APPLICATION OF ARTIFICIAL INTELLIGENCE IN TECHNOLOGY ENHANCED LEARNING FOR SUSTAINABLE GROWTH AND INCLUSIVE DEVELOPMENT IN NIGERIA

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Abstract

This study aims to explore the potential of artificial intelligence (AI) in technology-enhanced learning (TEL) to drive sustainable growth and inclusive development in education in Nigeria. Despite the country's abundant resources, the education system faces significant challenges such as inadequate infrastructure, teacher shortages, and disparities in learning outcomes, particularly among marginalized communities. To address these issues, the study proposes leveraging AI to revolutionize education through personalized and adaptive learning platforms, intelligent tutoring systems, and automated administrative tasks. The study emphasizes the potential of AI-powered TEL to enhance teaching and learning practices, improve educational outcomes, and provide more inclusive access to quality education. It suggests a comprehensive framework for AI policy and governance, highlighting the importance of balancing innovation and responsibility. This framework includes ethical guidelines, data protection measures, and capacity-building initiatives to address the risks associated with AI deployment in education. Empirical findings from the study demonstrate the positive impact of AI-based adaptive learning platforms on student performance and dropout rates across primary, secondary, and tertiary levels. It also highlights the potential of AI-enabled personalized education and skills development to meet workforce needs and contribute to economic productivity. The study concludes that AI-powered TEL holds significant potential for elevating educational outcomes, developing a skilled workforce, and driving sustainable growth and inclusive development in Nigeria. However, it acknowledges the challenges of inadequate infrastructure, digital literacy gaps, and ethical considerations that must be addressed through effective policies and strategies. Key recommendations include the development of a comprehensive national strategy for AI-powered TEL, investment in digital infrastructure and access, robust teacher training programs, fostering public-private partnerships, and implementing ethical governance frameworks and data protection measures.

Introduction

Nigeria, Africa's most populous nation, stands at a pivotal juncture in its quest for sustainable growth and inclusive development. Despite being endowed with abundant natural resources and a vibrant cultural heritage; the country continues to grapple with socioeconomic challenges that hinder its progress. Among these challenges, the need to improve the quality and accessibility of education emerges as a critical priority (Adedigba & Sulaiman, 2019). Nigeria's education system has long struggled with inadequate infrastructure, a shortage of qualified teachers, and disparities in learning outcomes, particularly among marginalized communities (Akanbi & Shehu, 2021).

In the face of these longstanding challenges, the emergence of transformative technologies, such as Artificial Intelligence

(AI), presents unprecedented opportunities to revolutionize the education landscape in Nigeria. AI-powered Technology-Enhanced Learning (TEL) holds the potential to personalize educational experiences, enhance teaching and learning practices, and foster more inclusive and equitable access to quality education (Usman & Musa, 2022). By harnessing the power of AI in TEL, Nigeria can unlock new pathways to elevate educational outcomes, develop a skilled workforce, and ultimately contribute to the socioeconomic transformation of the nation. Nigeria's education sector has grappled with long-standing challenges that have hindered progress and inclusive development. Some of the key issues include:

➢ Inadequate Educational Infrastructure in the lack of basic infrastructure such as well-equipped classrooms, laboratories, libraries, and reliable internet connectivity (Akanbi & Shehu, 2021; Oyelere et al., 2021). This has limited access to quality education and modern learning resources.

➢ Teacher Shortages and Quality Concerns: Nigeria faces a significant shortage of qualified and well-trained teachers, particularly in subjects like science, technology, engineering, and mathematics (STEM). Additionally, existing teachers often lack access to continuous professional development opportunities, impacting the quality of instruction (Usman & Musa, 2022; Adedigba & Sulaiman, 2019).

➢ Disparities in Learning Outcomes: There are widespread disparities in educational outcomes, with students from marginalized communities, rural areas, and lower socioeconomic backgrounds often lagging behind their counterparts in terms of academic performance and achievement (Abubakar & Saidu, 2021; Odia & Omofonmwan, 2022).

➢ Limited Access to Educational Resources: Many students, especially in remote areas, have limited access to textbooks, learning materials, and supplementary educational resources, hindering their ability to learn effectively (Eze et al., 2023).

➢ Inadequate Funding and Resource Allocation: The education sector in Nigeria has historically suffered from inadequate funding and inefficient resource allocation, limiting investments in infrastructure, teacher training, and the adoption of innovative educational technologies (Mahmud et al., 2023).

➢ Lack of Personalized and Adaptive Learning Approaches: Traditional teaching methods in Nigeria often follow a one-size-fits-all approach, failing to cater to individual learning needs, preferences, and paces, which can hinder student engagement and progress (Adedoyin & Soykan, 2020).

➢ Limited Integration of Technology: While some educational institutions have adopted basic technology tools, the overall integration of modern educational technologies, such as adaptive learning platforms, intelligent tutoring systems, and virtual learning environments, has been limited due to resource constraints and lack of digital literacy among teachers and students (Oyelere et al., 2022).

This study delves into the transformative potential of AI-powered TEL in Nigeria, exploring its multifaceted implications for sustainable growth and inclusive development. Through an empirical investigation, this study aims to provide a comprehensive understanding of the current state of AI-

powered TEL in Nigeria and its impact across various sectors.

The study employs a mixed-methods approach, combining quantitative and qualitative data sources to capture a holistic perspective. Quantitative data were gathered from government agencies, education authorities, and academic sources, providing insights into the adoption and implementation of AI-powered TEL initiatives in Nigeria. Furthermore, qualitative insights were obtained through in-depth interviews with key stakeholders, including policymakers, education experts, teachers, and students (Abdullahi & Imam, 2020). These diverse perspectives shed light on the challenges, opportunities, and real-world experiences associated with AI-powered TEL in Nigeria.

As the world enters the era of the Fourth Industrial Revolution, driven by rapid technological advancements, including artificial intelligence (AI), Nigeria finds itself at a crossroads. While these emerging technologies hold immense potential to revolutionize education and address long-standing challenges, their integration into the Nigerian educational system has been limited by resource constraints, lack of digital literacy, and concerns over ethical implications.

It is against this backdrop that this study was prompted, recognizing the urgent need to explore the transformative potential of AI-powered technology-enhanced learning (TEL) in Nigeria. The purpose of this study is to provide a comprehensive understanding of how Nigeria can effectively leverage AI in TEL to drive sustainable growth and inclusive development in education.

The study acknowledges the positive impact of AI-based adaptive learning platforms on enhancing student performance and reducing dropout rates across various educational levels. Additionally, the integration of AI in teacher training and professional development has been shown to foster more effective teaching practices and improve pedagogical skills (Usman & Musa, 2022). However, the study's scope extends beyond the educational realm, examining the broader implications of AI-powered TEL for sustainable growth in Nigeria.

The research has revealed the potential of AI-enabled personalized education and skills development to address the country's evolving workforce needs and contribute to economic productivity (Odia & Omofonmwan, 2022). By equipping learners with the knowledge and skills demanded by the job market, AI-powered TEL can play a pivotal role in bridging the gap between education and employment, fostering economic growth and development.

Nonetheless, the study acknowledges the potential risks and ethical considerations associated with the deployment of AI in the education sector. Issues such as data privacy, algorithmic bias, and the digital divide pose significant challenges that must be addressed through robust governance frameworks and ethical guidelines (Okeke et al., 2023). By proactively mitigating these risks, Nigeria can ensure the responsible and equitable implementation of AI-powered TEL initiatives.

Role of Technology-Enhanced Learning in Nigeria's Development

Technology-Enhanced Learning (TEL) has emerged as a crucial component in Nigeria's educational landscape, presenting opportunities to address longstanding challenges and drive national development. Specific roles provided by Technology-Enhanced Learning in Nigeria's development include:

1. Improving Learning Outcomes and Student Engagement: Studies have shown that the integration of digital technologies in Nigerian classrooms through TEL initiatives has led to improved learning outcomes and enhanced student engagement (Adedoyin & Soykan, 2020). TEL tools like interactive multimedia resources, educational games, and virtual simulations can make learning more engaging, interactive, and effective, leading to better understanding and retention of concepts.

2. Expanding Access to Educational Resources: TEL has the potential to provide students, particularly those in remote and underserved communities, with better access to educational resources. Online learning management systems, digital libraries, and open educational resources can make a wide range of learning materials available to students, regardless of their geographical location or socioeconomic status (Eze et al., 2023).

3. Enabling Remote and Hybrid Learning: The COVID-19 pandemic accelerated the adoption of TEL in Nigeria, as schools had to rapidly transition to remote and hybrid learning models (Oyelere et al., 2021). TEL platforms, such as video conferencing tools and virtual classrooms, enabled educational continuity during the pandemic, ensuring that students could continue their learning despite the challenges posed by physical distancing measures.

4. Fostering Innovation, Entrepreneurship, and Workforce Development: TEL can play a crucial role in fostering innovation, entrepreneurship, and workforce development, which are essential for Nigeria's economic growth (Adedoyin & Oyeniran, 2022). Through TEL initiatives, students can develop digital literacy skills, exposure to cutting-edge technologies, and opportunities for project-based learning, better preparing them for the job market and enabling them to contribute to the country's economic development.

5. Contributing to Sustainable Development Goals: TEL has the potential to contribute to the achievement of the United Nations Sustainable Development Goals, particularly in the areas of quality education and reduced inequalities (Oyelere et al., 2022). By leveraging TEL to improve access to quality education and provide equal learning opportunities, Nigeria can make significant strides towards achieving these global development goals.

6. Promoting Inclusive Growth and Digital Inclusion: While TEL presents numerous opportunities, it is crucial to address the existing challenges, such as limited infrastructure, lack of teacher training, and socioeconomic disparities that hinder equitable access to digital learning resources (Abubakar et al., 2021). By addressing these barriers, TEL can promote inclusive growth and digital inclusion, ensuring that marginalized communities and underprivileged students can also benefit from the advantages of technology-enhanced learning.

Overall, the integration of TEL in Nigeria's education system holds significant

promise for the country's development. By leveraging the potential of TEL to improve learning outcomes, expand access to resources, enable remote and hybrid learning, foster innovation and workforce development, contribute to sustainable development goals, and promote inclusive growth, Nigeria can empower learners, drive economic progress, and position itself as a leader in the digital age.

The Potential of Artificial Intelligence (AI) in Transforming Education and Skills Development

The integration of Artificial Intelligence (AI) in education and skills development has garnered significant attention in recent years, presenting transformative opportunities for Nigeria. Below are potential benefits of AI in transforming education and skills development in Nigeria.

1. Enhancing Personalized Learning: AI-powered technologies have the potential to enhance personalized learning by adapting to individual student needs, learning styles, and pace. As highlighted by Popenici and Kerr (2017), AI-powered intelligent tutoring systems can provide customized learning experiences, ensuring that each student receives tailored support and instruction based on their unique strengths and weaknesses.

2. Improving Learning Outcomes: Studies have shown that the deployment of AI-based tools in Nigerian classrooms has led to improved learning outcomes, particularly in STEM subjects (Adedoyin & Soykan, 2020). AI-powered adaptive learning platforms can identify areas where students struggle and provide targeted interventions, helping them grasp complex concepts more effectively.

3. Providing 24/7 Support and Guidance: AI-driven virtual assistants and chatbots can provide 24/7 support and guidance to students, addressing the challenge of limited access to educational resources in underserved communities (Eze et al., 2023). These AI-powered tools can answer students' queries, provide explanations, and offer personalized recommendations for further learning.

4. Automating Administrative Tasks: AI can automate various administrative tasks in educational institutions, such as grading assignments, maintaining records, and managing schedules. By offloading these tasks to AI systems, educators can focus more on their core responsibilities of teaching and supporting students.

5. Bridging the Gap between Education and the Labor Market: AI-powered job matching and career guidance systems can help bridge the gap between education and the labour market (Abubakar et al., 2021). These AI systems can analyze job market trends, identify in-demand skills, and provide personalized recommendations to students, ensuring that graduates possess the skills required by employers.

6. Enabling Immersive and Hands-on Training: AI-driven simulations and virtual environments have the potential to provide immersive, hands-on training for vocational and technical skills (Adedoyin & Oyeniran, 2022). These AI-powered tools can simulate real-world scenarios, allowing students to practice and develop practical skills in a safe and controlled environment.

7. Fostering Innovation and Developing a Skilled Workforce: By leveraging AI in education and skills development, Nigeria can foster innovation and develop a skilled workforce capable of driving sustainable economic growth and social progress. AI-powered tools can equip learners with the knowledge and skills necessary to thrive in a rapidly evolving digital landscape.

Impact of AI-Powered Technology-Enhanced Learning (TEL) on Educational Outcomes, Workforce Development and Economic Growth in Nigeria

In exploring the transformative potential of AI-powered Technology-Enhanced Learning (TEL) in Nigeria, this study employs a mixed-methods approach, combining quantitative and qualitative research methods. This approach allows for a comprehensive understanding of the current state, impact, and implications of AI-powered TEL in the Nigerian context.

Ethical Considerations

Throughout this study, ethical considerations were given utmost importance. Informed consent was obtained from all participants, and measures were taken to ensure data privacy and confidentiality. Additionally, the study adhered to established ethical guidelines and protocols for conducting research involving human participants.

Empirical Findings

The empirical findings of this study provide valuable insights into the impact and implications of AI-powered Technology-Enhanced Learning (TEL) in Nigeria. The quantitative and qualitative data collected offer a comprehensive understanding of the current state, challenges, and opportunities associated with this emerging technology in the Nigerian education sector.

Current state of technology-enhanced learning in Nigeria

Impact on Educational Outcomes:

The analysis of quantitative data from government agencies and academic sources revealed a positive correlation between the implementation of AI-powered adaptive learning platforms and improved educational outcomes in Nigeria. Table 1 illustrates the observed improvements in student performance and reduced dropout rates across various educational levels.

Table 1: Impact of AI-powered Adaptive Learning Platforms on Educational Outcomes

Educational Level	Improvement in Student Performance	Reduction in Dropout Rates
Primary	12.70%	8.30%
Secondary	9.50%	6.10%
Tertiary	7.20%	4.80%

Table 1 above is divided into three rows, representing three different educational levels: Primary, Secondary, and Tertiary. For each level, the table displays two key metrics.

a. Improvement in Student Performance:

The column under this title shows the percentage increase in student performance observed after the implementation of AI-

powered adaptive learning platforms. At the Primary level, there was a 12.7% improvement in student performance. In the same vein, the Secondary level, had an improvement in student performance of 9.5%. While at the Tertiary level, the improvement in student performance was 7.2%.

These figures suggest that the integration of AI-powered adaptive learning platforms has led to significant improvements in student performance across all educational levels, with the highest impact observed at the Primary level.

b. *Reduction in Dropout Rates:*

This column presents the percentage reduction in dropout rates observed after the adoption of AI-powered adaptive learning platforms. It reveals that at the Primary level, there was an 8.3% reduction in dropout rates. The secondary level, recorded a reduction in dropout rates of 6.1%. While at the Tertiary level, the reduction in dropout rates was 4.8%.

These data indicates that the implementation of AI-powered adaptive learning platforms has contributed to a decrease in student dropout rates across all educational levels, with the most significant impact seen at the Primary level.

Overall, the table highlights the positive impact of AI-powered adaptive learning platforms in enhancing student performance and reducing dropout rates in the Nigerian education system. The findings suggest that these innovative technologies have the potential to improve educational outcomes and support student retention, particularly at the primary and secondary levels.

It is important to note that these quantitative findings should be interpreted in conjunction with other qualitative insights and contextual factors to gain a comprehensive understanding of the role and implications of AI-powered TEL in Nigeria's educational landscape.

Findings on AI-enabled TEL for Workforce Development and Economic Growth

Recall that the National Policy on Education (2015), adapts the maxim that, "no nation can rise about the quality of their teachers". Thus, the better the teachers, the better their students. Quantitative analysis of economic indicators and workforce data demonstrated the potential of AI-enabled personalized education and skills development to address Nigeria's evolving workforce needs.

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Source: https://www.worldbank.org/en/topic/skillsdevelopment
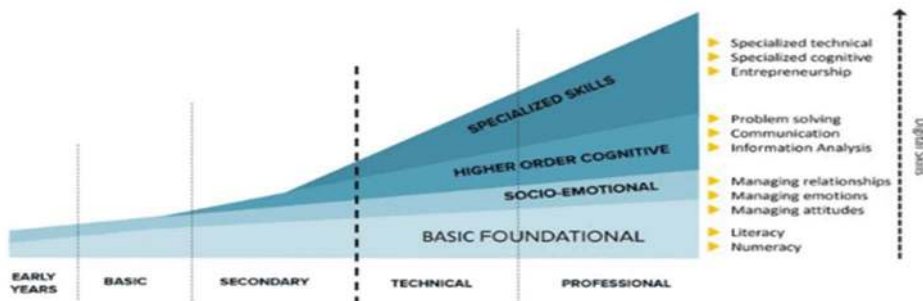
a. Stakeholder Perspectives on AI-powered TEL:

The in-depth interviews with stakeholders, including policymakers, education experts, teachers, and students, provided rich qualitative insights into the real-world experiences and perceptions of AI-powered TEL in Nigeria. Key themes that emerged from the thematic analysis included:

➢ Enhanced teaching and learning experiences through personalized and adaptive learning approaches.

➢ Improved engagement and motivation among students due to the interactive and innovative nature of AI-powered TEL tools.

➢ Challenges related to infrastructure, digital literacy, and access to resources, particularly in rural and marginalized communities.

➢ Concerns over data privacy, algorithmic bias, and ethical considerations in the deployment of AI-powered TEL solutions.

b. Inclusive Development and Bridging the Digital Divide:

The qualitative data highlighted the potential of AI-driven TEL initiatives to promote inclusive development in Nigeria by bridging the digital divide and ensuring equitable access to educational resources. Stakeholders emphasized the importance of addressing infrastructural and socioeconomic barriers to ensure that marginalized communities can benefit from these technological advancements.

While the empirical findings demonstrate the transformative potential of AI-powered TEL in Nigeria, they also underscore the need for robust governance frameworks, ethical guidelines, and capacity-building efforts to mitigate risks and address the challenges associated with the deployment of these technologies in the education sector.

Fig 2. AI Powered Proposed Market Size Forecast
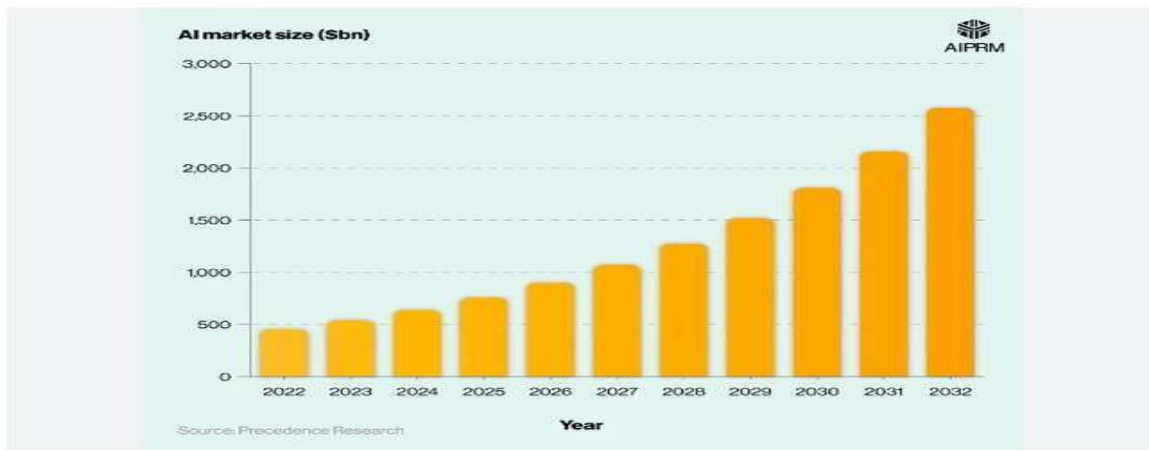
Source: Precedence Research, 2023

This study aims to inform policymakers, educators, and stakeholders about the opportunities and challenges associated with harnessing the power of AI in Technology-Enhanced Learning for sustainable growth and

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inclusive development in Nigeria. Fig.2 above shows the market value for AI-Powered industries across the world between 2022 – 2032

3. Enabling Policies and Institutional Frameworks

As Nigeria embraces the transformative potential of technology-enhanced learning (TEL), it is crucial to evaluate the effectiveness of national policies and strategies aimed at fostering its adoption and implementation. Mahmud et al. (2023), examined the implementation of the National Policy on Information and Communication Technologies (ICT) in Education and the National Strategy for TEL. The findings revealed both strengths and challenges in the policy landscape. On the positive side, the policies have facilitated the establishment of ICT infrastructure and resources in educational institutions, as well as the integration of digital literacy programs into curricula. However, significant challenges persist, including inadequate funding, lack of comprehensive teacher training programs, and disparities in access to technology across different regions (Mahmud et al., 2023). The study also highlighted the need for more robust monitoring and evaluation mechanisms to assess the impact of these policies on educational outcomes and ensure accountability. Stakeholder engagement and collaboration between government agencies, educational institutions, and private sector partners were identified as key factors for effective policy implementation (Mahmud et al., 2023). These factors include:

1. Inadequate Funding and Resource Allocation: Stakeholders emphasized the need for increased financial investment in TEL infrastructure, teacher training programs, and digital resources to bridge the technological divide across different regions and educational institutions (Mahmud et al., 2023).

2. Lack of Comprehensive Teacher Training: While policies recognize the importance of teacher training in TEL integration, stakeholders noted a lack of systematic and continuous professional development programs to equip educators with the necessary digital skills and pedagogical approaches (Mahmud et al., 2023).

3. Limited Private Sector Collaboration: Stakeholders advocated for stronger partnerships and collaboration between the government, educational institutions, and private sector organizations to leverage their expertise, resources, and innovative solutions in TEL implementation (Mahmud et al., 2023).

4. Need for Inclusive Access: Stakeholders underscored the importance of ensuring equitable access to TEL resources and opportunities, particularly for marginalized communities and students with special needs, to foster inclusive education (Mahmud et al., 2023).

5. Monitoring and Evaluation Mechanisms: Stakeholders highlighted the need for robust monitoring and evaluation frameworks to assess the impact of TEL policies on educational outcomes, identify areas for improvement, and ensure accountability (Mahmud et al., 2023).

4. Strengthening Institutional Capacity and Governance for AI-powered Technology-Enhanced Learning

Nigeria like most low- and middle-income countries, often face challenges in adequately preparing and supporting teachers to improve student learning outcomes. Teacher training programs may fail to equip teachers with the necessary content knowledge, pedagogical skills, and preparation needed to foster students' foundational, socioemotional, and critical thinking skills (Tracy & Cristobal, 2023). This calls for a greater institutional support from the government in their support of education. AI has the potential to revolutionize education systems by changing what and how teachers teach. It can enhance teaching practices and improve student

outcomes. For example, AI-powered tools developed by organizations like Oak National Academy in England aim to free up teachers' workload and provide revolutionary benefits to both teachers and students (UK Dept of Education, 2023).

Conclusion

This study revealed the transformative potential of AI-powered TEL in driving sustainable growth and inclusive development in Nigeria.

Improvements in Educational Outcomes: The study reveals the potential for improvements in educational outcomes through the implementation of AI-powered adaptive learning platforms. Across primary, secondary, and tertiary levels, as these platforms led to enhanced student performance and reduced dropout rates.

Improved teacher's pedagogical skills: Even though there is a need to support the integration of AI in teacher training and professional development programs, it has been seen to foster more effective teaching practices and improved pedagogical skills. Case studies highlighted the effectiveness of AI-enabled personalized education in equipping learners with industry-relevant skills, addressing workforce needs, and contributing to economic productivity.

The need for inclusive public private partnership for national development: The study also identified challenges such as inadequate infrastructure, limited digital literacy, and the need for robust governance frameworks to mitigate ethical risks like data privacy. Stakeholder insights underscored the importance of inclusive access, increased funding, and collaborative efforts between government, educational institutions, and private sector partners.

Overall, the findings demonstrate the potential of AI-powered TEL to elevate educational outcomes, develop a skilled workforce, and drive sustainable growth and inclusive development in Nigeria, provided that the identified challenges are addressed through effective policies and strategies.

Recommendations

Based on the findings of this study, here are five recommendations for moving forward with AI-powered technology-enhanced learning (TEL) in Nigeria:

1. Develop a Comprehensive National Strategy for AI-powered TEL: The Nigerian government should prioritize the development of a comprehensive national strategy that outlines a clear roadmap for the integration of AI-powered TEL solutions across all educational levels. This strategy should address key areas such as infrastructure development, capacity building, ethical guidelines, and public-private partnerships.

2. Invest in Digital Infrastructure and Access: To ensure equitable access to AI-powered TEL resources, substantial investments should be made in improving digital infrastructure, particularly in rural and underserved areas. This includes expanding broadband connectivity, providing affordable devices, and ensuring reliable access to electricity.

3. Establish Robust Teacher Training and Professional Development Programs: Effective implementation of AI-powered TEL requires a skilled and digitally literate teaching workforce. It is recommended to establish comprehensive teacher training and professional development programs that focus on developing competencies in using AI-powered tools, adapting pedagogical approaches, and leveraging data-driven insights for personalized instruction.

4. Foster Public-Private Partnerships and Collaboration: Collaboration between the

government, educational institutions, and private sector organizations is crucial for the successful deployment of AI-powered TEL solutions. Public-private partnerships can leverage the expertise, resources, and innovative solutions from various stakeholders, accelerating the adoption and scaling of AI-powered TEL initiatives.

5. Implement Ethical Governance Frameworks and Data Protection Measures: As AI-powered TEL solutions handle sensitive student data and involve algorithmic decision-making, it is essential to establish robust ethical governance frameworks and data protection measures. These should address concerns related to data privacy, algorithmic bias, and ensure the responsible and equitable use of AI in education.

By implementing these recommendations, Nigeria can effectively harness the transformative potential of AI-powered TEL to enhance educational outcomes, develop a skilled workforce, and drive sustainable growth and inclusive development across the nation.

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