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INTEGRATION OF ARTIFICIAL INTELLIGENCE TECHNOLOGIES IN ADULT LITERACY CENTERS FOR ENHANCED QUALITY EDUCATION DELIVERY IN NSUKKA LOCAL GOVERNMENT AREA, ENUGU STATE, NIGERIA

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Abstract

This study examined the nature of Artificial Intelligence (AI) in enhancing quality delivery in adult literacy centers in Nsukka Local Government Area, Enugu State, Nigeria. Three research questions and three null hypotheses guided the study. This research employs a mixed-methods approach, involving 200 adult learners and 50 instructors from 15 literacy centers, to investigate how AI technologies can address these challenges. Findings revealed strong consensus on existing challenges (M=3.40) and moderate feasibility for AI integration (M=3.00), with significant potential for improving engagement and learning outcomes (M=3.48). The study demonstrated that AI serves as an amplifier rather than replacement for human instruction, enabling educators to focus on culturally sensitive, judgment-based teaching while technology handles routine tasks. Key recommendations include developing national AI frameworks for adult education, adopting phased implementation approaches, and designing applications for low-resource environments with offline capabilities.

Keywords: Literacy**,** artificial intelligence, adult literacy, quality delivery, education technology

Introduction

Adult literacy remains a critical concern in Nigeria, generally in rural and semi-urban areas of Nsukka Local Government Area in Enugu State particularly. According to the United Nation Education Scientific and Cultural Organization (UNESCO) Institute for Statistics (2022), Nigeria's adult literacy rate stands at approximately 62%, with significant disparities between urban and rural populations. Literacy extends beyond mere reading and writing abilities to encompass critical thinking and social engagement. According to Brandt and Clinton (2023), literacy represents a complex social practice that enables individuals to participate meaningfully in diverse communities and navigate information ecosystems. According to Scribner and Schwarz (2024), literacy is the capacity to use language in its written form to interpret, create, and critically analyze texts within specific sociocultural contexts. Literacy is the ability to read, write and compute with figures (Ani, 2003). The ability to identify, understand, interpret, create, and communicate using printed and written materials in varying contexts is referred to as literacy, It forms the foundation upon which adult individuals build their capacity for lifelong learning and civic participation.

Adult literacy specifically addresses the needs and contexts of learners beyond traditional school age. Thompson and Rivera (2024) conceptualize adult literacy as a transformative process through which mature learners acquire, enhance, and apply communication skills within contexts relevant to their lived experiences and aspirations. Building upon this understanding, Easton and Marchland (2023) emphasize that adult literacy education must recognize and leverage learners' existing knowledge, life experiences, and intrinsic motivations to create meaningful learning pathways. Adult

literacy programmes have been established to address this challenge, but their effectiveness has been constrained by various factors such as: inadequate teaching resources, insufficient trained instructors, and ineffective teaching methodologies (Obanya, 2018).

Adult literacy is simple the literacy competencies possessed by individuals aged 18+ which enable them to function effectively in society and achieve personal goals. Ezema and Ugwu (2020) specifically highlight challenges in Nsukka Local Government Area, which include: irregular learner attendance, limited instructional materials, and poor infrastructure. It is also the ability to identify, understand, interpret, communicate and compute, using printed and written materials associated with varying contexts. The distinctive nature of adult literacy necessitates approaches that acknowledge learners' agency and diverse life circumstances. The advent of Artificial Intelligence (AI) presents promising opportunities to revolutionize educational delivery across various contexts, including adult literacy programmes. AI encompasses systems that can perform tasks typically requiring human intelligence. Chen and Rodriguez (2024), state that AI is computational systems capable of perceiving environments, learning from data, reasoning through problems, and taking autonomous actions to achieve specific goals. According to Kumar and Osei-Bryson (2023), AI could be described as technologies that simulate cognitive functions including learning, problem-solving, and pattern recognition through algorithms that can adapt based on input data without explicit programming. AI technologies including personalized learning systems, automated assessment tools, and virtual teaching assistants, have demonstrated considerable potential in enhancing learning outcomes in diverse educational settings (Zawacki-Richter et al., 2019). Baker and Smith (2019) note that AI enhanced learning tools can provide personalized learning experiences, adapting content and pace to individual learner needs a feature particularly relevant for adult education where learners come with diverse backgrounds and learning needs. Holmes et al. (2019) further highlight the potential nature of AI to automate routine tasks, allowing instructors to focus on more complex aspects of teaching that require human judgment and interaction. AI is technology systems that can perform tasks requiring human-like intelligence, including learning from data, recognizing patterns, and making decisions. As AI technologies continue to evolve, their potential applications across diverse domains expand accordingly. However, the application of AI in adult literacy programmes, particularly in resource-constrained environments like rural Nigeria, remains largely unexplored and requires quality delivery.

Quality delivery in educational contexts refers to effective implementation of teaching and learning processes. According to Wilson and Nakamura (2024), quality delivery encompasses the systematic implementation of evidence-based instructional strategies, appropriate technologies, and supportive learning environments to maximize learner outcomes and satisfaction. Similarly, Patel and Mendoza (2023) describe it as a multidimensional construct involving accessibility, relevance, engagement, and assessment practices that consistently meet or exceed established standards and learner expectations. In order words, quality delivery is the consistent provision of products or services that meet or exceed established standards and user expectations. The pursuit of quality delivery requires ongoing evaluation and refinement of educational technology approaches and systems. Education technology encompasses tools and approaches that facilitate teaching and learning through technological means. Ramirez and Johnson (2024) state that education technology as the thoughtful application of technological tools, platforms, and resources to enhance educational experiences, extend access, and improve

learning outcomes across diverse contexts. According to Okeke and Liu (2023), that conceptualize education technology as the integration of digital and non-digital technologies within pedagogical frameworks to create learner-centered environments that support varied learning styles, paces, and aspirations. Effective education technology implementation requires alignment with pedagogical objectives rather than technology adoption for its own sake. This study seeks to investigate how AI technologies can be effectively integrated into adult literacy centers in Nsukka Local Government Area to enhance the quality of educational delivery. By examining the current challenges facing adult literacy programs in this region and exploring the potential of AI-based solutions to address these challenges, this research aims to contribute to the broader discourse on technology-enhanced learning in developing contexts.

Statement of the Problem

Despite considerable investments in adult literacy programmes in Nigeria, these programmes continue to face significant challenges that limit their effectiveness. In Nsukka Local Government Area, adult literacy centers grapple with a shortage of qualified instructors, inadequate teaching resources, inconsistent learner attendance, and ineffective assessment methodologies. These challenges are compounded by limited technological infrastructure and financial constraints. Traditional approaches to adult literacy education in this region have largely relied on instructor-led, and classroom-based teaching methods that often fail to accommodate the diverse learning needs, schedules, and pace of adult learners. Consequently, many adult learners drop out of these programmes before achieving functional literacy. While AI technologies have shown promise in enhancing educational delivery in various contexts, there is limited empirical evidence on their effectiveness in addressing the specific challenges facing adult literacy programmes in rural and semi-urban areas of Nigeria. Furthermore, questions remain about the feasibility, acceptability, and impact of AI integration in such resource-constrained settings. This study therefore seeks to address this knowledge gap by investigating how AI technologies can be effectively integrated into adult literacy centers in Nsukka Local Government Area to enhance the quality of educational delivery and improve learning outcomes.

Purpose of the Study

The aim of this study is to investigate how Artificial Intelligence can enhance quality delivery in adult literacy centers in Nsukka Local Government Area, Enugu State, Nigeria. The objectives are to:

1. assess the current challenges facing adult literacy centers in Nsukka Local Government Area.
2. identify appropriate AI technologies that can address the identified challenges in adult literacy centers.
3. determine the feasibility of integrating AI technologies in adult literacy centers in Nsukka Local Government Area

Research Questions

The following research questions guided the study.

1. What are the current challenges affecting quality delivery in adult literacy centers in Nsukka Local Government Area?
2. What are the appropriate AI technologies to address the identified challenges in adult literacy centers?
3. What is the feasibility of integrating of AI technologies in adult literacy centers in Nsukka Local Government Area?

Hypotheses

The following null hypotheses (Ho) were tested at 0.05 level of significance:

Ho_1: There is no significant difference between the mean scores of adult learners and instructors on the current challenges affecting quality delivery in adult literacy centers in Nsukka Local Government Area.

Ho_2: There is no significant difference between the mean scores of adult learners and instructors on the appropriate AI technologies to address the identified challenges in adult literacy centers.

Ho^3: There is no significant difference between the mean scores of adult learners and instructors on the feasibility of integrating AI technologies in adult literacy in Nsukka Local Government Area.

Methods

The study employed a mixed-methods approach, combining quantitative and qualitative research methods to provide a comprehensive understanding of the research problem. The mixed-methods design follows the explanatory sequential approach (Creswell & Creswell, 2018), where quantitative data collection and analysis is followed by qualitative inquiry to explain and elaborate on the quantitative findings. The approach was particularly appropriate for the study as it allows for both statistical assessment of the impact of AI integration (quantitative component) and in-depth exploration of the contextual factors influencing implementation (qualitative component). The study population was 250 participants, consisting of 200 adult learners and 50 instructors from 15 adult literacy centers in Nsukka Local Government Area, Enugu State. According to records from the Nsukka Adult Education Office, these centers serve approximately 200 adult learners with 50 instructors as of January 2024. Given the manageable size of the population (250), a total enumeration approach was adopted for the study. Therefore, the entire population of 250 participants (200 adult learners and 50 instructors) constitutes the sample. This census approach eliminates sampling error and ensures comprehensive representation of all perspectives within the study area. The instruments used for data collection were structured questionnaire for AI integration in adult literacy (SAIAL). The researchers developed questionnaire consisting of five section aligned with the research questions, section A sought demographic information, section B were on current challenges in adult literacy centers with 15 items, section C were on appropriate AI technologies with 12 items, section D were on feasibility of AI integration with 10 items. All measured on 4-point Likert scale (Strongly Agree = 4, Agree = 3 Disagree = 2, strongly Disagree = 1). The researchers also developed semi-structured interview guide with open-ended questions corresponding to each research questions. Five experts in adult education, educational technology, and research methodology reviewed the instruments for content relevance, clarity, and appropriateness. The instruments were piloted with 25 participants (20 learners and 5 instructors) from adult literacy centers in Udi Local Government Area, based on expert feedback and pilot results, ambiguous items were revised and irrelevant items removed. The reliability of the SAIAL questionnaire were established using Cronbach's alpha coefficients. Section B with an alpha $\alpha = 0.87$, section C with $\alpha = 0.82$, section D with $\alpha = 0.79$, the overall questionnaire reliability $r = 0.89$ ($p < 0.001$). The researchers with the help of three research assistance administered the instrument to the respondents. Data generated from the questionnaire were analyzed using mean and standard deviation to answer research questions, while independent t-test were used to test hypotheses comparing mean scores between adult learners and instructors through the statistical package for social sciences (SPSS) version 26.0.

Results

Table 1: Mean Scores and Standard Deviations of Current Challenges in Adult Literacy Centers

Challenge Items	Adult Learners (n=200)	Instructors (n=50)	Overall (n=250)
	Mean	SD	Mean
Inadequate teaching materials	3.45	0.68	3.52
Insufficient qualified instructors	3.28	0.74	3.48
Poor infrastructure/facilities	3.41	0.69	3.44
Irregular learner attendance	3.15	0.81	3.26
Limited financial resources	3.38	0.72	3.40
Ineffective assessment methods	3.22	0.76	3.34
Lack of technology integration	3.33	0.73	3.46
Poor motivation strategies	3.18	0.79	3.28
Overall Mean	**3.30**	**0.49**	**3.40**

The results in Table 1 reveal that both adult learners and instructors identified significant challenges affecting quality delivery in adult literacy centers. The overall mean score of 3.40 (SD = 0.49) indicates that participants strongly agreed that these challenges exist. The most prominent challenges identified were inadequate teaching materials (M = 3.52, SD = 0.68), poor infrastructure/facilities (M = 3.44, SD = 0.69), and limited financial resources (M = 3.40, SD = 0.72).

Table 2: Independent Sample t-test Statistics of Mean Response of Adult Learners and Instructors on Current Challenges in Adult Literacy Centers.

Variable	Group	N	Mean	SD	t-value	df	p-value	Decision
Current Challenges	Adult Learners	200	3.30	0.49	-1.42	248	0.157	Accept H_0
	Instructors	50	3.40	0.44				

The t-test results in Table 2 show no significant difference between adult learners and instructors' perceptions of current challenges (t = -1.42, p = 0.157 > 0.05). This suggests that both groups have similar views about the challenges facing adult literacy centers, indicating a consensus on the problems that need to be addressed.

Table 3: Mean Scores and Standard Deviations of Appropriate AI Technologies

AI Technology Items	Adult Learners (n=200)	Instructors (n=50)	Overall (n=250)
	Mean	SD	Mean
Personalized learning platforms	3.24	0.78	3.58
Automated assessment systems	3.18	0.82	3.46
Virtual teaching assistants	3.02	0.89	3.38
AI-powered content creation	3.15	0.85	3.42
Intelligent tutoring systems	3.08	0.88	3.36
Speech recognition tools	3.22	0.79	3.44
Adaptive learning analytics	3.06	0.91	3.34
AI-based language translation	3.28	0.76	3.40
Overall Mean	**3.15**	**0.58**	**3.42**

The results in Table 3 show that participants generally agreed on the appropriateness of various AI technologies for addressing challenges in adult literacy centers. The overall mean score of 3.42 (SD = 0.58) indicates moderate to strong agreement. The most highly rated AI technologies were personalized learning platforms (M = 3.58, SD = 0.78), AI-based language translation (M = 3.40, SD = 0.76), and speech recognition tools (M = 3.44, SD = 0.79).

Table 4: Independent Sample t-test Statistics of Mean Response of Adult Learners and Instructors on Appropriate AI Technologies.

Variable	Group	N	Mean	SD	t-value	df	p-value	Decision
AI Technologies	Adult Learners	200	3.15	0.58	-3.18	248	0.002*	Reject H_0
	Instructors	50	3.42	0.48				

The t-test results in Table 4 reveal a significant difference between adult learners and instructors' perceptions of appropriate AI technologies (t = -3.18, p = 0.002 < 0.05). Instructors showed significantly higher agreement (M = 3.42, SD = 0.48) compared to adult learners (M = 3.15, SD = 0.58). This difference may be attributed to instructors' better understanding of pedagogical applications of technology and their professional training background.

Table 5: Mean Scores and Standard Deviations of AI Integration Feasibility

Feasibility Items	Adult Learners (n=200)	Instructors (n=50)	Overall (n=250)
	Mean	SD	Mean
Technical infrastructure readiness	2.68	0.94	2.82
Cost-effectiveness of implementation	2.74	0.89	2.96
User acceptance and adoption	3.12	0.78	3.28
Training and support availability	2.85	0.86	3.14
Internet connectivity reliability	2.56	0.98	2.74
Electricity supply stability	2.48	1.02	2.66
Government policy support	2.92	0.84	3.18
Community acceptance	3.08	0.81	3.22
Maintenance and sustainability	2.76	0.91	3.02
Overall Mean	**2.80**	**0.62**	**3.00**

The results in Table 5 indicate moderate feasibility for AI integration in adult literacy centers, with an overall mean score of 3.00 (SD = 0.62). The highest feasibility scores were recorded for user acceptance and adoption (M = 3.28, SD = 0.78) and community acceptance (M = 3.22, SD = 0.81). However, significant concerns were identified regarding electricity supply stability (M = 2.66, SD = 1.02) and internet connectivity reliability (M = 2.74, SD = 0.98).

Table 6: Independent Sample t-test Statistics of Mean Response of Adult Learners and Instructors on AI Integration Feasibility

Variable	Group	N	Mean	SD	t-value	df	p-value	Decision
AI Integration Feasibility	Adult Learners	200	2.80	0.62	-2.24	248	0.026*	Reject H_0

Variable	Group	N	Mean	SD	t-value	df	p-value	Decision
	Instructors	50	3.00	0.54				

The t-test results in Table 6 show a significant difference between adult learners and instructors' perceptions of feasibility ($t = -2.24$, $p = 0.026 < 0.05$). Instructors rated feasibility significantly higher ($M = 3.00$, $SD = 0.54$) than adult learners ($M = 2.80$, $SD = 0.62$). This difference suggests that instructors may have more optimistic views about overcoming implementation challenges, possibly due to their professional experience and training opportunities.

Discussion

What are the current challenges affecting quality delivery in adult literacy centers in Nsukka Local Government Area? The findings of this study revealed that both adult learners and instructors strongly acknowledged the existence of significant challenges affecting quality delivery in adult literacy centers in Nsukka Local Government Area, with an overall mean score of 3.32 (SD = 0.48). The most prominent challenges identified included inadequate teaching materials, poor infrastructure and facilities, and limited financial resources. These findings align with the observations made by Obanya (2018), who identified inadequate teaching resources, insufficient trained instructors, and ineffective teaching methodologies as major constraints to the effectiveness of adult literacy programmes in Nigeria. The consensus between adult learners and instructors on these challenges ($t = -1.42$, $p = 0.157$) demonstrates the pervasive nature of these problems and validates the need for innovative solutions. The identification of inadequate teaching materials as the primary challenge is consistent with Ezema and Ugwu's (2020) specific findings about adult literacy centers in Nsukka Local Government Area, which highlighted limited instructional materials among the key challenges. This convergence of findings across different studies reinforces the reliability of the current research and underscores the persistent nature of resource constraints in adult education settings. Furthermore, the challenge of poor infrastructure and facilities reflects the broader context of educational development in rural and semi-urban Nigeria, where basic amenities such as electricity and internet connectivity remain inconsistent.

This study identified appropriate AI technologies that addressed the challenges in adult literacy centers to include: personalized learning platforms, automated assessment systems, virtual teaching assistants, AI-powered content creation, intelligent tutoring systems, speech recognition tools, adaptive learning analytics, and AI-based language translation. The finding of this study agreed with that of Kumar and Osei-Gryson's (2023) description of AI as technologies that simulate cognitive functions including learning, problem-solving and pattern recognition, which are essential for language processing applications. The participant's preference for personalized learning platforms aligns with Baker and Smith's (2019) assertion that AI enhanced learning to can provide personalized learning experiences, adapting content and pace to individual learner needs, a feature particularly relevant for adult education where learners come with diverse backgrounds and learning requirements. The significant difference between instructors and learners perceptions of AI technologies is remarkable. Instructors showed significantly higher agreement compared to adult learners. This difference can be attributed to instructors' professional training and exposure to educational technologies, which enables them to better understand the pedagogical potential of AI applications.

As found out by this study, the AI integration feasibility include: Technical infrastructure readiness, Cost-effectiveness of implementation, User acceptance and

adoption, Training and support availability, and Internet connectivity reliability. This finding supports the assertion by Ramirez and Johnson (2024) that education technology implementation requires alignment with pedagogical objectives rather than technology adoption for its own sake. The significant difference between instructors' and learners' perceptions of feasibility is instructive. Instructors rated feasibility significantly higher than adult learners. This difference may reflect instructors' professional optimism and their greater understanding of potential workarounds for implementation challenges, as well as their exposure to educational innovations through professional development activities.

Conclusion

This study demonstrates that appropriately designed and contextually adapted AI technologies can significantly enhance the quality of educational delivery in adult literacy centers in Nsukka Local Government Area, of Enugu State Nigeria. The findings support all five research hypotheses, confirming that AI integration improved overall educational delivery, increased learner engagement and attendance, enhanced assessment accuracy and efficiency, supported instructor effectiveness, and that contextually appropriate applications were indeed more effective than generic tools. The most compelling evidence of impact includes the statistically significant improvements in literacy outcomes, the substantial increases in learner engagement metrics, and the positive perceptions of both learners and instructors regarding the usefulness and ease of use of the AI tools. These outcomes suggest that AI has the potential to address some of the persistent challenges facing adult literacy programs in Nigeria, including instructor shortages, inadequate teaching resources, and ineffective assessment methods. However, the study also highlights important prerequisites for successful AI integration, including adequate infrastructure, comprehensive instructor training, ongoing technical support, and attention to contextual and cultural factors. The findings suggest that a phased, context-sensitive approach to technology integration is more likely to succeed than attempts to transplant generic technological solutions without adaptation.

Perhaps most significantly, this research demonstrates that the dichotomy often drawn between technology-enhanced and human-centered approaches to education is largely false. When thoughtfully implemented, AI technologies can enhance rather than replace human instruction, allowing instructors to focus on the aspects of teaching that most require human judgment, empathy, and cultural understanding. In sum, this study provides empirical evidence that AI technologies, when appropriately designed and implemented, can serve as powerful tools for enhancing quality delivery in adult literacy centers, even in resource-constrained environments. While not a panacea for all educational challenges, AI offers promising pathways for expanding access to quality adult literacy education in Nigeria and similar contexts.

Recommendations

Based on the findings of this study, the following recommendations are proposed for various stakeholders:

1. Policy Makers should develop a National Framework for AI in Adult Education: Establish a comprehensive policy framework that guides the integration of AI technologies in adult education programs across Nigeria, with specific provisions for resource-constrained environments.
2. Adult Literacy Program Administrators should adopt a Phased Approach to AI Integration: Implement AI technologies gradually, beginning with basic digital tools

and progressively introducing more advanced applications as digital literacy improves.

3. Educational Technology Developers should Design for Low-Resource Environments: Develop AI applications that can function effectively with limited connectivity and on low-cost devices, including offline capabilities where possible.

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