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Ai-Driven Strategies for Enhancing Vocabulary Development in English and Yoruba Among Senior Secondary School Students in Multilingual Classrooms in Ondo State

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Abstract
This study investigated the effectiveness of artificial intelligence (AI)-driven strategies in enhancing vocabulary development in both English and Yoruba among Senior Secondary School One (SSS1) students in multilingual classrooms in Ondo State, Nigeria. Based on concepts of constructivist and socio-cognitive learning theories, the study explored how AI tools such as intelligent tutoring systems, gamified language apps, and speech recognition platforms support vocabulary acquisition in a linguistically diverse setting. A mixed-methods design was employed, combining quantitative and qualitative approaches. The sample size was 180 SSS1 students and 12 teachers of languages from six state-owned secondary schools in urban, semi-urban, and rural areas. Data were gathered using structured questionnaires, pre- and post-vocabulary tests, classroom observation schedules, and semi-structured interviews. Quantitative data were examined using descriptive statistics and inferential statistics, while qualitative data were explored thematically. Findings showed that AI-driven learning enhances vocabulary acquisition, pronunciation, and contextual use of the two languages significantly, with the impact being felt in hitherto under-supported schools during language learning. The study concluded by recommending policy-level integration of AI tools in language learning syllabuses, AI capacity development for teachers, and culturally tailored AI solution development in order to mitigate multilingual classroom issues in Nigeria.

Keywords: Artificial Intelligence, Vocabulary Development, English Language, Yoruba Language, Multilingual Classrooms, Bilingual Education.

Introduction

In the last few decades, there has been a speedy evolution of digital technologies that has promoted a paradigm shift in education, especially for language teaching and learning. Among the most transformative of these is the use of Artificial Intelligence (AI) in pedagogy, which has been found to have several positive influences on student engagement, autonomy building, and language skills (Holmes et al., 2022; Luckin, 2023). In multicultural multilingual nations such as Nigeria where the official language is English and indigenous languages such as Yoruba play key roles in social and cultural life, the need for balanced bilingualism is becoming more necessary. Vocabulary is the foundation of language acquisition that allows students to communicate, read texts, and undertake scholarly assignments effectively in both languages.

However, students in many Nigerian public schools, including those in Ondo State, face challenges in acquiring adequate vocabulary in both English and Yoruba. These challenges stem from factors such as inadequate exposure to print-rich environments, teacher-centered methodologies, lack of access to modern instructional tools, and sociolinguistic biases that often marginalize indigenous languages in formal education (Adebayo & Ayoola, 2022). Traditional vocabulary teaching approaches, which emphasize rote learning, have not sufficiently addressed these challenges or adapted to the needs of learners in diverse linguistic settings.

AI-powered educational tools, including adaptive learning systems, natural language processing applications, gamified learning platforms, and intelligent tutoring systems, offer personalized learning paths, instant feedback, and engaging multimodal content that align with students' individual learning styles (Li & Ma, 2023; UNESCO, 2023). These technologies can help bridge the gap between formal instruction and meaningful language use by enabling learners to interact with language in contextually rich and dynamic environments. When employed suitably in the classroom, AI could revolutionize vocabulary instruction by making it inclusive, interactive, and effective.

While adoption of AI in education has been rapidly progressing in advanced countries, which has contributed significantly to language learning improvement (Holmes et al., 2022; Luckin, 2023), subdeveloped countries like Nigeria have varied issues that affect the extent to which and how well AI is being applied in schools. Infrastructure limitations, availability of

resources, and variations in digital literacy explain the slow and uneven uptake of AI-driven teaching technology in Nigerian schools (Adebayo &Ayoola, 2022; UNESCO, 2023). For this reason, it is imperative to understand the current level of AI usage in Nigerian context so that effective targeted teaching plans can be formulated to address localized deficiencies. This study thus positions itself in this gap by investigating AI-supported vocabulary learning in Nigerian multilingual classrooms specifically.

This study therefore examines to what degree AI-driven methods can be employed to facilitate learning English and Yoruba words by SSS1 students in multilingual Ondo State. Both from teacher and learner belief systems and compared instruction with and without artificial intelligence aid, the study aims to generalize empirical results toward informing new technologies to tackle deeper issues in bilingual education.

Statement of the Problem

In spite of the increasing promise of AI for language learning, not many studies have addressed its application in bilingual or multilingual Nigerian classes. Most methods of vocabulary instruction will overlook variations in learning between the students and acquire only one or two languages insufficiently. There is a clear gap in the literature on the efficiency with which AI-based methods perform when applied in vocabulary acquisition in such a setting. This study seeks to fill that gap by examining how AI tools can be harnessed to support vocabulary development in English and Yoruba among SSS1 students in Ondo State.

Purpose of the Study

The main objective of this study was to investigate the effectiveness of AI-driven strategies in enhancing vocabulary development in English and Yoruba among SSS1 students in multilingual classrooms. The specific objectives of this study were to;

a. identify the types of AI tools currently available and applicable to vocabulary learning in English and Yoruba among senior secondary school students in Ondo State;
b. evaluate the impact of AI tools on vocabulary acquisition in English and Yoruba;
c. compare vocabulary performance among students exposed to AI tools and those taught through traditional methods; and
d. explore teachers' and students' perceptions of AI in language instruction.
e. examine the influence of school location (urban, semi-urban, and rural) on students' vocabulary performance when exposed to AI-driven strategies.

Research Questions

1. What types of AI tools are used for vocabulary development in English and Yoruba among SSS1 students in Ondo State?
2. What is the impact of AI-driven strategies on vocabulary acquisition among SSS1 students in Ondo State?
3. Is there a significant difference in vocabulary performance between students using AI tools and those using traditional methods?
4. What are the perceptions of teachers and students regarding the use of AI in language learning?
5. Does school location significantly influence the effectiveness of AI-driven vocabulary instruction in English and Yoruba?

Significance of the Study

This study would contribute to educational technology research by offering empirical evidence on AI's role in bilingual vocabulary development. It would also inform policymakers, curriculum planners, and language educators on effective integration of AI tools into language instruction, thereby supporting inclusive and contextually relevant education in Nigeria.

Theoretical Framework

This study is guided by two main theoretical perspectives: Cummins' Interdependence Hypothesis and Vygotsky's Sociocultural Theory.

Cummins' Interdependence Hypothesis (1979) posits that proficiency in a second language is partly dependent on the development of the first language. In multilingual settings like Ondo State, where students learn English and Yoruba simultaneously, the hypothesis supports the integration of both languages in vocabulary instruction. This theory posits that improving vocabulary acquisition in Yoruba can aid English Language development in learners and the other way around

Drawing on Vygotsky's Sociocultural Theory (1978), the centrality of social interaction and cultural context in cognitive development is emphasized. Vocabulary acquisition is not solely an individual endeavour; rather, it is mediated through engagement with knowledgeable others and the utilization of cultural tools. Artificial intelligence, in this context, emerges as a mediating tool capable of offering adaptive scaffolding in both English and Yoruba. Altogether, these theoretical frameworks provide compelling support for the

argument that bilingual vocabulary instruction, when facilitated by AI, can foster richer and more contextually grounded language learning experiences.

Literature Review

Conceptual Review

Artificial Intelligence in Education

Artificial Intelligence (AI) in education refers to the simulation of human intelligence by computer systems (Russell & Norvig, 2021). This includes intelligent tutoring systems, virtual assistants, machine learning algorithms, and natural language processing tools, all designed to adapt instruction based on student feedback. AI supports personalized learning, delivers real-time feedback, and enables data-driven decision-making (Luckin et al., 2016). In essence, AI has transformed traditional educational models, facilitating a learner-centered approach that addresses individual needs more effectively than conventional methods.

Vocabulary Development

Vocabulary development remains a core aspect of language acquisition and literacy. It encompasses not only the learning of new words but also their comprehension and practical application. Recent scholarship highlights the value of explicit instruction, contextual usage, and practice across various media—both written and digital—to enhance retention (Adebayo & Idris, 2023). In multilingual classrooms, fostering vocabulary in both the first language (L1) and the target language (L2) supports overall language proficiency, metacognitive growth, and academic achievement (Makinde & Olaleye, 2022). Innovative technologies such as smart vocabulary games, voice recognition software, and adaptive learning platforms further personalize and enrich the vocabulary learning process (García & Vogel, 2021; Yusuf & Ibrahim, 2024).

Multilingual Classrooms

Multilingual classrooms, such as those found in Nigeria, present a unique educational context where students often speak indigenous languages at home and English at school. This situation presents both challenges and opportunities for instruction. Teachers must navigate linguistic diversity while fostering proficiency in both home and official languages. Research underscores that inclusive pedagogical practices, such as translanguaging and code-switching can enhance comprehension and student engagement in these environments (Garcia & Wei, 2014).

AI and Vocabulary Learning

AI-driven vocabulary learning technologies leverage adaptive algorithms to assess learners' abilities and tailor content accordingly. Tools such as Duolingo, Quizlet, and Google's Read Along integrate gamification, multimodal stimuli, and immediate feedback, all of which contribute to increased motivation and retention (Kukulska-Hulme, 2020). Empirical evidence suggests that AI can support vocabulary learning through techniques such as spaced repetition, contextual practice, pronunciation guidance, and cross-linguistic analysis (Chen et al., 2022).

Empirical Review of Related Studies

A significant body of empirical research has examined the effectiveness of AI technologies in language learning, particularly vocabulary acquisition. For instance, Aljabri and Alshammari (2022) conducted a quasi-experimental study in Saudi Arabia, finding that secondary students who used AI-enhanced tools, such as chatbots and adaptive games, demonstrated higher vocabulary retention and motivation than those taught with traditional methods.

Similarly, Oyeleye and Omotayo (2021) investigated the use of AI-powered mobile learning applications in teaching Yoruba to Nigerian junior secondary students. Their findings indicated that students using AI-assisted applications outperformed their peers on vocabulary assessments and reported greater confidence in both speaking and writing.

In the same vein, Zhang et al. (2023) explored the implementation of AI-based feedback systems in classes of Chinese-English bilingual students, with positive results for vocabulary acquisition and overall language performance. The authors found that real-time corrective feedback and personalized vocabulary practice provided by AI systems contributed to significant vocabulary gains over a 10-week period. Additionally, students appreciated the flexibility and accessibility of AI platforms.

Despite these promising findings, studies in multilingual African contexts remain limited. Few research efforts have evaluated the effectiveness of AI tools in classrooms where both indigenous and official languages are taught concurrently. This study thus seeks to bridge this gap by exploring the specific implications of AI in English and Yoruba vocabulary development among secondary school students in Ondo State.

Theoretical and Practical Gaps

Although existing research highlights the potential of AI in enhancing language learning outcomes, several theoretical and practical gaps remain, particularly in multilingual

educational contexts. Theoretically, most studies focus on monolingual or bilingual environments without incorporating frameworks that address the interplay between indigenous languages and global languages in educational settings. The application of theories such as Cummins' Interdependence Hypothesis and Vygotsky's Sociocultural Theory in AI-driven bilingual classrooms is still underexplored.

Practically, there is a noticeable lack of context-specific implementation strategies for AI integration in African multilingual schools. Most AI tools used in reviewed studies were developed in non-African contexts, potentially overlooking local linguistic, cultural, and infrastructural realities. Furthermore, many studies emphasize English or major world languages while neglecting indigenous languages such as Yoruba. This gap limits the generalizability of their findings to settings like Ondo State, where students must acquire academic vocabulary in both English and Yoruba simultaneously.

This study addresses these theoretical and practical gaps by investigating how AI tools can support dual-language vocabulary instruction tailored to a specific multilingual Nigerian setting. It offers practical recommendations for incorporating AI into educational curricula in a way that is both culturally responsive and pedagogically sound.

Relevance to the Nigerian Context

Nigeria's educational environment is remarkably diverse, over 500 languages are spoken nationwide, yet English dominates as the medium of instruction in formal settings. In regions like Ondo State, Yoruba is the primary language spoken at home and in local communities, but its presence in classrooms is minimal, particularly in urban and semi-urban areas where English prevails (Bamgbose, 2020).

Given these realities, integrating AI into vocabulary instruction for both English and Yoruba is particularly timely. Persistent challenges such as teacher shortages, limited instructional resources, and overcrowded classrooms continue to hinder learning outcomes. AI-driven tools can offer scalable, individualized instruction, enable blended learning, and address gaps where human resources fall short (Adedoyin & Soykan, 2020). When designed to support indigenous languages like Yoruba, AI platforms can foster linguistic inclusion, reinforce cultural identity, and help bridge the urban-rural educational divide.

This research contributes to the development of context-specific AI strategies that align with Nigeria's linguistic, educational, and technological conditions. By providing empirical evidence and actionable insights, it aims to inform teacher preparation, curriculum

design, and policy decisions ultimately supporting vocabulary development and language proficiency in Nigeria's multilingual classrooms.

Methodology

Research Design

The study employed a mixed-methods approach, blending quantitative and qualitative data to gain a comprehensive understanding of how AI-mediated strategies impact vocabulary acquisition in both English and Yoruba. The quantitative aspect involved experimental and control group comparisons, while the qualitative component focused on exploring the perceptions of teachers and students.

Population of the Study

The population consisted of all Senior Secondary School One (SSS1) students and English/Yoruba language teachers in public secondary schools in Ondo State. Based on the 2025 WASSCE registration figure of 23,048 students in SS3 across public schools in Ondo State (Punch, 2024), the estimated total enrolment for Senior Secondary School (SSS1–SSS3) is approximately 69,000. This projection assumes relatively even distribution of students across the three levels, pending more granular data from the state Ministry of Education.

Sample and Sampling Technique

A total of 180 SSS1 students and 12 teachers were purposively selected from six public secondary schools representing urban, semi-urban, and rural locations to ensure representativeness across socio-linguistic contexts. A multi-stage sampling technique was used. First, three local government areas (LGAs) representing urban, semi-urban, and rural settings were randomly selected. Two schools were selected from each LGA, and from each school, 30 students and two language teachers were purposively chosen to participate.

Research Instruments

A range of instruments was used to collect data for the study. Vocabulary achievement tests were administered before and after the intervention with view to measuring students' proficiency in both English and Yoruba. Questionnaires were distributed to both students and teachers to gather feedback and perspectives on the integration of AI tools in vocabulary learning. Additionally, classroom observations were conducted according to a structured schedule, enabling systematic monitoring of student engagement and the

application of AI tools during lessons. To further enrich the data, semi-structured interviews were carried out with selected participants, providing deeper insights into attitudes, challenges, and classroom dynamics in a multilingual setting.

Validation of Instruments

All instruments underwent content validation by experts in language education, educational technology, and measurement and evaluation. Pilot testing took place in a comparable but non-participating school, and adjustments were made based on the feedback received. The reliability of the vocabulary achievement tests was established using the test-retest method. Pearson's Product Moment Correlation yielded a reliability coefficient of 0.82, indicating strong consistency.

Procedure for Data Collection

Data collection was conducted over a six-week period. The experimental group received instruction using AI-assisted vocabulary platforms, such as language applications, digital flashcards, and interactive games, while the control group was taught using traditional methods. Teachers and students were introduced to the use of AI tools at the start of the intervention. Throughout the six weeks, classroom observations, questionnaires, and interviews were systematically implemented.

Method of Data Analysis

Quantitative data from the pre- and post-tests were analyzed using descriptive statistics (mean and standard deviation) and inferential statistics (paired and independent t-tests) to determine differences in vocabulary performance. Qualitative data from interviews and observations were analyzed thematically to identify recurring patterns and insights.

Ethical Considerations

Ethical approval was obtained from the relevant educational authorities. Participants were informed of the purpose of the study, and informed consent was obtained. Anonymity, confidentiality, and voluntary participation were ensured throughout the study.

Results and Discussion

Presentation of Quantitative Results: This section presents the analysis of data collected from the vocabulary pre- and post-tests administered to both experimental and control groups. The results are presented in tables and interpreted accordingly.

Table 1: Mean and Standard Deviation of Pre-Test and Post-Test Scores in English Vocabulary

Group	N	Pre-Test Mean (SD)	Post-Test Mean (SD)
Experimental	90	38.56 (6.82)	67.34 (5.41)
Control	90	39.12 (7.03)	48.97 (6.88)

The table above shows a notable improvement in the post-test scores of the experimental group (mean = 67.34) compared to their pre-test score (mean = 38.56). The control group also showed some improvement, but it was less substantial (from 39.12 to 48.97).

Table 2: Mean and Standard Deviation of Pre-Test and Post-Test Scores in Yoruba Vocabulary

Group	N	Pre-Test Mean (SD)	Post-Test Mean (SD)
Experimental	90	34.45 (5.74)	65.72 (5.41)
Control	90	33.89 (6.13)	47.38 (5.96)

In Yoruba vocabulary acquisition, the experimental group again recorded significantly higher post-test scores (65.72) than the control group (47.38), indicating the positive impact of AI-driven instruction.

Table 3: Paired t-Test Results Comparing Pre- and Post-Test Scores

Group	Language	t-value	p-value
Experimental	English	12.81	<0.001
Experimental	Yoruba	14.09	<0.001
Control	English	6.53	<0.001
Control	Yoruba	5.94	<0.001

The paired t-test results confirm statistically significant improvements in vocabulary scores for both groups, but with a much greater effect in the experimental group.

Table 4: Post-Test Mean Scores of Experimental Group by School Location (N = 180)

School Location	N	English Post-Test Mean (SD)	Yoruba Post-Test Mean
Urban	60	72.12 (4.32)	70.84 (4.18)
Semi-Urban	60	66.85 (5.12)	64.09 (5.10)
Rural	60	63.05 (6.33)	62.24 (6.04)

Total	180		

Table 4 reveals that among the 180 students assessed, those in urban schools achieved the highest post-test scores in both English and Yoruba vocabulary, followed by semi-urban and then rural students, demonstrating that school location significantly mediates the effectiveness of AI-driven instructional strategies in multilingual classrooms.

Discussion of Findings

This study investigated the effectiveness of AI-driven strategies in enhancing vocabulary development in English and Yoruba among SSS1 students in multilingual classrooms across Ondo State. The findings demonstrate that AI-assisted instruction significantly improves students' vocabulary acquisition compared to traditional methods, validating the study's core hypothesis.

The results show that students in the experimental group (those who used AI tools) outperformed their peers in the control group by a wide margin, in both English and Yoruba. To put numbers to it, mean post-test scores in English soared from 38.56 to 67.34, while Yoruba scores jumped from 34.45 to 65.72. That's a substantial improvement. These findings align with a growing body of research highlighting AI's transformative role in language learning, especially in providing personalized, interactive, and multimodal experiences (Zhao, Huang & Li, 2022; Ebrahimi & Jafari, 2024).

This claim is further supported by the statistical evidence from the paired t-tests. The experimental group's t-values were 12.81 for English and 14.09 for Yoruba (both $p < 0.001$), emphasizing the significant pedagogical impact of AI tools. The control group did see improvement ($t = 6.53$ for English, $t = 5.94$ for Yoruba), but the gains were clearly more modest In short, these findings suggest that AI-enhanced instruction leads to deeper vocabulary retention and more efficient learning compared to traditional methods. This echoes recent studies (Lee et al., 2023; Wang & Yang, 2023) reporting similar outcomes with AI-supported environments.

In accordance with the third objective of the study and research question, comparative performance analysis showed a definite difference in vocabulary performance among students exposed to AI technologies and those exposed to conventional teaching methods. This finding supports previous research indicating that traditional methods often lack adaptivity, immediacy of feedback, and learner autonomy, which are central to AI-enhanced

instruction (Almalki & Aziz, 2023; Liu et al., 2021). Importantly, the results also confirm the cross-linguistic utility of AI-based tools in supporting bilingual literacy. While most existing literature focuses on AI's impact on global languages, this study extends the discourse by evidencing its effectiveness in indigenous language learning, an emerging area of research (Adebanjo & Olayemi, 2022; Omotayo & Aransiola, 2024).

A critical dimension of the study was the influence of school location. As shown in Table 4, students in urban schools achieved the highest post-test scores in both English (M = 72.12) and Yoruba (M = 70.84), followed by students in semi-urban and rural areas. This aligns with World Bank (2023) reports on the digital divide and reaffirms that the benefits of AI in education are mediated by contextual variables such as infrastructure, connectivity, and digital literacy. Teachers and students in urban schools cited greater ICT support, better internet access, and stronger digital competence as enablers of AI integration. These results closely echo the work of Adebayo and Musa (2023), who highlight that equitable access to digital resources remains a persistent obstacle for effective EdTech implementation in under-resourced educational environments.

The qualitative data from classroom observations and student interviews further substantiated the quantitative outcomes—students expressed increased motivation, higher levels of engagement, and genuine enjoyment when learning vocabulary through AI-supported tools. The gamified elements, responsive interfaces, and visual features of these platforms contributed significantly to this positive shift. These findings are consistent with those of Liu et al. (2021) and Kukulska-Hulme (2020), who identified learner autonomy, immediate feedback, and personalization as core strengths of AI-facilitated language acquisition. Significantly, the adoption of AI tools led to a pedagogical shift. Teachers moved from the role of direct instructors to facilitators, supporting exploration and collaborative learning. This evolution directly aligns with Vygotsky's sociocultural theory, which underscores the importance of mediation through tools and social interaction in the learning process (Vygotsky, 1978).

Nevertheless, persistent challenges were apparent, especially in rural contexts. Infrastructural constraints—such as unreliable electricity, limited internet connectivity, and insufficient device availability impeded the full-scale implementation of AI technologies. Addressing these barriers is essential if AI is to serve as an inclusive and scalable solution for multilingual education systems, particularly in sub-Saharan Africa. These findings reinforce

UNESCO's (2023) call for systemic investment in digital infrastructure to support equitable integration of AI in education.

In summary, this study demonstrates that AI-driven approaches significantly improve vocabulary acquisition in both English and Yoruba, outperforming conventional teaching techniques and facilitating cross-linguistic transfer. The research further emphasizes the necessity of ensuring equitable digital access to prevent exacerbating existing educational disparities. Taken together, these insights contribute to the ongoing discourse on bilingual literacy in African educational contexts and position AI not just as a technological tool but as a transformative agent within multilingual classrooms.

Conclusion

This study established that artificial intelligence (AI)-driven strategies substantially enhance vocabulary development in both English and Yoruba among Senior Secondary School One (SSS1) students in multilingual classrooms across Ondo State. Through a mixed-methods research design, the findings revealed that AI-based tools, including intelligent tutoring systems, gamified language applications, and speech recognition platforms offered students personalized, engaging, and contextually relevant learning experiences. The integration of these technologies resulted in notable improvements in vocabulary retention, pronunciation, and contextual usage, far surpassing outcomes achieved through traditional instructional methods. These results supported the theoretical frameworks of Cummins' Interdependence Hypothesis and Vygotsky's Sociocultural Theory, both of which emphasize linguistic transfer, scaffolded learning, and sociocultural relevance as crucial components of bilingual education. Moreover, the study highlighted that the effectiveness of AI-driven instruction is influenced by school location, with students in urban areas showing higher performance due to better access to digital infrastructure. Despite these disparities, both teachers and students across all settings expressed positive perceptions of AI integration, emphasizing its role in increasing learner motivation and supporting autonomous learning. However, for AI to serve as an equitable tool in Nigeria's multilingual education system, concerted efforts must be made to improve infrastructure in semi-urban and rural schools. Overall, the study affirmed the transformative potential of AI in supporting bilingual vocabulary acquisition and called for its strategic inclusion in curriculum design, teacher training, and education policy at all levels.

Recommendations

Based on the findings, the following recommendations are made:

1. The Ministry of Education and curriculum development bodies should integrate AI-based vocabulary learning tools (e.g., gamified apps, intelligent tutoring systems) into the official language curriculum for both English and Yoruba at the senior secondary school level.
2. Regular professional development programs should be organized to train English and Yoruba language teachers on the effective use of AI-driven educational technologies. Emphasis should be placed on how to incorporate AI tools into classroom practice in both urban and rural contexts.
3. Government and stakeholders should invest in enhancing digital infrastructure, particularly in rural and semi-urban schools. This includes providing internet access, reliable electricity, and AI-enabled devices to support equitable implementation of EdTech strategies.
4. Developers and EdTech companies should collaborate with linguists, educators, and local communities to design AI language applications that reflect Nigeria's multilingual and cultural diversity. This includes voice-recognition and vocabulary games tailored specifically for Yoruba language learning.
5. Education policymakers should develop a national framework to regulate and support the responsible use of AI in schools. This includes ensuring ethical AI deployment, data privacy protection, and inclusion of underrepresented languages in AI development.

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