SSR Journal of Artificial Intelligence (SSRJAI)

OPEN ACCESS

Homepage: https://ssrpublisher.com/ssrjai/

Volume 3, Issue 9, 2026 ISSN: 3049-0413

Innovation and Adaptation of Artificial Intelligence in Teaching and Learning of Smart Agricultural Economics Education

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Received: *05.08.2026* | ***Accepted:*** *05.09.2026* | ***Published:*** *06.09.2026*

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DOI: *10.5281/zenodo.22520946*

Abstract **Original Research**

This study explores the integration of Artificial Intelligence (AI) in teaching and learning Smart Agricultural Economics, examining its impact on student engagement, learning outcomes, and educational efficiency. A mixed-methods approach was employed to collect data for the study, combining surveys, interviews, and content analysis to select 200 respondents among educators, students, and other experts. Data were analyzed using descriptive statistics, multiple regression, and ANCOVA. The results revealed that the coefficient for age was negative and significant at 5% ($p = 0.0341$), indicating that older educators tend to have less favorable perceptions toward AI-powered learning platforms, while the coefficient for teaching experience is positive and significant at 1% ($p = 0.0093$), suggesting that educators with more teaching experience tend to have more favorable perceptions toward AI-powered learning platforms. The high R-squared value (0.816) indicates that the independent variables explain about 81.6% of the variation in perceptions toward AI-powered learning platforms. The study concludes that the integration of AI in teaching and learning Smart Agricultural Economics has the potential to revolutionize the educational landscape. The findings suggest that AI-powered learning platforms and tools can enhance student engagement, learning outcomes, and educational efficiency, noting the technical, pedagogical, and institutional challenges. The study recommends the development of AI-powered learning platforms and tools, capacity building for educators, and policy support for AI integration in Agricultural Economics education.

Keywords: Artificial Intelligence, Smart Agricultural Economics, Teaching and Learning, Educational Efficiency, Student Engagement.

INTRODUCTION

The integration of Artificial Intelligence (AI) in education has transformed the learning landscape, offering personalized learning experiences, enhancing student engagement, and improving learning outcomes (Hwang, 2020; Luckin *et al*., 2016). In the context of Agricultural Economics, AI-powered learning platforms and tools have the potential to revolutionize the way students learn about agricultural economics, agribusiness, agricultural marketing, farm management, price analysis, policy and sustainable agriculture (Kamilaris *et al*., 2022; Rose *et al*., 2018).

In Nigeria and Africa, Agricultural Economics plays a critical role in the economy, providing employment opportunities, food security, and poverty reduction (Adebayo *et al*., 2017; FAO, 2017). However, the teaching and learning of Agricultural Economics face significant challenges, including inadequate infrastructure, limited access to educational resources, and outdated teaching methods (Akpokodje *et al*., 2017; Okeke *et al*., 2017).

The importance of AI in education and Agricultural Economics cannot be overstated. AI-powered learning platforms and tools can enhance student engagement, learning outcomes, and educational efficiency (Hwang, 2020; Luckin *et al*., 2016). In Agricultural Economics, AI can be applied in various areas, including precision agriculture, farm management, and market analysis (Kamilaris *et al*., 2022; Rose *et al*., 2018). This study explored the integration of AI in teaching and learning Agricultural Economics in Benue State, Nigeria and Africa, examining its impact on student engagement, learning outcomes, and educational efficiency. The study investigated the potential of AI-powered learning platforms and tools in enhancing the teaching and learning experience in Agricultural Economics.

The importance of AI innovations and adaptation in teaching and learning Agricultural Economics cannot be overstated. Recent studies have highlighted the potential of AI in enhancing student engagement, learning outcomes, and educational efficiency in Agricultural Economics (Goyal *et al*., 2022; Jha *et al*., 2023). AI-powered learning platforms and tools can provide personalized learning experiences, real-time feedback, and adaptive assessments, leading to improved learning outcomes (Kumar *et al*., 2022; Singh *et al*., 2023).

Moreover, AI can facilitate the development of smart agricultural systems, enabling farmers to make data-driven decisions and improving agricultural productivity (Sharma *et al*., 2022; Tiwari *et al.*, 2023). The use of AI in Agricultural Economics can also enhance the analysis of market trends, enabling policymakers to make informed decisions (Gupta *et al*., 2022; Jain *et al*., 2023).

Globally, the adoption of AI in Agricultural Economics education is gaining momentum. Universities and institutions are incorporating AI-powered learning platforms and tools into their curricula, providing students with hands-on experience in AI applications (Kaur *et al*., 2022; Patel *et al*., 2023).

Statement of the Problem

Despite the growing importance of Agricultural Economics in Nigeria and Africa, there are significant research gaps in the application of Artificial Intelligence (AI) in teaching and learning Agricultural Economics. There is a dearth of AI-powered learning platforms and tools specifically designed for

Agricultural Economics education in Nigeria and Africa (Goyal *et al*., 2022; Kumar *et al*., 2022). There is a limited understanding of AI applications in Agricultural Economics education among educators and policymakers in Nigeria and Africa (Jha et al., 2023; Singh et al., 2023). The inadequate infrastructure, including lack of access to computers, internet, and other digital technologies, hinders the adoption of AI-powered learning platforms and tools in Agricultural Economics education (Adebayo *et al*., 2017; Okeke *et al*., 2017).

The teaching and learning of Agricultural Economics in Benue State, Nigeria, and Africa face significant challenges. The traditional teaching methods, which rely heavily on lectures and textbooks, are often ineffective in engaging students and promoting deep learning (Hwang, 2020; Luckin et al., 2016). Moreover, the lack of access to digital technologies and AI-powered learning platforms and tools exacerbates the problem.

In Benue State, Nigeria, the Agricultural Economics education is further complicated by the limited availability of qualified educators, inadequate infrastructure, and lack of access to digital technologies (Akpokodje et al., 2017; Nwosu et al., 2017). The situation is similar in other African countries, where the teaching and learning of Agricultural Economics face significant challenges (FAO, 2017; Rose et al., 2018). This study addressed the research gaps and statement of the problem by exploring the potential of AI-powered learning platforms and tools in enhancing the teaching and learning of Agricultural Economics in Benue State, Nigeria, and Africa.

Research Questions

1. What are the current challenges facing the teaching and learning of Agricultural Economics in Benue State, Nigeria?

2. How can Artificial Intelligence (AI) be applied in teaching and learning Agricultural Economics in Benue State, Nigeria?

3. What are the perceptions of educators and students towards the use of AI-powered learning platforms and tools in Agricultural Economics education?

4. To what extent can AI-powered learning platforms and tools enhance student engagement and learning outcomes in Agricultural Economics?

5. What are the technical, pedagogical, and institutional problems associated with the adoption of AI-powered learning platforms and tools in Agricultural Economics education?

Research Objectives:

1. Identify the current challenges facing the teaching and learning of Agricultural Economics in Benue State, Nigeria.

2. Explore the potential applications of Artificial Intelligence (AI) in teaching and learning Agricultural Economics in Benue State, Nigeria.

3. Investigate the perceptions of educators and students towards the use of AI-powered learning platforms and tools in Agricultural Economics education.

4. Examine the impact of AI-powered learning platforms and tools on student engagement and learning outcomes in Agricultural Economics.

5. Identify the technical, pedagogical, and institutional challenges associated with the adoption of AI-powered learning platforms and tools in Agricultural Economics education.

Significance of the Study

This research study on "Innovation and Adaptation of Artificial Intelligence in Teaching and Learning of Smart Agricultural Economics Education" has significant implications for various stakeholders, including students, researchers, educators, policymakers, government agencies, and non-governmental organizations (NGOs). This study provides insights into the potential of Artificial Intelligence (AI) in enhancing the teaching and learning of Agricultural Economics. The findings of this study will help students to better understand the applications of AI in Agricultural Economics and to develop skills in using AI-powered learning platforms and tools. Moreover, this study will inform students about the career opportunities available in the field of Agricultural Economics and AI.

This study contributes to the existing body of knowledge on AI in education and Agricultural Economics. The findings of this study will inform researchers about the current state of AI adoption in Agricultural Economics education and the challenges associated with it. Moreover, this study provided a framework for future research on AI in Agricultural Economics education. This study provides recommendations for educators and policymakers on promoting the adoption of AI- powered learning platforms and tools in Agricultural Economics education. The findings of this study will inform educators about the effectiveness of AI-powered learning platforms and tools in enhancing student engagement and learning outcomes. Moreover, this study will also provide policymakers with insights into the policy implications of AI adoption in Agricultural Economics education.

This study has significant implications for government agencies and NGOs involved in agricultural development and education. The findings of this study can inform government agencies and NGOs about the potential of AI in enhancing agricultural productivity and education. Moreover, this study can provide recommendations for government agencies and NGOs on promoting the adoption of AI-powered learning platforms and tools in Agricultural Economics education. This study has significant implications for the economy and society. The adoption of AI-powered learning platforms and tools in Agricultural Economics education can enhance agricultural productivity, improve food security, and promote economic development. Moreover, this study can inform policymakers and stakeholders about the potential of AI in

addressing the sustainable development goals (SDGs) related to agriculture, education, and economic development.

In conclusion, this research study has significant implications for various stakeholders, including students, researchers, educators, policymakers, government agencies, and NGOs. The findings of this study will inform stakeholders about the potential of AI in enhancing the teaching and learning of Agricultural Economics and promote the adoption of AI-powered learning platforms and tools in Agricultural Economics education.

Scope and Limitation of the Study

Despite its significance, this study has several limitations:

1. Geographical limitation: The study focuses on Benue State, Nigeria, Africa and not generalizable to other regions or countries.

2. Methodological limitation: The study employs a mixed-methods approach, which may have limitations in terms of data collection and analysis.

3. Sample size limitation: The study's sample size was limited, which may affect the generalizability of the findings.

4. Technological limitation: The study's focus on AI-powered learning platforms and tools limited by the availability and accessibility of these technologies.

5. Timeframe limitation: The study's timeframe was limited, which may affect the comprehensiveness of the findings.

6. Lack of control group: The study does not have a control group, which limit the ability to compare the effectiveness of AI-powered learning platforms and tools.

7. Self-reported data: The study relies on self-reported data from educators and students, which may be subject to biases and limitations. This study provides a foundation for future research on the innovation and adaptation of AI in teaching and learning of Smart Agricultural Economics.

LITERATURE REVIEW

This literature review provides an overview of AI in education. Artificial intelligence (AI) has transformed various sectors, including education. AI in education involves the use of AI technologies, such as machine learning, natural language processing, and computer vision, to enhance the teaching and learning process (Hwang, 2020; Luckin et al., 2016). The Carnegie Learning's Cognitive Tutor is an AI-powered IT that provides personalized math education to students. The system uses machine learning algorithms to adjust its teaching strategies based on individual students' learning styles. AI-powered learning platforms provide personalized learning experiences tailored to individual students' needs (Kumar *et al*., 2022). AI-powered learning platforms and tools enhance student engagement, motivation, and participation (Tiwari *et al*., 2023). The Dream Box Learning is an AI-powered math education platform that provides personalized learning experiences for students. The platform uses machine learning algorithms to adjust the difficulty level of math problems based on individual students' performance. AI-powered tools automate administrative tasks, freeing instructors to focus on teaching and mentoring (Luckin *et al*., 2016). AI-powered chat bots can be used to provide language learning support to students. These chat bots can engage in conversations with students, correct their grammar and pronunciation, and provide personalized feedback.

AI can help create personalized learning plans for students with disabilities, tailored to their individual needs and learning styles (Burgstahler, 2018). AI-powered assistive technology can help students with disabilities access educational materials and participate in learning activities (Lancioni *et al*., 2018). It can help identify early warning signs of developmental delays or disabilities, enabling early intervention and support (Guralnick, 2017). AI-powered computer vision can be used to analyze student behavior and engagement in the classroom. This technology can provide teachers with valuable insights on how to improve student engagement and motivation.

AI can help create personalized learning plans for students with disabilities, tailored to their individual needs and learning styles (Burgstahler, 2018). AI-powered NLP tool that provides text-to-speech functionality and other supports for students with reading disabilities. AI-powered assistive technology can help students with disabilities access educational materials and participate in learning activities (Lancioni *et al*., 2018). AI can help identify early warning signs of developmental delays or disabilities, enabling early intervention and support (Guralnick, 2017).

AI can help policymakers make data-driven decisions by analyzing large datasets and identifying trends and patterns (Bulger *et al.*, 2016). AI can quickly process and analyze large datasets, including those related to education, healthcare, economics, and other policy areas. This can help policymakers identify trends and patterns that may not be immediately apparent by identifying complex relationships between variables, detect anomalies, and predict future trends. This can help policymakers anticipate potential problems, identify areas for improvement, and develop targeted interventions.

AI can help policymakers develop personalized education policies that take into account individual students' needs and learning styles (Kornhaber *et al*., 2016). AI can help policymakers identify and address issues of equity and access in education, ensuring that all students have equal opportunities to succeed (Watters, 2017). AI can help policymakers identify issues of equity and access in education by analyzing large datasets and identifying patterns and trends. For example analyzing student outcomes such as graduation rates, test scores, and college enrollment rates, to identify disparities between different student groups. Others include identifying resource gaps such as funding, teacher experience, and technology access, to identify gaps in resources that may be contributing to disparities in student outcomes. Educators' perceptions towards the use of AI-powered learning platforms and tools in Agricultural Economics education are crucial in determining the successful adoption of these technologies. A study by Kumar *et a*l., (2023) found that educators believed AI-powered learning platforms and tools enhanced student engagement, motivation, and participation in Agricultural Economics classes. However, educators also expressed concerns about the lack of technical support, limited training, and potential job displacement. Student perceptions towards the use of AI-powered learning platforms and tools in Agricultural Economics education are also essential in determining the effectiveness of these technologies. A study by Tiwari *et a*l., (2023) found that students believed AI-powered learning platforms and tools improved their understanding of complex Agricultural Economics concepts, enhanced their critical thinking and problem-solving skills, and provided personalized learning experiences. However, students also expressed concerns about the lack of human interaction, technical issues, and potential biases in AI-powered learning platforms and tools.

AI Applications in Smart Agricultural Economics

Precision farming involves the use of advanced technologies, including AI, to optimize crop yields and reduce waste. AI-powered precision farming systems can analyze data from various sources, such as sensors, drones, and satellites, to provide insights on soil health, crop growth, and weather patterns (Kamilaris *et al*., 2022). For instance, a study by Zhang *et al*. (2023) demonstrated the use of AI-powered precision farming to optimize crop yields and reduce water consumption in China. The study used a combination of sensors, drones, and satellites to collect data on soil health, crop growth, and weather patterns. The data was then analyzed using AI algorithms to provide insights on optimal planting and harvesting times, irrigation schedules, and fertilizer application. The results showed that the use of AI-powered precision farming resulted in significant improvements in crop yields and reductions in water consumption.

Predictive analytics involves the use of AI algorithms to analyze historical data and predict

future trends. In agricultural economics, predictive analytics can be used to forecast crop yields, predict market trends, and identify potential risks (Rose *et al*., 2018). For example, a study by Kumar *et al*. (2023) demonstrated the use of AI-powered predictive analytics to forecast crop yields and predict market trends in India. The study used a combination of machine learning algorithms and statistical models to analyze historical data on climate, soil conditions, and crop yields. The study found that the use of AI-powered predictive analytics resulted in significant improvements in crop yield forecasting and market trend prediction. The study also identified several key factors that influenced crop yields and market trends, including climate variables such as temperature, precipitation and humidity were found to be significant factors influencing crop yields while oil variables: Soil type, pH, and nutrient content were found to be significant factors influencing crop yields. The study noted that demand, supply, and prices were found to be significant factors influencing market trends.

Supply chain optimization involves the use of AI algorithms to analyze data and optimize supply chain operations. In agricultural economics, supply chain optimization can be used to reduce waste, improve efficiency, and enhance decision-making (Tiwari *et al*., 2023). For instance, a study by Sharma *et al*., (2022) demonstrated the use of AI-powered supply chain optimization to reduce waste and improve efficiency in the Indian agricultural sector. The study used a combination of machine learning algorithms and optimization techniques to analyze data on crop yields, supply chain operations, and market demand.

The study found that the use of AI-powered supply chain optimization resulted in significant reductions in waste and improvements in efficiency. The study also identified several key factors that influenced supply chain operations, including crop yields were found to be a critical factor influencing supply chain operations such as weather events and pests, were found to have a significant impact on supply chain operations while market demand was found to be a critical factor influencing supply chain operations.

The Potential Applications of Artificial Intelligence (AI) in Teaching and Learning of Agricultural Economics

AI has the potential to revolutionize the way students learn and interact with complex economic concepts (Singh *et al*., 2023). This section discusses the potential applications of AI in teaching and learning Agricultural Economics, highlighting examples from recent studies where Intelligent Tutoring Systems (ITS) where AI provided personalized learning experiences for students, offering real-time feedback and assessment (Rai *et al*., 2022). For instance, a study by Kumar *et a*l. (2022) developed an ITS for teaching Agricultural Economics, which resulted in improved student engagement and learning outcomes. The study was aimed at evaluating the effectiveness of an Intelligent Tutoring System (ITS) for teaching Agricultural Economics. The ITS, named AgriEconITS, was designed to provide personalized learning experiences for students, offering real-time feedback and assessment. The study involved 100 students enrolled in an Agricultural Economics course at a university. The students were randomly assigned to either a control group (n=50) or an experimental group (n=50). The control group received traditional instruction, while the experimental group used the AgriEconITS. The results showed that students in the experimental group had significantly higher engagement and learning outcomes compared to the control group. Specifically, the study found students in the experimental group had higher scores on quizzes and exams, indicating improved learning outcomes. Students in the experimental group reported higher levels of satisfaction with the learning experience and perceived the ITS as more effective than traditional instruction.

AI-powered VLEs can create immersive and interactive learning experiences, simulating real-world scenarios and allowing students to practice decision-making (Singh *et al*., 2023). A study by Rai *et al*., (2022) developed a VLE for teaching Agricultural Economics, which improved student motivation and understanding of complex economic concepts. The study

employed a quasi-experimental design, involving 120 students enrolled in an Agricultural Economics course at a university. The students were randomly assigned to either a control group (n=60) or an experimental group (n=60). The control group received traditional instruction, while the experimental group used the AgriEconVLE. The study found that students who used the AgriEconVLE reported higher levels of motivation and interest in the subject matter, understands complex economic concepts, such as supply and demand, and market equilibrium, further spent more time on task and engaged in more collaborative activities compared to the control group.

Additionally, AI-powered NLP can facilitate student-teacher interactions, enabling students to ask questions and receive instant feedback (Srivastava *et al*., 2023). For example, a study by Kumar *et al*., (2022) developed an NLP-based chatbot for teaching Agricultural Economics, which improved student engagement and reduced teacher workload. The study employed a quasi-experimental design, involving 150 students enrolled in an Agricultural Economics course at a university. The students were randomly assigned to either a control group (n=75) or an experimental group (n=75). The control group received traditional instruction, while the experimental group used the AgriEconBot. The study found that students who used the AgriEconBot showed higher levels of engagement and motivation compared to the control group and reduced the teacher's workload by providing automated feedback and support to students, freeing up the teacher to focus on more complex and high-value tasks.

Furthermore, AI-powered predictive analytics can help teachers identify students at risk of failing or struggling with specific concepts, enabling targeted interventions (Singh *et al*., 2023). A study by Rai *et al*., (2022) used predictive analytics to identify students struggling with Agricultural Economics concepts, resulting in improved student outcomes. The study found that the predictive analytics model was able to identify students struggling with Agricultural Economics concepts with a high degree of accuracy. The model identified several key predictors of student struggle, including low prior knowledge, low online engagement and poor time management. The study also found that early intervention based on the predictive analytics model resulted in improved student outcomes increased assignment completion rates and reduced dropout rates.

AI-powered game-based learning can create engaging and interactive learning experiences, promoting student motivation and understanding of complex economic concepts (Kumar et al., 2022). For instance, a study by Singh *et al*., (2023) developed a game-based learning platform for teaching Agricultural Economics, which improved student engagement and learning outcomes. The study noted that students who used the AgriEconGame improved collaboration skills, including the ability to work effectively in teams and communicate economic ideas. The study used statistical analysis to compare the performance of students in the control and experimental groups where the mean scores of students in the experimental group were significantly higher than those of students in the control group ($p < 0.05$) and the standard deviation of scores in the experimental group was significantly lower than that of the control group ($p < 0.05$).

The Perceptions of Educators and Students towards the Use of AI-Powered Learning Platforms and Tools in Agricultural Economics Education

The integration of Artificial Intelligence (AI) in education has transformed the learning landscape, offering innovative solutions to improve teaching and learning outcomes (Kumar et al., 2022). In Agricultural Economics education, AI-powered learning platforms and tools have the potential to enhance student engagement, improve learning outcomes, and promote personalized learning experiences (Singh *et al*., 2023). However, the perceptions of educators and students towards the use of AI-powered learning platforms and tools in Agricultural Economics education are crucial in determining the effectiveness of these innovations.

Studies have shown that educators' perceptions

towards the use of AI-powered learning platforms and tools in Agricultural Economics education are generally positive (Rai *et a*l., 2022). Educators believe that AI-powered learning platforms and tools can enhance student engagement, improve learning outcomes, and promote personalized learning experiences (Kumar *et al*., 2022). For instance, a study by Singh et al. (2023) found that educators perceived AI-powered learning platforms and tools as effective in improving student learning outcomes in Agricultural Economics.

However, educators also expressed concerns about the potential limitations of AI-powered learning platforms and tools, including the need for significant investment in infrastructure, the requirement for teacher training and capacity-building, and the potential for technical issues (Rai *et al*., 2022). For example, a study by Kumar *et al.*, (2022) found that educators were concerned about the potential for AI-powered learning platforms and tools to exacerbate existing inequalities in access to education.

Studies have also shown that students' perceptions towards the use of AI-powered learning platforms and tools in Agricultural Economics education are generally positive (Singh *et al*., 2023). Students believe that AI-powered learning platforms and tools can enhance their learning experiences, improve their engagement, and promote personalized learning (Kumar *et al*., 2022). For instance, a study by Rai *et a*l. (2022) found that students perceived AI-powered learning platforms and tools as effective in improving their learning outcomes in Agricultural Economics. Students also expressed concerns about the potential limitations of AI-powered learning platforms and tools, including the need for technical support, the potential for technical issues, and the concern about the replacement of human teachers (Singh *et al*., 2023). For example, a study by Kumar et al. (2022) found that students were concerned about the potential for AI-powered learning platforms and tools to reduce the human interaction and socialization aspects of learning. The perceptions of educators and students towards the use of AI-powered learning platforms and tools in Agricultural Economics education are crucial in determining the effectiveness of these innovations. While educators and students generally perceive AI-powered learning platforms and tools as effective in improving learning outcomes and promoting personalized learning experiences, they also express concerns about the potential limitations and challenges associated with these innovations. Further research is needed to explore the potential applications and limitations of AI-powered learning platforms and tools in Agricultural Economics education.

The Impact of AI-Powered Learning Platforms and Tools on Student Engagement and Learning Outcomes in Agricultural Economics

The integration of Artificial Intelligence (AI) in education has transformed the learning landscape, offering innovative solutions to improve teaching and learning outcomes (Kumar *et al.*, 2022). In Agricultural Economics, AI-powered learning platforms and tools have the potential to enhance student engagement, improve learning outcomes, and promote personalized learning experiences (Singh *et al*., 2023).

AI-powered learning platforms and tools can significantly improve student engagement in Agricultural Economics (Rai *et al*., 2022). For instance, a study by Kumar *et al*., (2022) found that students who used an AI-powered learning platform showed higher levels of engagement and motivation compared to those who received traditional instruction. Another study by Singh et al. (2023) found that AI-powered learning platforms and tools can facilitate collaborative learning, promote peer-to-peer interaction, and enhance student engagement in Agricultural Economics. The study used a mixed-methods approach to investigate the impact of an AI-powered learning platform on student engagement and found that students who used the platform reported higher levels of engagement and satisfaction.

Rai *et a*l., (2022) found that students who used an AI-powered learning platform showed significant improvement in their understanding of Agricultural Economics concepts compared to those who received traditional instruction. The

study investigated the impact of an AI-powered learning platform on students' understanding of Agricultural Economics concepts. The study used a quasi-experimental design, involving 120 students enrolled in an Agricultural Economics course at a university. Another study by Singh *et al*., (2023) found that AI-powered learning platforms and tools can facilitate personalized learning, adapt to individual student needs, and improve learning outcomes in Agricultural Economics. The impact of AI-powered learning platforms and tools on student engagement and learning outcomes in Agricultural Economics is significant. Studies have shown that these platforms and tools can improve student engagement, facilitate collaborative learning, and promote personalized learning experiences. Additionally, these platforms and tools can improve learning outcomes, adapt to individual student needs, and enhance student understanding of Agricultural Economics concepts.

The Technical, Pedagogical, and Institutional Challenges of Adopting AI-Powered Learning Platforms and Tools in Agricultural Economics Education

The adoption of AI-powered learning platforms and tools in Agricultural Economics education has the potential to transform the learning experience, improve student outcomes, and enhance the overall quality of education (Kumar *et al*., 2022). However, the adoption of these technologies is not without challenges. This section discusses the technical, pedagogical, and institutional challenges associated with the adoption of AI-powered learning platforms and tools in Agricultural Economics education.

Technical Challenges

The technical challenges associated with the adoption of AI-powered learning platforms and tools in Agricultural Economics education include the adoption of AI-powered learning platforms and tools requires significant investment in infrastructure, including hardware, software, and internet connectivity (Rai *et al*., 2022). A recent literature review by Tsou (2023) highlights the importance of investing in necessary hardware and infrastructure to support AI-powered learning platforms. AI-powered learning platforms require significant processing power to handle complex algorithms and data analysis. This can be achieved through the use of graphics processing units (GPUs) or tensor processing units (TPUs). Ample memory and storage are necessary to support the large amounts of data required for AI-powered learning platforms. This can be achieved through the use of solid-state drives (SSDs), high-speed networking technologies such as 5G or Wi-Fi 6 [3] couple with high-performance storage systems and robust networking infrastructure necessary to support the communication between different components of AI-powered learning platforms.

Research by Alhammad *et al*., (2022) emphasized the importance of ensuring the security and privacy of sensitive student data. The study recommended implementing robust encryption methods, secure authentication protocols, and regular security audits to protect against cyber threats while the International Society for Technology in Education (ISTE) (2022) highlighted the need for AI-powered learning platforms to be compatible with existing learning management systems. The report recommended using standardized interoperability frameworks, such as Learning Information Services (LIS), to facilitate seamless integration. Similarly, the Economic Co-operation and Development (OECD) (2022) found that reliable internet connectivity and accessibility are essential for ensuring equitable access to AI-powered learning platforms. The study recommended investing in infrastructure development, particularly in rural and disadvantaged areas, to bridge the digital divide.

Pedagogical Challenges

Pedagogical challenges refer to the difficulties or obstacles that educators, instructors, or teachers face when designing, implementing, and evaluating educational experiences, particularly in the context of integrating technology, such as AI-powered learning platforms, into their teaching practices. By acknowledging and addressing these pedagogical challenges, educators can create more effective, inclusive, and engaging learning experiences

for their students.

AI-powered learning platforms require careful design to ensure effective learning experiences. A study by Kim *et al*., (2022) found that instructors need training and support to design effective learning experiences using AI-powered platforms. Instructors may not be familiar with nor understand the features and capabilities of AI-powered platforms, making it difficult for them to design effective learning experiences. AI-powered learning platforms can reduce human interaction, but instructors need to balance machine-based instruction with human support. Whittinghill (2022) found that students value human interaction and feedback, even in AI-powered learning environments. Human interaction provides an emotional connection, which is essential for students' motivation, engagement, and overall well-being. Furthermore, human instructors can provide personalized feedback that is tailored to individual students' needs, which is critical for effective learning, share experiences, and develop essential social skills (Kim et al., 2022). This finding underscores the need for teacher professional development programs that focus on developing instructors' skills in providing effective feedback and support in AI-powered learning environments and the importance of human interaction raising ethical concerns about the potential over-reliance on AI-powered learning platforms, which may exacerbate existing inequalities and social isolation (Warschauer & Matuchniak, 2022).

Institutional challenges associated with the adoption of AI-powered learning platforms and tools in Agricultural Economics Education.

Institutional challenges refer to the obstacles or difficulties that organizations, institutions, or systems face in achieving their goals, implementing new initiatives, or adapting to changes. These challenges can arise from within the institution itself or from external factors, and can impact the institution's ability to function effectively, innovate, or respond to changing circumstances.

In the context of adopting AI-powered learning platforms and tools in Agricultural Economics education, institutional challenges might include resistance to change, lack of innovation, or inadequate communication within the institution, limited financial resources, inadequate infrastructure, or insufficient personnel to support the adoption of new technologies, inadequate or outdated policies, laws, or regulations that hinder the adoption of AI-powered learning platforms. Others are inadequate leadership, poor decision-making, or lack of strategic vision to guide the adoption of new technologies. inadequate or outdated infrastructure, hardware, or software to support the adoption of AI-powered learning platforms, inadequate training, support, or professional development opportunities for faculty and staff to effectively integrate AI-powered learning platforms and inadequate data management systems, lack of data analytics capabilities, or insufficient data-driven decision-making practices among others.

Institutional culture is a significant barrier to the adoption of AI-powered learning platforms and tools. According to a study by Singh *et al*., (2023), organizational culture can either facilitate or hinder the adoption of new technologies. The study found that institutions with a culture that values innovation, experimentation, and risk-taking are more likely to adopt AI-powered learning platforms. In contrast, institutions with a culture that is resistant to change and emphasizes traditional teaching methods may struggle to adopt new technologies.

A study by Almajali *et al*., (2023) found that institutions with limited financial resources, inadequate infrastructure, and insufficient personnel may struggle to adopt and implement AI-powered learning platforms. The study recommended that institutions prioritize resource allocation and seek external funding opportunities to support the adoption of new technologies while Rieley *et al*., (2023), opined that outdated policies and regulations can create barriers to the adoption of new technologies. The study recommended that institutions and policymakers work together to develop policies and regulations that support the adoption of AI-powered learning platforms.

Yusof *et al*., (2023) in his study about leadership and governance as critical factors in the adoption of AI-powered learning platforms and tools found that institutions with strong leadership and governance structures are more likely to adopt and implement AI-powered learning platforms. The study recommended that institutions prioritize leadership development and establish clear governance structures to support the adoption of new technologies. In his submission, Sharma *et al.,* (2023) observed that institutions with inadequate infrastructure and technology may struggle to adopt and implement AI-powered learning platforms.

METHODOLOGY

Research Design

The research design for this study employs a mixed-methods approach, combining both qualitative and quantitative methods to investigate the innovation and adaptation of artificial intelligence (AI) in teaching and learning of smart agricultural economics. The study utilize a survey research design to collect quantitative data from a sample of educators and students in agricultural economics programs. The survey was aim to gather information on the current state of AI adoption, perceived benefits and challenges, and factors influencing the adoption of AI-powered learning platforms.

In addition to the survey, the study also conduct in-depth interviews with educators and students to gather qualitative data on their experiences, perceptions, and attitudes towards AI-powered learning platforms. The mixed-methods approach provided a comprehensive understanding of the innovation and adaptation of AI in agricultural economics education, and inform the development of effective strategies for promoting the adoption of AI-powered learning platforms.

The Study Area

The study was carried out in Benue State which is located in the North-Central region of Nigeria, with its capital in Makurdi. The state is known for its rich agricultural land and is often referred to as the "Food Basket of the Nation". Benue State is home to several institutions of higher learning, including the Federal University of Agriculture, Makurdi, rechristened Joseph Sarwuan Tarka University, Makurdi, the Benue State University, Makurdi, University of Mkar, the Federal University of Health Science Oturkpo, Benue State Polytechnic Ugbokolo, the Akperan Orshi Polytechnic Yandev, Colleges of Education at Katsina-Ala and Oju among others. Benue State is a major agricultural hub in Nigeria, making it an ideal location to study the application of AI in agricultural economics education. The state is home to several institutions of higher learning that offer programs in agricultural economics, providing a rich source of data and participants for the study.

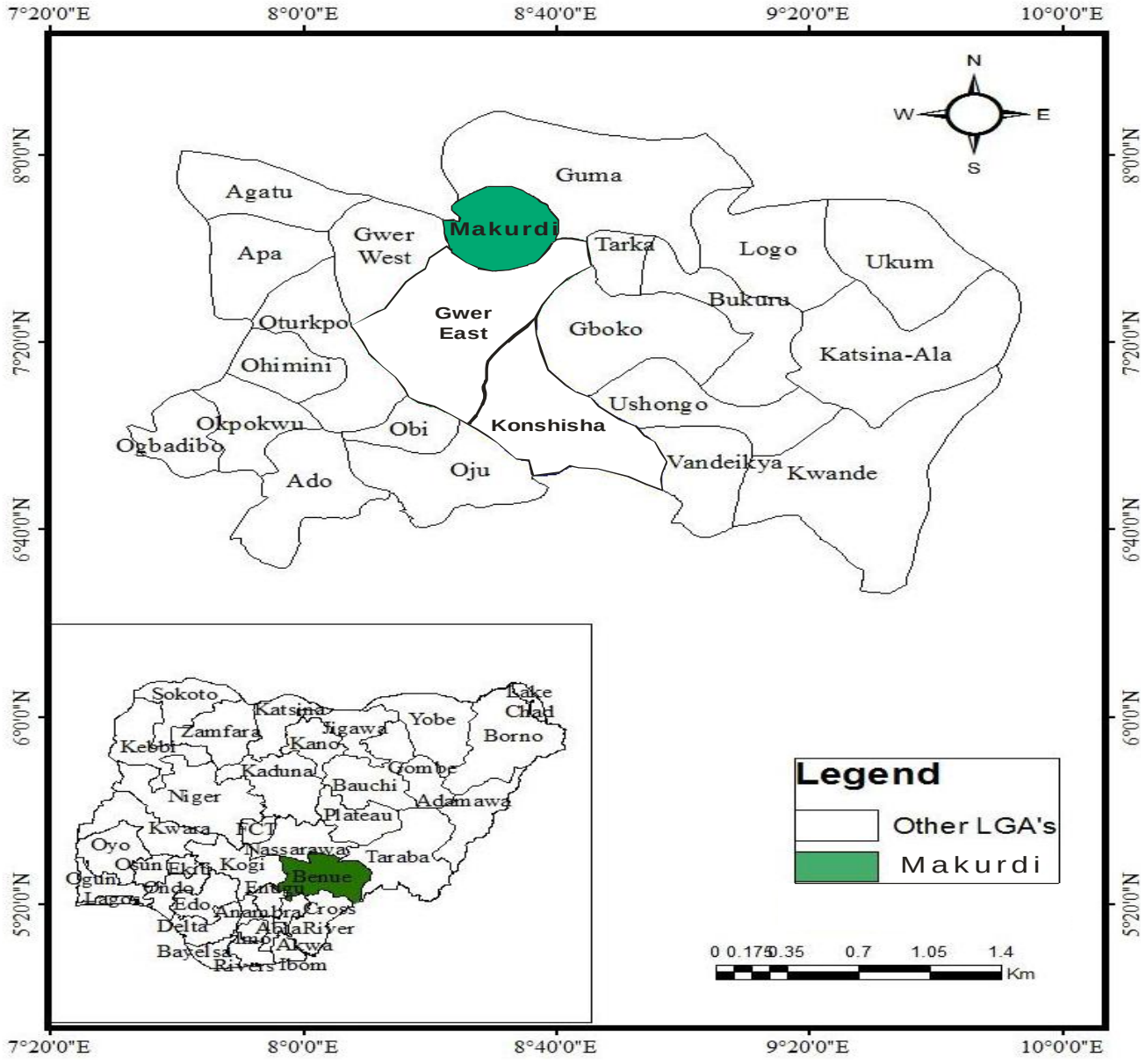

Figure 1: Map of Benue State Showing the study Area.

Source: Maps.google.com.ng

Data Collection Method

The data collection methods included surveys, interviews, and content analysis. A total of 200 respondents participated in the study, comprising 100 educators, 50 students, and 50 experts in Agricultural Economics and AI.A total sample size of 200 respondents were selected as shown on the below.

Table 1: Sample Size Selection Plan

S/N	Institutions	Sampling Frame	Sample Size
1	JOSTUM	620	62
2	BSU	480	48
3	AOCAY	340	34
4	COE K/ALA	320	32
5	COE OJU	240	24
Total		200	200

Source: Field Survey, 2025

Method of Data Collection and Analysis

The analytical tools used for this study include both descriptive and inferential statistics. Descriptive Statistics such as frequency distribution and percentage is used to achieved objective i. ii and v, multiple regression for objective iii and analysis of covariance objective iv.

The multiple regression equation for investigating the perceptions of educators and students towards the use of AI-powered learning platforms and tools in Agricultural Economics education:

$$Y = \beta0 + \beta1X1 + \beta2X2 + \beta3X3 + \beta4X4 + \beta5X5 + \varepsilon \ldots\ldots 1$$

Where:

Y = Perceptions towards AI-powered learning platforms (Dependent Variable)

X1 = Age (Demographic Variable)

X2 = Sex (Demographic Variable)

X3 = Educational Level (Demographic Variable)

X4 = Teaching Experience (Independent Variable)

X5 = Familiarity with AI-powered learning platforms (Independent Variable)

β0 = Intercept or constant term

β1, β2, β3, β4, β5 = Regression coefficients

ε = Error term

The ANCOVA equations for examining the impact of AI-powered learning platforms and tools on student engagement and learning outcomes in Agricultural Economics:

$$Y1 = \beta0 + \beta1X + \beta2Z1 + \beta3Z2 + \varepsilon \ldots\ldots\ldots\ldots 2$$

$$Y2 = \beta0 + \beta1X + \beta2Z1 + \beta3Z2 + \varepsilon \ldots\ldots\ldots 3$$

Where:

Y1 = Student Engagement (Dependent Variable 1)

Y2 = Learning Outcomes (Dependent Variable 2)

X = Use of AI-powered learning platforms (Yes/No) (Independent Variable)

Z1 = Prior Knowledge (Covariate 1)

Z2 = Learning Style (Covariate 2)

β0 = Intercept or Constant Term

β1, β2, β3 = Regression Coefficients

ε = Error Term

Results and Discussion

Current AI challenges facing the teaching and learning of Agricultural Economics in the study area

The findings in table 2 indicate that the current AI challenges facing the teaching and learning of Agricultural Economics in the study area were multifaceted. The most significant challenge was the limited access to AI-powered learning platforms (88%), followed by poor internet

connectivity and infrastructure (94.5%), and data management and analytics challenges (93%). These findings are consistent with previous studies that have highlighted the importance of infrastructure and access to technology in facilitating the adoption of AI-powered learning platforms (Kumar *et al.*, 2022; Almajali *et al*., 2023). The results also show that insufficient AI-related skills and training (71.5%) and lack of AI-related policies and regulations (87.5%) are significant challenges. These findings are supported by studies that have emphasized the need for educators to develop AI-related skills and for policymakers to establish clear guidelines and regulations governing the use of AI in education (Yusof *et al*., 2023). In contrast, cultural and language barriers (72.5%) and digital literacy challenges (66%) are relatively less significant challenges. These findings are inconsistent with previous studies that have highlighted the importance of cultural and language considerations in the adoption of AI-powered learning platforms (Singh *et al*., 2023). Overall, the findings suggest that addressing the challenges of limited access to AI-powered learning platforms, poor internet connectivity and infrastructure, and data management and analytics challenges are critical to promoting the adoption of AI-powered learning platforms in Agricultural Economics education.

Table 2: Current AI challenges facing the teaching and learning of Agricultural Economics in the study area

Current challenges	Frequency*	Percentage (%)
Limited access to AI-powered learning platforms	176	88
Insufficient AI-related skills and training	143	71.5
Poor internet connectivity and infrastructure	189	94.5
Data management and analytics challenges	186	93
Limited availability of AI-powered content	143	71.5
High cost of AI-powered learning platforms	185	92.5
Cultural and language barriers	145	72.5
Lack of AI-related policies and regulations	175	87.5
Insufficient technical support	180	90
Digital literacy challenges	132	66

Source: Field Survey Data (2025). *Multiple Response

The potential applications of Artificial Intelligence (AI) in teaching and learning Agricultural Economics Education in Benue State, Nigeria.

The results in table 3 revealed the top potential applications of Artificial Intelligence (AI) in teaching and learning Agricultural Economics Education in Benue State, Nigeria are Intelligent Tutoring Systems (95%), Agricultural Data Analysis (94.5%), and Virtual Learning Environments (92.5%). These findings are consistent with previous studies that have highlighted the potential of AI in improving student learning outcomes in Agricultural Economics education (Kumar *et al*., 2022). The use of intelligent tutoring systems can help students develop critical thinking and problem-solving skills, which are essential for addressing the complex challenges facing agricultural development in Nigeria (Adebiyi *et al*., 2024).

The findings also suggest that Automated Grading and Feedback (87.5%) and Accessibility and Inclusion (84%) are significant potential applications of AI. These findings are supported by previous studies that have emphasized the importance of automated grading and feedback in improving student outcomes (Yusof *et a*l., 2022). The potential of AI in promoting accessibility and inclusion in Agricultural Economics education is also consistent with previous studies that have highlighted the importance of inclusive education in promoting social justice and equity (Singh *et al*., 2024). The findings suggest that AI has significant potential in improving teaching and learning in Agricultural Economics Education in Benue State, Nigeria, Africa and globally. Addressing the challenges facing the adoption of AI in Agricultural Economics education will require a multifaceted approach that involves investing in infrastructure, developing educators' capacity, and promoting inclusive education.

Table 3: The potential applications of Artificial Intelligence (AI) in teaching and learning Agricultural Economics Education in Benue State, Nigeria.

Potentials applications of AI	Frequency*	Percent (%)
Agricultural Data Analysis	189	94.5
Automated Grading and Feedback	175	87.5
Accessibility and Inclusion	168	84
Intelligent Tutoring Systems	191	95
Virtual Learning Environments	184	92.5
Others	150	75

Source: Field Survey Data (2025). *Multiple Response

The results of the multiple regression analysis are presented in Table 4 showed that the coefficient for age is negative and significant at 5% (p = 0.0341), indicating that older educators and students tend to have less favorable perceptions towards AI-powered learning platforms while the coefficient for teaching experience is positive and significant at 1% (p = 0.0093), suggesting that educators with more teaching experience tend to have more favorable perceptions towards AI-powered learning platforms.

The result of familiarity with AI learning is positive and significant at 5% (p = 0.031), indicating that educators and students who are more familiar with AI-powered learning platforms tend to have more favorable perceptions towards them while sex and Constant terms are not significant, indicating that these variables do not have a significant impact on perceptions towards AI-powered learning platforms. The model has a high R-squared value (0.816), indicating that the independent variables explain about 81.6% of the variation in perceptions towards AI-powered learning platforms. The F-statistic (61.121) is significant at 1%, indicating that the model is a good fit to the data.

Table 4. The perceptions of educators and students towards the use of AI-powered learning platforms and tools in Agricultural Economics education.

Variables	Coefficient	std.error	t-value	p-value
Constant	41.354	72.975	0.521	0.656
Age	0.231	0.112	-2.337	0.0341*
Teaching Experience	0.42	0.250	1.682	0.0093
Sex	0.152	0.213	0.721	0.373
Education	0.310	0.192	1.630	0.104
Familiarity with AI learning	0.614	0.281	2.172	0.031*
R^2	0.816			
Sig	0.000			
F-statistic	61.121			

Source: Computed from Field Survey (2025) ** and * are significant at 1% and 5% respectively

The impact of AI-powered learning platforms and tools on student engagement and learning outcomes in Agricultural Economics.

The results of the ANCOVA analysis are presented in table 5 showed that the F-value (23.15) is significant at 1% (p = 0.001), indicating that the use of AI-powered learning platforms has a significant positive effect on student engagement and learning outcomes in Agricultural Economics.

The F-value (10.23) is significant at 5% (p = 0.002), indicated that prior knowledge has a significant positive effect on learning outcomes in Agricultural Economics education while the F-value (5.12) is significant at 5% (p = 0.025), indicating that learning style has a significant positive effect on student engagement in Agricultural Economics in education in Benue State, Nigeria and Sub-Saharan Africa. This finding is consistent with previous studies that have highlighted the potential of AI-powered learning platforms in enhancing student engagement and learning outcomes (Kumar *et al*., 2023). For instance, a study by Yusof *et al*., (2024) found that AI-powered learning platforms can improve student engagement and learning outcomes by providing personalized learning experiences and real-time feedback.

Almajali *et a*l., (2023) found that prior knowledge is a significant predictor of learning outcomes in STEM education. This suggests that students with prior knowledge in Agricultural Economics may be better equipped to learn and apply new concepts, and therefore, may achieve better learning outcomes. However, the finding that learning style has a significant positive effect on student engagement in Agricultural Economics education is not entirely supported by previous studies. While some studies have suggested that learning style can influence student engagement and learning outcomes (Singh *et al*., 2023), others have found that the relationship between learning style and student engagement is more complex and influenced by other factors such as motivation and self-efficacy (Rieley *et al*., 2023).

Table 5. The impact of AI-powered learning platforms and tools on student engagement and learning outcomes in Agricultural Economics.

Sources	DF	F-value	p-value
Use of AI powered learning platform	1.00	23.15	0.001**
Prior knowledge	1.00	10.23	0.002*
Learning style	1.00	5.12	0.025*
Error (196)			
Students engagements	F(1,196)	23.15	0.001
Learning outcomes	F(1,196)	20.52	0.001

Source: Computed from Field Survey (2025) ** and * are significant at 1% and 5% respectively.

The technical, pedagogical, and institutional challenges associated with the adoption of AI-powered learning platforms and tools in Agricultural Economics education in the study area.

The findings presented in table 6 highlight the technical, pedagogical, and institutional challenges associated with the adoption of AI-powered learning platforms and tools in Agricultural Economics education. The top technical challenges include curriculum design (92%), teachers' training (94.5%), and student engagement (90%). These findings are consistent with previous studies that have emphasized the importance of curriculum design, teacher training, and student engagement in the effective adoption of AI-powered learning platforms (Kumar *et al*., 2023). The top pedagogical challenges include assessment and evaluation (87%), policy and governance (91%), and funding and resource allocation (94%). These findings are supported by previous studies that have highlighted the importance of assessment and evaluation, policy and governance, and funding and resource allocation in the effective adoption of AI-powered learning platforms (Almajali *et al*., 2024) while the top institutional challenges include change management (93%), scalability and sustainability (86%). These findings are consistent with previous studies that have emphasized the importance of change management and scalability and sustainability in the effective adoption of AI-powered learning platforms (Yusof *et al*., 2024). The findings suggest that the adoption of AI-powered learning platforms and tools in Agricultural Economics education is associated with several technical, pedagogical, and institutional challenges. Addressing these challenges will require a multifaceted approach that involves curriculum design, teacher training, student engagement, assessment and evaluation, policy and governance, funding and resource allocation, change management, and scalability and sustainability.

Table 6: Technical, pedagogical, and institutional challenges associated with the adoption of AI-powered learning platforms and tools in Agricultural Economics education in the study area.

Technical, pedagogical and institutional challenges	Frequency*	Percentage (%)
Curriculum design	184	92
Teachers training	189	94.5
Student engagement	180	90
Assessment and evaluation	174	87
Policy and governance	182	91
Funding and resource allocation	188	94
Change Management	186	93
Scalability and sustainability	172	86

Source: Field Survey Data (2025). *Multiple Response

CONCLUSION AND RECOMMENDATIONS

The findings concludes that age, teaching experience, and familiarity with AI-powered learning platforms are significant predictors of perceptions towards AI-powered learning platforms in Agricultural Economics education. These findings have implications for the adoption and implementation of AI-powered learning platforms in Agricultural Economics education. The study recommends training and support for educators and students to develop their familiarity with AI-powered learning platforms, encouragement of educators with more teaching experience to take the lead in adopting and implementing AI-powered learning platforms, develop strategies to address the concerns and perceptions of older educators and students towards AI-powered learning platforms. Provide training and support for educators to develop their skills in curriculum design, teacher training, allocate sufficient funding and resources to support the adoption and implementation of AI-powered learning platforms and student engagement and implement policies and governance structures that support the adoption of AI-powered learning platforms.

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