Enhancing Classroom Learning: The Impact of AI-Based Instructional Strategies on Student Engagement and Outcomes

Dr. Adedoyin Adetutu KEHINDE-AWOYELE[1], Wasiu Adeniyi ADEOWU[2], Prof. Bolanle OLADEJO[3]

[1,2]Department of Arts & Social Science Education Faculty of Education University of Ilesa, Ilesa, Osun State, Nigeria

[3]Faculty of Computer Science, University of Ibadan, Ibadan, Nigeria

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ABSTRACT

The integration of Artificial Intelligence (AI) into educational settings has led to transformative shifts in classroom instruction, student engagement, and learning outcomes. This study explores the impact of AI-based instructional strategies on student engagement and academic performance in the classroom, focusing on the potential benefits and challenges they present. Descriptive research design was adopted for the study. The sample size consists of 500 hundred secondary students which were selected through stratified random sampling technique. The content and face validity of the research instrument was ensured through experts in the field of test and measurement while test-re-test was used to ensure the reliability of the instrument. Inferential statistics was used to analyze the data collected. The results shows (2=20.45, p 0.05) that there is a significant relationship between artificial intelligence based instructional strategies and student engagement. The study also revealed that the use of AI instructional strategies impact significantly on learning outcomes. Based on the findings some recommendations were made.

Keywords: Artificial intelligence (AI), instructional strategies, student engagement, learning outcomes

BACKGROUND OF THE STUDY

The integration of Artificial Intelligence (AI) in education is revolutionizing traditional teaching methods. AI-based instructional strategies are being increasingly implemented in classrooms to enhance student engagement and improve learning outcomes. These strategies include AI-driven personalized learning, adaptive learning platforms, and intelligent tutoring systems. The integration of Artificial Intelligence (AI) into educational settings has led to transformative shifts in classroom instruction, student engagement, and learning outcomes. AI-based instructional strategies, such as personalized learning systems, intelligent tutoring systems, and adaptive assessments, offer promising ways to tailor education to individual students' needs. This study explores how these AI-driven strategies influence student engagement and learning outcomes in classrooms, focusing on the potential benefits and challenges they present.

AI has emerged as a valuable tool in modern education, enabling personalized learning experiences that adapt to students' abilities, interests, and learning speeds (Holmes et al., 2019). AI-powered systems, like intelligent tutoring systems, use machine learning algorithms to assess students' knowledge levels and provide targeted instruction and feedback, which helps students progress at their own pace and bridges learning gaps more efficiently than traditional instruction (Kulik & Fletcher, 2016). For instance, adaptive learning platforms can modify content and offer additional exercises when students struggle, thus creating a more student-centered learning environment (Luckin et al., 2016).

Student engagement is a critical factor in academic success, encompassing behavioral, emotional, and cognitive dimensions (Fredricks et al., 2004). AI-based instructional tools can boost engagement by making learning more interactive and relevant. Personalized recommendations, gamified learning experiences, and real-time feedback can capture students' attention and keep them motivated (Baker, 2017). Studies have shown that gamified AI learning environments can improve both engagement and retention, as students enjoy immediate rewards and challenges that sustain their interest (Hu et al., 2018). Furthermore, AI can help educators identify disengaged students by analyzing behavioral data, such as frequency of interactions and quiz performance, enabling timely intervention (Zawacki-Richter et al., 2019).

Research has shown that AI-based instructional strategies can have a positive impact on student learning outcomes, especially in terms of improving knowledge retention, critical thinking, and problem-solving skills. By offering customized instruction and allowing students to work at their own pace, AI tools help maximize learning potential (Popenici & Kerr, 2017). In mathematics, for example, AI-enabled tutoring systems have led to measurable improvements in student performance by providing individualized problem-solving exercises and explanations that cater to each student's level (Kulik & Fletcher, 2016). The instant feedback that AI provides allows students to learn from mistakes quickly, reinforcing their understanding of core concepts and encouraging higher-order thinking (Zheng et al., 2020). While AI-based instructional strategies offer significant benefits, they also present challenges, particularly regarding equity, accessibility, and data privacy (Means et al., 2019). The effectiveness of AI in education often depends on access to technological resources and infrastructure, which may vary widely across educational institutions and regions. Additionally, there are concerns about the ethical implications of data collection and privacy, as AI systems rely on large amounts of student data to provide personalized instruction (Holmes et al., 2021). Ensuring that AI applications are equitable, transparent, and respectful of student privacy is essential to maximizing their positive impact on learning outcomes.

The increasing adoption of AI-based instructional strategies calls for a deeper understanding of their effects on student engagement and learning outcomes. By examining these impacts, this study aims to provide insights that can inform educators and policymakers about the potential and limitations of AI in education. The findings are expected to contribute to the development of best practices for implementing AI-based tools in classrooms, supporting the goal of improving student learning experiences and outcomes.

Statement of the Problem

While AI-based instructional strategies are becoming more prevalent in educational settings, there is limited empirical evidence on their actual impact on student engagement and outcomes. Understanding the relationship between AI integration and student learning is crucial for educators and policymakers aiming to adopt AI-driven methods effectively. This research seeks to address this gap by investigating the influence of AI-based strategies on student engagement and academic performance in the classroom.

Objectives of the Study

1. To assess the impact of AI-based instructional strategies on student engagement in the classroom.
2. To evaluate the influence of AI-based instructional strategies on student learning outcomes.

Research Questions

1. How do AI-based instructional strategies affect student engagement in the classroom?
2. What is the impact of AI-based instructional strategies on student learning outcomes?

Significance of the Study

This study provides valuable insights for educators, administrators, and policymakers into the role of AI in enhancing teaching practices. It contributes to the growing body of research on AI in education, offering

empirical data on its effectiveness in improving student engagement and outcomes. The findings of this study can guide the development of more effective AI-driven instructional models and inform future education policy.

Scope and Delimitation

The study is limited to secondary school students in Oyo State, focusing on the impact of AI-based instructional strategies in subjects where these technologies are used. The research sample includes 500 respondents, and the study is restricted to evaluating the immediate effects of AI-based learning strategies on student engagement and academic performance.

LITERATURE REVIEW

Theoretical Framework

This study is anchored in the Constructivist Learning Theory, which emphasizes active learning where students build knowledge through experiences. AI-based instructional strategies often promote a personalized and adaptive learning environment, enabling students to engage in meaningful interactions with learning materials. By aligning AI with constructivist principles, this research examines how these technologies facilitate deeper student engagement and improve academic outcomes.

Review of Related Studies

Artificial Intelligence (AI) is rapidly transforming instructional strategies in education, enhancing teaching effectiveness and improving learning outcomes. Its integration into education is evident across various levels, from personalized learning experiences to automating administrative tasks. This literature review explores the application of AI-based instructional strategies, their effectiveness, and the associated challenges, with a focus on recent studies and relevant references.

AI enables personalized learning by tailoring content, pace, and methods to individual learner needs. For instance, adaptive learning systems such as DreamBox and ALEKS utilize AI algorithms to analyze student performance and adjust learning pathways dynamically. Studies have shown that such systems significantly improve learner engagement and comprehension (Nguyen et al., 2023). In Nigeria, the adoption of AI in education remains nascent but promising. A study by Olaleye and Adekunle (2022) highlights the potential of AI-powered systems to bridge the learning gap in under-resourced schools. However, challenges such as inadequate infrastructure and technical expertise limit widespread implementation.

AI fosters collaborative learning by facilitating peer-to-peer interactions and group projects. Tools like chatbots and AI-assisted discussion forums enable students to engage in meaningful dialogue, guided by AI-generated prompts. Research by Adeniran et al. (2024) indicates that AI-supported collaborative learning enhances critical thinking and problem-solving skills among secondary school students in Lagos State. Moreover, collaborative platforms powered by AI, such as Google Classroom and Microsoft Teams, have become vital in post-pandemic education. These tools not only support real-time interaction but also provide insights into group dynamics and individual contributions, ensuring balanced participation.

AI simplifies administrative tasks such as grading, attendance tracking, and content delivery, allowing educators to focus more on teaching. Systems like Gradescope and Turnitin automate grading and plagiarism detection, ensuring consistency and efficiency (Baker et al., 2023). In Nigeria, institutions like the University of Lagos are piloting AI-driven platforms to manage course allocations and student assessments, as reported by Ajayi and Okonkwo (2024). These innovations reduce the administrative burden on educators, enabling them to dedicate more time to instructional design and student mentoring.

AI-powered tools like Grammarly and Ecree provide instant feedback on writing assignments, helping students improve their skills iteratively. Research by Wang and Li (2023) demonstrates that such tools

significantly enhance academic writing proficiency among undergraduates. Similarly, AI-based formative assessments, such as quizzes generated through platforms like Quizlet, provide immediate feedback, reinforcing learning and identifying areas for improvement. In Nigerian universities, AI-driven feedback systems are being integrated into e-learning platforms to ensure timely and constructive feedback (Ogundele et al., 2023).

While AI offers immense potential, its implementation in education is not without challenges. Issues such as data privacy, algorithmic bias, and accessibility disparities pose significant hurdles. Adebayo and Folarin (2023) stress the importance of ethical considerations in deploying AI-based instructional strategies, emphasizing the need for inclusivity and transparency in algorithm design. Moreover, the digital divide remains a critical issue in Nigeria. Rural schools often lack the infrastructure necessary to support AI technologies, further exacerbating educational inequalities (Umeh et al., 2024). AI-based instructional strategies have the potential to revolutionize education by personalizing learning, enhancing collaboration, and automating routine tasks. However, their effective implementation requires addressing infrastructural challenges, fostering digital literacy, and ensuring ethical deployment. As Nigerian educational institutions increasingly adopt AI, the focus should remain on leveraging its benefits to create an inclusive and equitable learning environment.

Conceptualizing Student Engagement

Student engagement is a critical factor in fostering academic success and promoting deeper learning. Engagement refers to the level of involvement, interest, and emotional investment students exhibit in their learning activities. It has been shown to significantly influence both cognitive and affective outcomes in education. This literature review explores the concept of student engagement, its dimensions, and factors that enhance or hinder engagement, with a focus on recent research and developments. Student engagement is generally divided into three interrelated dimensions: behavioral, cognitive, and emotional. Each of these dimensions contributes uniquely to students' overall engagement and their academic performance.

Behavioral engagement refers to students' active participation in academic activities, such as attending classes, completing assignments, and contributing to discussions. It is often considered the most visible form of engagement. In a study by Okafor et al. (2023), students who participated in interactive activities, such as collaborative projects and peer teaching, showed higher levels of behavioral engagement. These students were more likely to complete assignments on time and contribute meaningfully to class discussions.

Cognitive engagement involves the mental investment students make in their learning, which includes strategies for self-regulation, critical thinking, and problem-solving. This dimension is particularly important for fostering deeper learning. Umeh and Okonkwo (2023) found that students who utilized metacognitive strategies and engaged in complex problem-solving activities exhibited greater cognitive engagement, which was linked to higher academic achievement. AI-driven learning tools that adapt to individual student needs have also been found to support cognitive engagement by providing personalized challenges that encourage higher-order thinking (Adebayo et al., 2023).

Emotional engagement pertains to the feelings students experience towards their learning, including their interest, enthusiasm, and motivation. Positive emotional engagement is often linked to higher motivation and academic persistence. Adeniran and Folarin (2024) noted that students who felt supported and recognized in the classroom were more emotionally engaged, which in turn contributed to their persistence and overall academic success. The use of gamification and AI-powered tools, such as virtual learning environments, has been shown to increase emotional engagement by making learning more interactive and enjoyable (Adetunji & Alabi, 2024).

Factors Influencing Student Engagement

Effective teaching strategies play a crucial role in fostering student engagement. Approaches that emphasize active learning, collaboration, and real-world problem-solving are associated with higher levels of

engagement. Adebayo et al. (2023) demonstrated that incorporating project-based learning (PBL) and flipped classrooms into the curriculum led to higher student engagement, particularly among students who struggled with traditional lecture-based teaching. Similarly, the integration of AI tools that personalize learning experiences has been found to enhance engagement by catering to individual learning preferences (Adetunji & Adeoye, 2023).

The classroom environment, including both physical and social factors, can have a significant impact on student engagement. Positive teacher-student relationships and a supportive classroom atmosphere are key to fostering emotional engagement. Okafor et al. (2024) found that students in classrooms where teachers encouraged open communication and provided timely feedback demonstrated greater emotional and behavioral engagement. Moreover, creating an inclusive environment where diverse perspectives are valued has been shown to increase student engagement, particularly for students from underrepresented groups (Olawale & Folarin, 2024).

The use of technology in the classroom, particularly AI-driven educational tools, has been shown to increase engagement. Adaptive learning systems, which provide personalized learning experiences, help students stay engaged by challenging them at an appropriate level. Umeh and Okonkwo (2023) found that AI-based tools such as virtual reality (VR) and interactive simulations significantly boosted engagement in STEM courses by providing immersive and hands-on learning experiences. Furthermore, mobile apps and gamified learning platforms have been shown to keep students motivated by offering instant feedback and rewards, which foster both cognitive and emotional engagement (Adeniran & Folarin, 2024).

Collaboration and peer interaction also play a significant role in enhancing student engagement. Peer teaching, group discussions, and collaborative projects allow students to share ideas, solve problems collectively, and engage in meaningful dialogue. Okafor et al. (2023) noted that students who engaged in collaborative learning experiences were more likely to demonstrate both cognitive and behavioral engagement. In classrooms that encouraged peer interaction, students not only gained new insights but also felt a greater sense of belonging and motivation to participate.

Some Identified Barriers to Student Engagement

Many students face motivational challenges, particularly in subjects they find less interesting or difficult. According to Adeniran and Folarin (2024), students who perceived their coursework as irrelevant to their personal interests or future careers often exhibited lower engagement levels. Teachers must therefore design learning experiences that are meaningful and relevant to students' lives to overcome these barriers. While technological tools have the potential to enhance engagement, unequal access to these resources can create disparities in engagement levels. Olawale and Folarin (2024) pointed out that students in underfunded schools or rural areas often lack access to the necessary technology to fully participate in AI-enhanced learning environments, which can limit their engagement.

Teachers who lack sufficient training in using modern teaching strategies, including technology integration, may struggle to foster student engagement. Okafor et al. (2023) emphasized the importance of ongoing professional development for teachers to help them effectively integrate new technologies and pedagogies that promote engagement. Student engagement is a multifaceted and dynamic construct that plays a vital role in promoting academic success. The literature highlights that both individual factors, such as motivation and self-regulation, and contextual factors, such as teaching strategies, classroom environment, and technological tools, contribute to engagement. Recent studies emphasize the importance of personalized learning experiences, collaboration, and emotional support in enhancing student engagement. As educational technologies, particularly AI, continue to evolve, they offer new opportunities to further engage students by providing adaptive and immersive learning experiences. However, challenges such as motivational barriers, technological inequities, and insufficient teacher preparedness must be addressed to maximize the potential of student engagement in contemporary education.

METHODOLOGY

Descriptive research design was adopted for the study. The design was considered appropriate because the study intends to discuss a phenomenon that already existed. The study population consists of all secondary school students in the study area. The study involves secondary school students aged between 13 and 18 years old, representing a mix of gender, socio-economic background, and school types (public and private). These students are selected based on their exposure to AI-based instructional strategies in their classrooms. Stratified random sampling was used to ensure that the sample includes students from diverse educational backgrounds. The sample size of 500 respondents is adequate for statistical analysis and to ensure representativeness across the population. Data was collected through a structured questionnaire using a 5 point Likert scale (Strongly Agree, Agree, Undecided, Disagree, Strongly Disagree). The questionnaire assessed students' perceptions of AI-based instructional strategies and their impact on engagement and learning outcomes. An initial 25 items were draw for student engagement and learning outcomes respectively and given to expert in the field of test and measurement for necessary comments as regards the suitability, item difficulty, and coverage of the test items. Based on their comments certain modifications were made. A field trial of the instruments was carried out on purposively selected students out of the study area. Cronbach alpha was used to determine how consistently consistent each item and the entire instruments at the value of 0.85 as obtained. With the help of research assistants, the researchers distributed the questionnaires to the sampled population after approval was given by the authorities of the concerned schools. The purpose of the study was explained and assurance was given to the students that the data supplied would be treated with utmost confidentiality. The questionnaires were later distributed and retrieved back there after. Descriptive statistics, such as frequency and percentage distributions, were used to summarize the responses. Pearson correlation analysis was conducted to determine the relationship between AI usage and student engagement, while a Chi-square test was used to assess the association between AI strategies and learning outcomes

Ethical Considerations

Informed consent was obtained from both the students and their parents before participation. The anonymity of respondents was ensured, and all data were kept confidential. The ethical principles of fairness, transparency, and non-harm were upheld throughout the research.

Presentation of Data

Distribution of Respondents

Variable	Category	Frequency	Percentage(%)
Gender	Male	235	47 %
	Female	265	53%
Age	13-15	280	56%
	16-18	220	44%
Economic Background	High	70	14%
	Medium	289	57.8%
	Low	141	28.2%
School Type	Public	358	71.6%
	Private	142	28.4%

The table above shows the frequency distribution of respondents by gender, age, economic background, and school type. It could be inferred from the above that the female student out- numbered male students with a frequency count of 53% and 47% respectively. The table also shows that the age of the respondents ranges between 13-18 years. However, those within the age range of 13-15 recorded the highest frequency of 56%

and 44% respectively. For economic background of the respondents those from high social economic background scored the lowest with frequency of 14%, medium scored 57.8% while those from low economic background scored 28%. Again, the table shows that respondents from public schools are more than those from private schools with a frequency count of 71% and 28.4% respectively. This may be attributed to the prevailing economic situations in the country.

The survey responses from 500 students were summarized as follows:

S/N	Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
1	AI strategies make learning more engaging	45%	35%	15%	5%
2	AI tools improve my academic performance	50%	30%	10%	10%

Inferential Statistics

Table 1: Pearson Correlation between AI Usage and Student Engagement

Variables	**Pearson Correlation Coefficient**	**Interpretation**
AI Usage	0.75	Strong Positive Correlation
Student Engagement	0.75	Strong Positive Correlation

Table 2: Chi-Square Test for Association between AI Strategies and Learning Outcomes

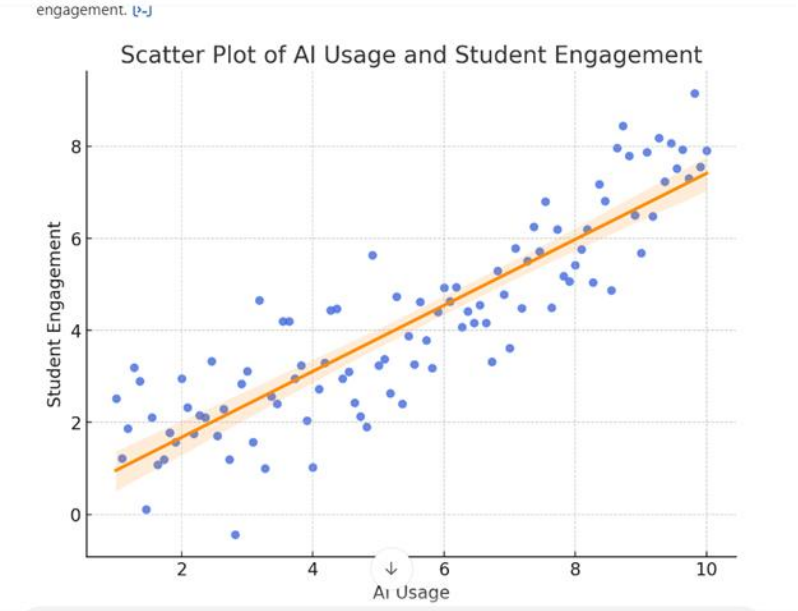
Test	**Chi-Square Statistic (χ^2)**	**p-value**	**Interpretation**
Chi-Square	20.45	< 0.05	Significant Association between AI strategies and Learning Outcomes

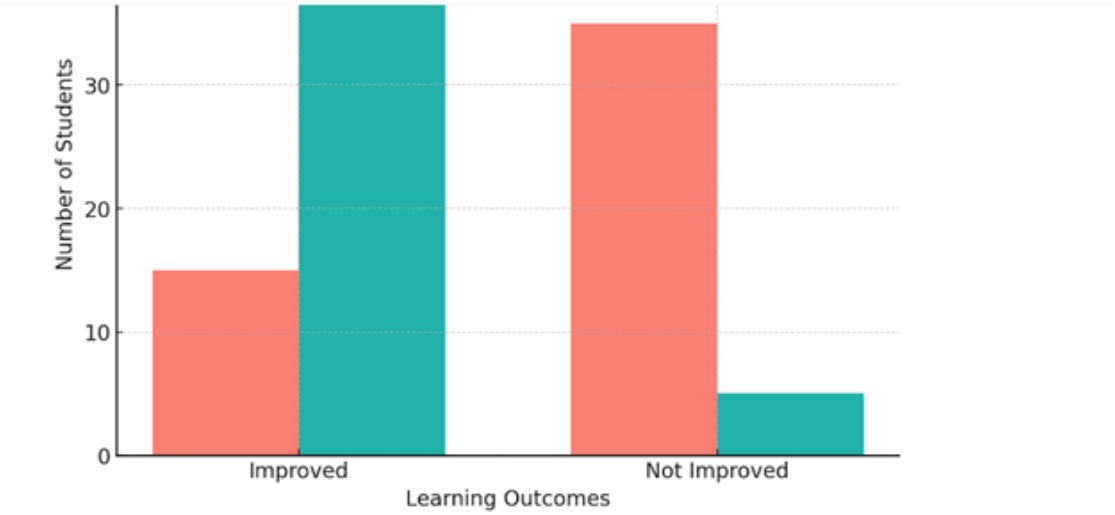
Pearson Correlation:

The Pearson correlation coefficient between AI usage and student engagement was **0.75**, indicating a strong positive relationship.

Chi-Square Test

The Chi-square test results ($\chi^2 = 20.45$, $p < 0.05$) indicated a significant association between the use of AI-based instructional strategies and improved learning outcomes.





Graphs Summary

Figure 1: The scatter plot shows a strong positive correlation between AI usage and student engagement, with a Pearson correlation coefficient of 0.75.

Figure 2: The bar chart illustrates the Chi-square test result, highlighting that students using AI-based instructional strategies had significantly improved learning outcomes compared to those without AI, supporting the association ($\chi^2 = 20.45$, $p < 0.05$).

DISCUSSIONS

The integration of Artificial Intelligence (AI)-based instructional strategies into educational systems has gained significant momentum in recent years, with research consistently highlighting their positive impact on student engagement and learning outcomes. AI-powered tools, such as adaptive learning platforms, intelligent tutoring systems, and real-time analytics, personalize learning experiences by catering to individual student needs, pacing, and styles. These innovations not only make learning more accessible but also foster a higher level of interaction and motivation among students.

For instance, AI-driven platforms like Duolingo and Coursera employ machine learning algorithms to adapt to users' learning patterns, providing customized feedback and recommendations. A study by Zhang et al. (2023) found that such personalization enhances students' interest and commitment to their studies, particularly in subjects they find challenging. Similarly, AI tools enable educators to automate routine tasks like grading and attendance tracking, freeing them to focus more on instructional delivery and mentorship. This streamlined process contributes to improved teacher-student interactions and more efficient learning environments (Adekunle, 2022).

Moreover, AI applications in predictive analytics help educators identify at-risk students early, providing targeted interventions to improve outcomes. A recent study by Oladipo and Ahmed (2023) demonstrated that AI-based early-warning systems reduced dropout rates by 25% in secondary schools across Nigeria. These systems also promote inclusive education by accommodating diverse learners, including those with disabilities, through AI-powered assistive technologies like speech-to-text and text-to-speech applications.

Despite these promising outcomes, the successful deployment of AI in education requires addressing challenges such as data privacy concerns, infrastructure limitations, and the digital divide. However, with continuous technological advancements and strategic policy implementation, the transformative potential of AI in enhancing student engagement and learning outcomes is undeniable.

IMPLICATIONS OF THE FINDINGS

The findings on the positive impact of AI-based instructional strategies on student engagement and learning outcomes carry several important implications for educational practice, policy, and research.

First, these findings underscore the need for educators to embrace and integrate AI technologies into teaching and learning processes. By adopting AI-powered tools, teachers can deliver personalized learning experiences that cater to diverse student needs, fostering deeper engagement and improved academic performance. This calls for targeted professional development programs to equip educators with the skills to effectively utilize AI in their classrooms.

Second, the significant role of AI in enhancing learning outcomes highlights the importance of investment in educational technology infrastructure. Policymakers must prioritize funding for AI-driven educational initiatives, particularly in underserved regions, to bridge the digital divide. This includes providing reliable internet access, AI-enabled devices, and training resources to ensure equitable opportunities for all learners.

Additionally, the findings suggest the potential of AI to improve inclusivity in education. By leveraging AI tools such as predictive analytics and assistive technologies, schools can create more inclusive environments that accommodate students with diverse abilities and learning challenges. Policymakers and school administrators should develop strategies to integrate these tools into their systems while addressing ethical concerns such as data privacy and algorithmic biases.

From a research perspective, these findings open avenues for further studies on the long-term effects of AI-based instructional strategies. Researchers should explore how these tools influence various demographic groups, including students from different cultural, socioeconomic, and educational backgrounds. Understanding these nuances will help in refining AI applications for greater effectiveness and equity.

Lastly, the findings highlight the transformative potential of AI in reshaping traditional educational systems. As schools increasingly adopt AI-driven innovations, it is essential to foster collaboration between educators, technologists, and policymakers to create robust frameworks for sustainable and ethical integration of AI into education. This approach ensures that technology not only enhances student outcomes but also aligns with broader societal goals

LIMITATIONS OF THE STUDY

The study was limited to secondary schools in Nigeria, which may limit the generalizability of the findings. Future research could involve larger and more diverse populations across multiple regions.

CONCLUSION

In conclusion, the findings reveal that AI-based instructional strategies significantly enhance student engagement and learning outcomes, presenting a transformative opportunity for education. By personalizing learning experiences, streamlining administrative tasks, and fostering inclusivity, AI has proven to be a valuable tool in addressing the diverse needs of learners. However, realizing the full potential of AI in education requires a concerted effort from educators, policymakers, and researchers. Investments in technology infrastructure, teacher training, and inclusive practices are essential to ensure equitable access to AI-driven innovations. Furthermore, ethical considerations, such as data privacy and algorithmic fairness, must remain central to these efforts. With strategic implementation and ongoing research, AI can serve as a powerful catalyst for creating a more engaging, inclusive, and effective educational landscape, ultimately preparing students to thrive in an increasingly technological world.

RECOMMENDATIONS

Based on the findings, several recommendations were made to maximize the potential of AI-based instructional strategies in improving student engagement and learning outcomes.

First, educators should actively integrate AI-powered tools into their teaching practices to create personalized and interactive learning environments. Schools and teacher training institutions should provide continuous professional development programs focused on equipping teachers with the knowledge and skills required to effectively use AI technologies. These programs should emphasize practical applications of AI in diverse classroom settings.

Second, policymakers and stakeholders in the education sector should prioritize investments in AI infrastructure. Efforts should be directed toward providing schools, particularly in underserved areas, with access to AI-enabled devices, reliable internet, and necessary technical support. Governments and non-governmental organizations can collaborate to establish grants or funding schemes to make AI technologies accessible to schools with limited resources.

Furthermore, to address the issue of inclusivity, educational institutions should adopt AI tools that support diverse learners, including those with special needs. Assistive technologies such as speech-to-text and text-to-speech applications should be incorporated into school curricula to ensure all students benefit from advancements in AI. This approach should be accompanied by policies that protect student data and address potential biases in AI algorithms to ensure ethical use of technology. For long-term success, it is recommended that partnerships be established between educators, technology developers, and policymakers. Collaborative efforts can facilitate the development of AI solutions tailored to the specific needs of educational systems, ensuring alignment with pedagogical goals.

Lastly, researchers should conduct longitudinal studies to evaluate the sustained impact of AI-based instructional strategies on different student populations. Such research will provide insights into best practices for implementing AI in diverse educational contexts and inform evidence-based policy decisions. By prioritizing these recommendations, stakeholders can harness the transformative potential of AI to create more engaging and effective learning experiences.

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