize textbooks and real-life objects for personalized learning, grouping students by ability. School administrators aim for personalized learning but face challenges in teacher digital literacy. All students appreciate technology's potential for engaging learning but doubt its practical implementation. Students desire personalized learning tailored to their needs and pace, but teachers worry about managing large classes. There's limited understanding of AI among students and teachers, but excitement exists for its potential in personalized feedback and learning support. Concerns about AI replacing teachers and its impact on emotional support arose. Students envision AI tutors, personalized learning tools, and AI-powered study aids. Educators see AI's potential but emphasize the need for user-friendly tools, balance with traditional methods, and effective teacher training. These findings are in tandem with research done by Seo et al. (2021) that investigated how students and teachers think AI systems affect students' and teachers' interaction in online learning settings. Their findings show that people have a more complex understanding of the pros and cons of using AI tools together. A major concern is that students and teachers are worried about the control, freedom, and privacy issues that come with AI making decisions. Some students feel that AI-driven learning is too rigid and doesn't allow for individual learning styles. While AI can improve communication, provide instant support, and strengthen connections, there are risks like privacy breaches and the potential to hinder independent learning. Also, Buluwan (2023),reported thatGenerative AI tools have provided secondary school students he studied in Noveletawith endless ideas that help them in creating their activities in school and helping them develop their creative thinking. AI tools have also been a guide through

their activities especially in giving them formats, explanations, ideas, etc which enhanced personalized learning.

For phase two, findings revealed that students who received instruction with generative AI tools (intervention group) outperformed those with traditional teaching methods (control group) on the post-test, scoring an average of 81.2 compared to 77.4 for the control. While the intervention group also began with slightly higher pre-test scores (72.5 vs. 71.8), their post-test scores were less spread out (standard deviation of 8.3 vs. 11.2), indicating a potentially greater consistency in learning outcomes. This finding collaborates with research done by Oyebola Olusola Ayeni et al., (2024). According to the research they conducted, AI-driven personalized learning increases academic success, retention, and understanding by accommodating a variety of learning styles. AI creates an inclusive and dynamic teaching environment that empowers students.

The study made by Oseremi Onesi-Ozigagun et al., (2024) also aligns with the findings of this phase of the study. The researchers found that generative AI is transforming education in two key ways: improving teaching methods and making school administration more efficient.

AI has the potential to revolutionize learning by tailoring education to each student's needs, providing teachers with instant feedback, automating grading, and using data to create better assessments. It can also simplify tasks like enrolling students and managing school resources.

While the study highlights the many benefits of AI in education, it also acknowledges important challenges such as protecting student data, preventing bias in AI systems, and ensuring teachers have the training they need to use AI effectively.

Additionally, the AI-assisted group showed slightly higher average engagement (8.7 vs. 7.9). However, it's important to note that less engagement data was collected for this group (85 vs. 92), possibly due to increased student independence facilitated by the AI tools.

Conclusion

The findings of this research illuminate a complex interplay of factors influencing the educational landscape. Students and educators alike express a strong desire for personalized learning, marked by active engagement and tailored instruction. While traditional methods have their place, the study reveals a clear preference for experiential learning and the strategic use of technology.

The integration of generative AI into the classroom holds significant promise. Preliminary results from the intervention group indicate potential for improved student outcomes, particularly in terms of average achievement and reduced performance variability. However, further research is necessary to establish causation and to address concerns about engagement data collection.

To fully harness the potential of AI in education, a multi-faceted approach is required. This includes developing user-friendly AI tools, providing comprehensive teacher training, and carefully considering the ethical implications of AI integration. By addressing the identified challenges and building upon the positive outcomes, educators can create a future where technology enhances, rather than replaces, the human element of teaching and learning.

Ultimately, the successful implementation of personalized learning, whether through traditional or technological means, depends on a collaborative effort involving students, teachers, administrators, and policymakers. By working together, it is possible to create educational environments that are engaging, effective, and equitable for all learners.

Recommendations

Based on the research findings, the following recommendations are proposed:

1. Educational institutions in the study area and Nigeria should invest in teacher training by providing a comprehensive training program to equip educators with the digital literacy and pedagogical skills necessary to integrate AI tools into their classrooms effectively.
2. Educational institutions should prioritize professional development to offer ongoing professional development opportunities to support teachers in adapting their instructional practices to personalized learning approaches.
3. The government should promote digital infrastructure to ensure equitable access to technology and high-speed internet for all students to support personalized learning initiatives.
4. The government should support AI integration in education byallocating resources for research, development, and implementation of school AI initiatives.

5. The government should Invest in teacher training by providing funding for teacher professional development programs focused on AI integration and personalized learning.

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