

Research Article

Evaluation of the impact of AI-driven adaptive learning on foundational literacy in preschoolers in Nigeria

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Abstract

This study evaluates the impact of AI-driven adaptive learning on foundational literacy development among preschoolers in Nigeria, set against a background of rapid technological transformation and persistent literacy gaps in early childhood education. The research aimed to evaluate how these personalised digital platforms influence early reading skills and engagement, while assessing the scope of digital infrastructure and teacher readiness across six Nigerian states: Kaduna State, Bauchi State, Abuja (Federal Capital Territory), Lagos State, Rivers State and Enugu State. Adopting a quantitative descriptive survey design, the study sampled 384 teachers and administrators using the "AI-Driven Adaptive Learning and Foundational Literacy Questionnaire" (ADALFLQ). The findings revealed that while AI-driven platforms significantly enhance letter recognition ($\bar{x} = 3.10$), phonemic awareness, and learner engagement ($\bar{x} = 3.23$), their overall effectiveness is critically hampered by low teacher preparedness ($\bar{x} = 2.32$), poor internet connectivity ($\bar{x} = 2.49$), and inadequate training ($\bar{x} = 2.25$). The study concluded that although AI-driven adaptive learning positively influences literacy outcomes, it cannot operate in a vacuum; thus, the difference in literacy scores between supportive and less supportive environments was not statistically significant at $p > 0.05$ due to systemic infrastructural deficits. Based on these results, it is recommended that the government and school proprietors prioritise robust digital infrastructure, stable electricity, and comprehensive teacher professional development in AI integration.

Keywords: Artificial Intelligence, Adaptive Learning, Foundational Literacy, Preschool Education, Nigeria, Digital Infrastructure.

1. Introduction

Education in the twenty-first century is undergoing a significant technological metamorphosis, whereby digital systems increasingly influence the ways in which children engage with language, symbols, and meaning even before formal schooling. In numerous developing nations, including Nigeria, the proliferation of mobile devices, internet connectivity, and digital learning platforms has facilitated

new prospects for promoting early literacy development through intelligent technologies (Okemakinde & Ogunyinka, 2025). Recently, artificial intelligence has emerged as a pivotal innovation within the educational technology domain. Unlike earlier computer-assisted instructional tools, AI-driven systems are capable of analysing learner responses, adapting instructional content in real time, and personalising

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learning experiences according to each child's individual pace and cognitive profile (Eleje et al., 2025). These advancements have garnered increasing interest among educational policymakers and researchers committed to enhancing foundational literacy among early learners, especially in contexts where traditional classroom instruction faces challenges in addressing the diverse learning needs of students (Okemakinde & Ogunyinka, 2025).

Early childhood education occupies a particularly strategic position in the educational development trajectory of any nation. During the preschool years, typically between ages three and five, children acquire the foundational linguistic and cognitive competencies that enable later academic learning. These include phonological awareness, vocabulary acquisition, letter recognition, early writing skills, and basic comprehension abilities (Akinrotimi et al., 2025). Studies consistently demonstrate that deficits in these early literacy skills often persist throughout schooling and contribute significantly to long-term educational inequality (Ewa, 2024). Within Nigeria, the challenge is substantial. Studies suggest that a large proportion of pupils entering primary school struggle with basic literacy tasks such as recognising letters or understanding simple sentences in English or indigenous languages (Eleje et al., 2025). These gaps have raised serious concerns about the effectiveness of early childhood instructional practices and the need for innovative pedagogical approaches that can support diverse learning needs.

According to Akinrotimi, Popoola, and Udo (2025), foundational literacy refers to the essential reading and language competencies that allow children to decode text, understand meaning, and communicate ideas effectively. These competencies typically include phonemic awareness, vocabulary development, listening comprehension, and early reading fluency. In many Nigerian preschool settings, however, foundational literacy instruction remains largely dependent on traditional teacher-centred methods such as rote repetition, chalkboard demonstrations, and recitation of alphabet sounds (Okemakinde & Ogunyinka, 2025). While these strategies have historically supported basic literacy acquisition, their effectiveness is often constrained by contextual factors, including large class sizes, limited instructional materials, and variations in teacher training. Consequently, some early childhood classrooms struggle to provide the level of individualised support required by learners who progress at different speeds (Akinrotimi et al., 2025).

Recent technological developments have therefore stimulated interest in using artificial intelligence to support literacy instruction in early childhood education. According to Oshinowo et al. (2025), Artificial intelligence in education generally refers to computer systems capable of performing

tasks that traditionally require human intelligence, including pattern recognition, adaptive feedback, automated assessment, and personalised instructional recommendations. Within educational settings, AI-driven adaptive learning platforms analyse learner responses to determine areas of difficulty and then adjust instructional content accordingly (Eleje et al., 2025). These systems may modify the complexity of reading passages, introduce targeted vocabulary exercises, or provide immediate feedback when children make errors. Such adaptive processes enable learners to engage with materials suited to their current developmental level, thereby reducing frustration and enhancing motivation (Oshinowo et al., 2025).

The concept of AI-driven adaptive learning has therefore become increasingly central to contemporary discussions on educational innovation. According to Adigun et al. (2025), adaptive learning systems are designed to personalise instruction by analysing learner data and dynamically adjusting content difficulty, instructional pacing, and feedback mechanisms. Rather than presenting identical learning materials to all learners, these systems generate customised learning pathways based on each child's performance patterns. In early literacy instruction, adaptive platforms may present phonics exercises, interactive storytelling tasks, or vocabulary games that evolve according to a child's responses (Oshinowo et al., 2024). Studies within emerging digital education contexts suggest that such systems can improve engagement and retention because learners receive instruction that aligns closely with their current cognitive readiness (Akinrotimi et al., 2025).

In Nigeria, interest in AI-supported learning has grown significantly over the past decade as educational stakeholders seek solutions to persistent literacy challenges. According to Ewa (2024), AI-assisted learning platforms have been introduced in selected private schools and experimental digital classrooms across urban centres such as Lagos, Abuja, and Port Harcourt. In some Montessori-inspired preschools in Lagos State, tablet-based phonics applications equipped with adaptive feedback mechanisms are used to help preschool learners practise sound recognition and word formation. These platforms monitor the learner's progress and automatically adjust the difficulty level of tasks, thereby allowing children who grasp concepts quickly to advance while providing additional support for those who struggle (Akinrotimi et al., 2025). Such interventions illustrate how adaptive learning technologies may complement classroom instruction by providing individualised reinforcement opportunities.

Despite these promising developments, the adoption of AI-driven adaptive learning in Nigerian preschool education remains uneven and relatively limited. According to Adigun et al. (2025), many early childhood institutions, particularly

in rural areas, still lack the digital infrastructure required to support such technologies. Access to stable electricity, internet connectivity, and digital devices continues to vary widely across regions. Even where digital tools are available, educators may lack the professional training necessary to integrate AI-supported instructional platforms effectively into early literacy teaching. As a result, the potential benefits of AI-based learning systems often remain unrealised within many Nigerian educational contexts (Eleje et al., 2025).

Another important dimension of the discussion concerns the evaluation of the actual impact of AI-driven adaptive learning on children's foundational literacy outcomes. While theoretical models suggest that personalised instruction should enhance learning efficiency, empirical evidence within the Nigerian early childhood education sector remains relatively limited. Some studies have reported improvements in literacy engagement and early reading skills when digital learning tools are introduced in classroom settings (Ewa, 2024). For instance, a quasi-experimental study conducted across ten early childhood centres in Nigeria found that pupils exposed to AI-supported instructional activities demonstrated higher scores in early reading comprehension and vocabulary recognition compared with those receiving conventional instruction. The researchers observed measurable improvements in attention span and participation during literacy lessons (Akinrotimi et al., 2025). This, therefore, suggests that adaptive learning environments may stimulate greater learner engagement.

However, scholars have also raised caution regarding the uncritical adoption of artificial intelligence within early childhood learning environments. According to Izuagie (2025), language acquisition and literacy development are deeply embedded in social interactions. Social interactions such as storytelling, conversation, and collaborative play enhance language acquisition and literacy development. Overreliance on automated learning systems may therefore risk reducing the richness of human-mediated learning experiences if not carefully integrated within broader pedagogical frameworks (Adigun et al., 2025).

Furthermore, the evaluation of AI-driven adaptive learning technologies must consider contextual realities within the Nigerian educational system. Socio-economic disparities significantly influence children's access to digital learning resources. According to Eleje et al. (2025), while some private preschools in metropolitan areas may possess advanced digital infrastructure, many public early childhood centres operate with limited teaching materials and overcrowded classrooms. These inequalities raise important questions regarding whether AI-based educational innovations might inadvertently widen existing learning gaps between children from different socio-economic backgrounds (Okemakinde & Ogunyinka, 2025). This

therefore suggests that effective evaluation of AI-driven learning interventions must consider not only learning outcomes but also issues of accessibility, equity, and contextual suitability.

Summarily, within this evolving educational landscape, the need to systematically evaluate the impact of AI-driven adaptive learning on foundational literacy development among preschool learners in Nigeria has become increasingly apparent. Understanding whether and how these technologies influence children's early learning abilities is essential for informing educational policy and instructional practice. Hence, by examining how these technologies influence early reading skills, engagement, and classroom learning processes, the study contributes to shaping the future of early childhood education in Nigeria.

The persistent challenge of low foundational literacy levels among Nigerian preschoolers has necessitated a shift toward innovative pedagogical interventions. AI-driven adaptive learning platforms have emerged as a promising solution, offering personalised instruction that aligns with a child's unique learning pace. In the Nigerian educational landscape, however, there is a significant gap between the adoption of these technologies and the understanding of their actual efficacy in fostering early literacy. Many preschools integrate these tools without clear evidence of how they specifically address the linguistic and cognitive needs of learners in a resource-constrained environment.

Although global studies highlight the potential of AI to bridge learning gaps, there is a scarcity of empirical evidence evaluating the impact of AI-driven adaptive learning on foundational literacy within the specific socio-cultural and infrastructural context of Nigeria. Furthermore, it remains unclear how factors such as digital infrastructure and teacher readiness influence the effectiveness of these platforms. This lack of localised data hinders the ability of school administrators and policymakers to design evidence-based strategies for early childhood education. Consequently, there is a need for a systematic investigation into the impact of AI-driven adaptive learning on foundational literacy in Nigerian pre-schoolers to provide a data-driven framework for its integration.

The objectives of the study are to:

- (i). examine the impact of AI-driven adaptive learning platforms on the foundational literacy development of pre-schoolers in Nigeria.
- (ii). assess the level of digital infrastructure and teacher readiness in the implementation of AI-driven learning tools.
- (iii). determine the moderating role of infrastructural support on the relationship between AI-driven adaptive learning and foundational literacy outcomes.

The following research question guided the study:

1. What is the impact of AI-driven adaptive learning and the role of infrastructural support on the foundational literacy of pre-schoolers in Nigeria?

The following null hypotheses were tested in the study:

1. There is no significant relationship between the use of AI-driven adaptive learning platforms and foundational literacy development among Nigerian pre-schoolers.
2. There is no significant influence of digital infrastructure availability and teacher readiness on the literacy outcomes of preschoolers using AI-driven tools

2. Methodology

A descriptive survey design was adopted for this study. The study population consisted of teachers of preschool-aged children in the selected states. Using a simple random sampling technique, which is a probability sampling method, a total sample size of 384 participants (64 from each state) was selected to participate in the study. This sample size is considered adequate for providing a statistically significant representation of the diverse educational environments present in Nigeria's major regions and ensures that the findings can be generalised across similar urban and semi-urban contexts.

The instrument used for data collection was a

researcher-designed questionnaire titled "AI-Driven Adaptive Learning and Foundational Literacy Questionnaire" (ADALFLQ). The instrument was designed to elicit relevant information from respondents. It consisted of three sections: Section A, which gathered socio-demographic information such as teaching experience and school type. Section B focused on the frequency and implementation of AI-driven adaptive learning and assessed foundational literacy outcomes and available infrastructural support. A 4-point Likert scale was used, with response options of Strongly Agree (4), Agree (3), Disagree (2), and Strongly Disagree (1).

The data collected were analysed using both descriptive and inferential statistical tools. Frequency counts, percentages, and means were used to answer the research questions, while inferential statistics, specifically the t-test and Chi-Square, were used to test the research hypotheses and determine the level of significance at 0.05.

3. Results

3.1 Demographic Characteristics of Respondents

This section offers an overview of the demographic characteristics of the respondents, including attributes such as gender, educational qualification, years of teaching experience, type of school, and availability of digital learning technologies

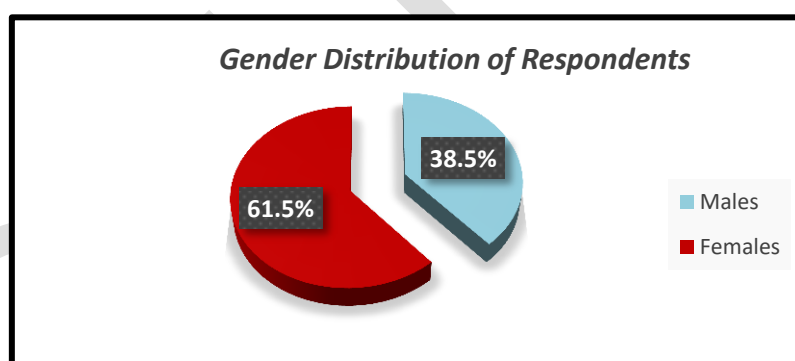


Figure 1. Gender Distribution of Respondents (Source: Field Survey, 2026)

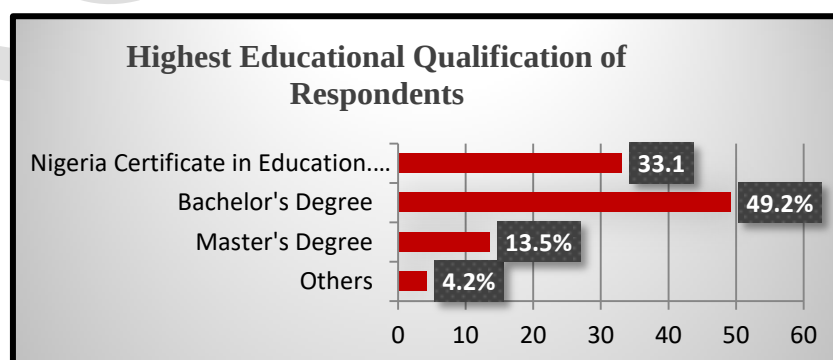


Figure 2. Highest Educational qualification (Source: Field Survey, 2026)



Figure3. Years of teaching experience (Source: Field Survey, 2026)

Figure 1 revealed the gender distribution of respondents. It showed a higher participation of females, who constitute 61.5 per cent of the sample, while males account for 38.5 per cent. This indicates a clear female dominance, which may reflect the existing gender structure within the preschool education sector in Nigeria, where women largely occupy early childhood teaching roles. Figure 2 shows that the educational qualifications of respondents are notably strong. A majority of 49.2 per cent possess a Bachelor's Degree, followed by 33.1 per cent holding NCE certificates.

Additionally, 13.5 per cent have Master's Degrees, while a small 4.2 per cent fall under other qualifications.

This suggests that the respondents are largely well-qualified and academically equipped to engage with AI-driven adaptive learning tools. Figure 3 revealed the teaching experience of respondents. A significant 37.0 per cent have 1-5 years of experience, followed by 30.7 per cent with 6-10 years. Those with 11-15 years account for 20.6 per cent, while 11.7 per cent have 16 years and above. This reflects a workforce dominated by early to mid-career professionals.

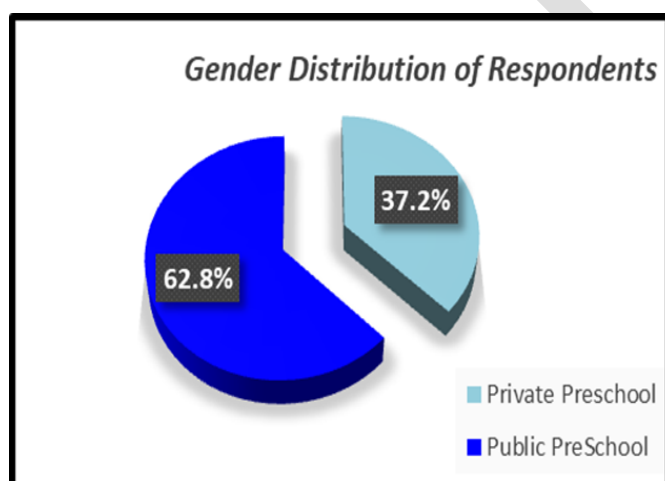


Figure 4. Type of School

Figure 4 shows that 62.8 per cent of respondents are from public preschools, while 37.2 per cent are from private preschools, indicating stronger representation from the public sector.

Figure 5 revealed that 43.8 per cent reported moderate

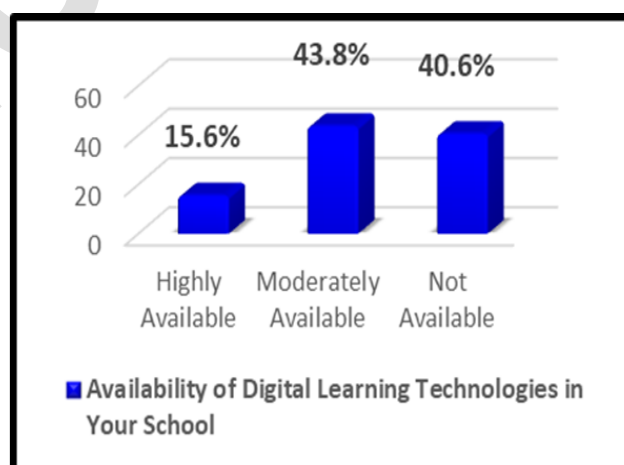


Figure 5: Availability of digital learning technologies in your school

availability of digital technologies, 40.6 per cent indicated non-availability, while only 15.6 per cent reported high availability, suggesting limited technological infrastructure across many schools.

Table 1: Mean and Standard Deviation showing the Impact of AI-Driven Adaptive Learning Platforms on Foundational Literacy Development

S/N	ITEMS	SA	A	SD	D	Mean	SD
1.	AI-driven adaptive learning platforms help preschool children recognise letters and sounds more quickly.	37.0	42.2	6.5	14.1	3.10	0.87
2.	AI-based learning tools improve preschool pupils' phonemic awareness and pronunciation of sounds.	35.9	43.8	5.5	14.8	3.10	0.85
3.	Adaptive learning technologies increase pupils' interest in early reading and literacy activities	41.4	40.9	5.5	12.2	3.18	0.85
4.	AI-driven learning applications help children develop vocabulary through interactive learning tasks.	38.5	43.0	5.5	13.0	3.15	0.84
5.	AI-driven adaptive learning systems improve pupils' ability to identify simple words and letters.	35.2	42.2	6.2	16.4	3.06	0.87
6.	The use of AI learning platforms makes literacy lessons more engaging for preschool learners.	43.5	41.1	4.7	10.7	3.23	0.82
7.	AI-driven learning technologies assist teachers in monitoring pupils' literacy progress effectively.	33.1	40.4	7.8	18.8	2.99	0.91
8.	Adaptive learning platforms encourage preschool pupils to practise reading independently.	33.9	41.1	7.3	17.7	3.02	0.90
9.	AI-based learning tools enhance pupils' comprehension of simple stories and instructions.	35.4	41.9	6.5	16.1	3.06	0.88
10.	Adaptive learning systems support the development of early writing and spelling skills.	32.3	39.8	8.1	19.8	2.96	0.92
11.	Teachers in my school are adequately prepared to use AI-driven learning technologies in teaching.	16.1	23.2	23.7	37.0	2.32	1.01
12.	Lack of digital infrastructure affects the implementation of AI-driven learning tools in preschools.	51.6	34.4	4.2	9.9	3.33	0.82
13.	Availability of computers or tablets supports the use of adaptive learning platforms in my school.	22.9	31.0	18.0	28.1	2.59	1.03
14.	Internet connectivity in the school facilitates the use of digital learning applications.	19.0	33.1	22.4	25.5	2.49	1.04
15.	Teachers receive adequate training for integrating AI-driven learning technologies into preschool instruction.	14.1	21.4	25.0	39.6	2.25	0.98
16.	A stable electricity supply supports the effective use of AI-driven adaptive learning tools.	55.5	30.7	4.2	9.9	3.37	0.83
17.	Government and school management support the integration of digital learning technologies in preschool education.	20.6	29.4	16.9	33.1	2.54	1.00
18.	Limited digital resources reduce the effectiveness of AI-driven adaptive learning platforms.	49.0	36.7	3.9	10.4	3.31	0.81
19.	Adequate infrastructural support improves the effectiveness of AI-driven learning tools in developing literacy skills.	45.1	40.9	4.2	9.9	3.27	0.80
20.	AI-driven adaptive learning platforms significantly improve foundational literacy outcomes among preschool learners.	38.5	42.2	5.7	13.5	3.14	0.85
Weighted Mean		3.01					

SA = Strongly Agree, A = Agree, D = Disagree, SD = Strongly Disagree

3.2 Answer to Research Question

Table 1 highlights the mean and standard deviation, showing the impact of AI-driven adaptive learning and infrastructural support on the foundational literacy of pre-schoolers in Nigeria. The table revealed agreement among the respondents, as items 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 16, 17, 18, 19, and 20 were accepted based on the decision rule (mean ≥ 2.50), while items 11, 14, and 15 were not accepted. The findings reveal the following: AI-driven adaptive learning platforms help preschool children recognise letters and sounds more quickly ($\bar{x} = 3.10$), improve phonemic awareness and pronunciation ($\bar{x} = 3.10$), and increase pupils' interest in early reading activities ($\bar{x} = 3.18$). AI-driven tools also support vocabulary development ($\bar{x} = 3.15$), enhance the identification of simple words ($\bar{x} = 3.06$), and make literacy lessons more engaging ($\bar{x} = 3.23$).

Furthermore, AI-driven learning technologies assist teachers in monitoring pupils' progress ($\bar{x} = 2.99$) and encourage independent reading practice among pupils

($\bar{x} = 3.02$). They also enhance comprehension of simple stories ($\bar{x} = 3.06$) and support early writing and spelling skills ($\bar{x} = 2.96$). However, the findings indicate limitations in teacher preparedness ($\bar{x} = 2.32$), internet connectivity ($\bar{x} = 2.49$), and teacher training ($\bar{x} = 2.25$).

In terms of infrastructural support, lack of digital infrastructure affects implementation ($\bar{x} = 3.33$), while availability of devices ($\bar{x} = 2.59$), stable electricity ($\bar{x} = 3.37$), and government support ($\bar{x} = 2.54$) influence the integration of AI-driven tools. Limited digital resources were also found to reduce effectiveness ($\bar{x} = 3.31$), whereas adequate infrastructural support enhances literacy development ($\bar{x} = 3.27$). Based on the weighted average of 3.01, it is inferred that AI-driven adaptive learning positively influences foundational literacy outcomes among preschool learners, although its effectiveness is moderated by infrastructural conditions.

Table 2: Association between AI-Driven Adaptive Learning and Foundational Literacy

Variable	χ^2 (Chi-Square)	df	Sig. (p-value)
AI-Driven Adaptive Learning $\times$ Foundational Literacy	15.736	4	0.003**

Source: Field Survey, 2026 (Significance level: $p < 0.05$)

3.3. Hypothesis I

The Chi-Square statistic ($\chi^2 = 15.736$, $df = 4$, $p = 0.003$) in Table 2. indicates a statistically significant association between the use of AI-driven adaptive learning platforms and foundational literacy development among Nigerian pre-schoolers. Since the p-value (0.003) is less than 0.05, the null

hypothesis of no significant relationship is rejected. This result suggests that increased utilisation of AI-driven adaptive learning tools is associated with improved foundational literacy outcomes, reinforcing the role of adaptive technologies in enhancing early reading, phonemic awareness, and literacy engagement among pre-school learners.

Table 3. Digital Infrastructure Availability and Teacher Readiness on the Literacy Outcomes of Pre-Schoolers Using AI-Driven Tools

Hypothesis	Statistical Result	Decision	Interpretation
H ₂ : Digital infrastructure and teacher readiness do not significantly influence the literacy outcomes of pre-schoolers using AI-driven tools.	$\chi^2 = 8.924$, $p = 0.063$	Retained	Digital infrastructure and teacher readiness do not independently influence literacy outcomes.

3.4. Hypothesis II

From Table 3, the non-significant result indicates that although digital infrastructure and teacher readiness contribute to the implementation of AI-driven tools, they do not independently produce a statistically significant effect on foundational literacy outcomes. This suggests that factors such as availability of devices, internet connectivity, and teacher preparedness may support learning processes but are not sufficient on their own to drive measurable improvements in literacy without the active application of AI-driven instructional strategies.

4. Discussion

Research question one reveals that AI-driven adaptive learning platforms are perceived as effective tools for enhancing foundational literacy development among pre-schoolers in Nigeria. This position aligns with the systematic review conducted by Akinrotimi et al. (2025), which established that AI-enabled learning applications significantly improve early literacy competencies through personalised instruction, interactive phonics engagement, and adaptive feedback mechanisms that support vocabulary acquisition

and reading comprehension. This outcome is further corroborated by the findings of Su and Yang (2023), whose intervention study in Hong Kong demonstrated that AI-supported learning environments enhance children's engagement with literacy tasks while simultaneously strengthening phonological awareness and early reading skills. Similarly, Oke-makinde & Ogunyinka (2025) indicate that digital learning technologies, particularly those with adaptive features, consistently promote early literacy development by enabling children to interact with content at their own pace while receiving immediate feedback that reinforces learning progression. The convergence of these findings reinforces the argument that AI-driven adaptive learning operates as a cognitively responsive instructional medium capable of accelerating foundational literacy acquisition among early learners.

Hypothesis one. The findings suggest that AI-driven adaptive learning enhances pupils' interest, engagement, and independent participation in literacy activities. This observation supports the conclusions of Wang, Li, and Ng (2026), who argue that AI-integrated learning environments promote active engagement, inquiry-based learning, and collaborative interaction among young learners by embedding interactive and experiential elements into instructional processes. Such engagement-driven outcomes are also consistent with the work of Kewalramani et al. (2021) cited in recent reviews, which emphasise that AI-enabled tools foster creative inquiry, emotional involvement, and sustained attention in early childhood learning contexts. Similarly, Akinrotimi et al. (2025) observed that adaptive storytelling systems and AI-supported literacy applications create immersive learning environments that stimulate curiosity and deepen comprehension. Additionally, Wang et al. (2026) suggest that interactive digital tools provide alternative pathways for engaging learners in overcrowded classrooms where individualised attention is limited. The implication is that AI-driven systems do not merely deliver content but actively structure the learning experience to sustain motivation and reinforce literacy engagement over time.

Hypothesis two. The findings demonstrate that while digital infrastructure plays an enabling role in implementing AI-driven learning tools, it does not independently determine literacy outcomes. This position is consistent with Wang et al's (2026) evidence suggesting that infrastructure alone is insufficient without effective pedagogical integration. For instance, Wang et al. (2026) indicate that although access to digital tools enhances learning opportunities, the actual impact on learning outcomes is mediated by how such tools are utilised within instructional contexts. This aligns with the findings of this study, which emphasise that infrastructural variables function primarily as supportive conditions rather than primary drivers of literacy development. Furthermore, the findings of this study raised similar concerns regarding

uneven access to digital infrastructure and its implications for educational technology adoption, particularly in public early childhood institutions.

The inferential findings further reveal that AI-driven adaptive learning exerts a more decisive influence on foundational literacy outcomes compared to infrastructural support. This conclusion is strongly supported by Su and Yang (2023), who emphasise the transformative role of adaptive technologies in personalising learning experiences. Su and Yang (2023) demonstrate that varying levels of exposure to AI-based learning environments produce differential learning outcomes, with higher exposure associated with improved literacy performance. Similarly, Vein et al. (2023) note that AI-driven systems enhance literacy development by tailoring instructional content to individual learner needs, thereby addressing learning gaps more effectively than traditional methods. These findings reinforce the argument of this study, stating that AI-driven adaptive learning functions as the primary mechanism through which literacy gains are achieved, while infrastructural support enhances but does not independently drive these outcomes.

5. Conclusion

Based on the findings of this study, it is concluded that AI-driven adaptive learning constitutes a significant instructional innovation capable of enhancing foundational literacy development among pre-schoolers in Nigeria. The study establishes that while infrastructural conditions and teacher readiness influence the implementation process, they do not independently determine literacy outcomes. Rather, the effectiveness of AI-driven learning is primarily derived from its capacity to personalise instruction, sustain learner engagement, and provide adaptive feedback that supports early literacy acquisition. The findings further suggest that the integration of AI technologies represents a shift toward more responsive, learner-centred pedagogical approaches in early childhood education. However, the realisation of this potential remains contingent upon the availability of supportive infrastructure and the professional competence of teachers to effectively mediate these technologies within classroom contexts.

Recommendations

1. Targeted Teacher Capacity Development: Educational authorities should prioritise continuous professional development programmes focused on AI integration in early childhood education, with emphasis on adaptive learning strategies and digital pedagogy.
2. Context-Sensitive Infrastructure Investment: Government and stakeholders should invest in scalable and context-appropriate digital infrastructure that supports the deployment of AI-driven learning tools in public pre-school settings.
3. Curriculum Integration of AI Tools: Curriculum developers should incorporate AI-driven adaptive learning

frameworks into early childhood education curricula to ensure structured and pedagogically aligned implementation.

4. Policy Framework for AI in Early Childhood Education: National education policymakers should develop clear guidelines for the ethical, effective, and contextually relevant use of AI technologies in early childhood learning environments.

Abbreviations

ADALFLQ AI-Driven Adaptive Learning and Foundational Literacy Questionnaire

Author Contributions

Kehinde Muritala Nuhu: Conceptualisation, Investigation, Validation, writing –Review & Editing, Project Administration, Methodology,

Oluwsagun Seun Adewara: Data Curation, Investigation, Formal Analysis, Writing - original draft.

Hamza Garba Leko: Writing- Review & Editing

Muhammed Ibrahim: Writing- Review & Editing

Akeem Omowumi Raheem: Writing- Review & Editing

Kehinde Adeyemi. Adeteju: Writing- Review & Editing

Charles Olubode Olumorin: Writing- Review & Editing

Conflicts of Interest

The author(s) declare that they have no known competing financial interests, professional affiliations or personal relationships that could have appeared to influence the work reported in this paper.

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