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Impact of Technology on Teaching and Learning Hausa and Arabic Grammar in Tertiary Institutions in Katsina State, Nigeria

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ABSTRACT

Technology-enhanced language instruction is increasingly promoted globally, but evidence from indigenous and classical language contexts in sub-Saharan Africa remains limited. This study investigated the association between technology-assisted instruction and students' grammar proficiency, motivation, and anxiety in learning Hausa and Arabic grammar, while also identifying contextual challenges to technology integration. A mixed-methods convergent design was employed. Quantitative data were collected from 300 randomly stratified students across six tertiary institutions in Katsina State, Nigeria, using a structured questionnaire (Cronbach's $\alpha = 0.84–0.89$ across subscales). Qualitative data were gathered through semi-structured interviews with 30 purposively selected lecturers and classroom observations. Technology-assisted instruction comprised eight weeks of access to grammar applications, multimedia tutorials, and online resources, compared with traditional lecture-based instruction. Students in the technology-assisted group demonstrated significantly higher grammar proficiency scores than the traditional instruction group ($t(298) = 11.43$, $p < .001$, Cohen's $d = 1.32$). They also reported higher motivation (65% positive response) and reduced anxiety (60%). Lecturers confirmed that digital tools simplified teaching of abstract grammatical concepts. However, 54% of participants identified poor internet connectivity, 42% limited device access, and 38% inadequate lecturer training as major barriers. Technology is associated with measurable improvements in Hausa and Arabic grammar learning, but its effectiveness depends on addressing infrastructural and capacity-building deficits. Findings support constructivist pedagogy while highlighting diffusion-of-innovation constraints.

INTRODUCTION

The integration of digital technologies into educational systems has reshaped pedagogical practices across the globe. International frameworks, including UNESCO's (2024) Global Education Monitoring Report, emphasize technology as a critical lever for achieving inclusive, equitable, and quality education under Sustainable Development Goal In language education specifically, technology-assisted instruction encompassing grammar applications, online resources, multimedia tutorials, and interactive platforms, has been associated with increased learner engagement, personalized pacing, and immediate feedback mechanisms (Chen *et al.*, 2021; Zhang & Zou, 2022). However, the transferability of these findings from well-resourced, predominantly English or European language contexts to low- and middle-income countries with distinct linguistic and infrastructural realities remains inadequately examined. This gap is particularly acute for indigenous and classical languages in sub-Saharan Africa, where empirical research on technology-enhanced grammar instruction remains sparse.

In Nigeria, the teaching and learning of Hausa and Arabic grammar occupy a unique and significant position. Hausa functions as a lingua franca across much of West Africa, serving not only as a medium of daily communication but also as a carrier of cultural identity, oral literature, and socio-economic interaction (Junaidu, 2000). Arabic, by contrast, is central to Islamic religious scholarship, legal traditions, and classical literary heritage, with deep historical roots in northern Nigeria (Abubakar, 2019). Mastery of the grammatical systems of both languages is therefore indispensable for academic achievement, cultural preservation, and, in the case of Arabic, religious literacy. Despite this importance, grammar instruction in Nigerian tertiary institutions has remained predominantly traditional characterized by lecture-based delivery, rote memorization of abstract rules, textbook dependence, and limited opportunities for active learner participation (Ogunsiji, 2020). Students frequently report difficulty with Hausa syntax and Arabic morphological structures, leading to low proficiency, high anxiety, and disengagement (Abdulraheem, 2019). These pedagogical challenges are compounded by infrastructural deficits, including inadequate classroom resources, large class sizes, and limited teacher training in contemporary language teaching methodologies.

Digital tools offer a plausible response to these challenges. Grammar applications (e.g., interactive exercises with instant feedback), online video tutorials, and multimedia presentations can transform abstract grammatical rules into accessible, contextualized learning experiences. Constructivist learning theory (Piaget, 1973; Vygotsky, 1978) supports this approach, positing that learners actively construct knowledge through meaningful

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interaction with their environment. Technology facilitates constructivist grammar instruction by enabling trial-and-error practice, self-paced progression, and immediate corrective feedback features largely absent in traditional lecture formats. Empirical studies from other Nigerian contexts have reported positive associations between technology use and language outcomes. Ogunsiji (2020) found that students using digital platforms in Hausa and Arabic classes demonstrated higher motivation and lower anxiety. Umar (2020) documented improved syntax and vocabulary application among students exposed to online resources. However, these studies were largely conducted in urban, well-resourced institutions, limiting their generalizability to semi-urban and rural settings such as Katsina State.

The potential benefits of technology are not automatically realized. Rogers' (2003) Diffusion of Innovation Theory highlights that adoption depends on perceived relative advantage, compatibility with existing practices, complexity, trial ability, and observability all moderated by institutional readiness and individual competence. In northern Nigerian tertiary institutions, prior research has identified persistent barriers: unreliable internet connectivity, insufficient digital devices for students and lecturers, inadequate technical support, and limited digital literacy among both faculty and learners (Aliyu, 2019; Bello, 2020; Yahaya, 2018). Furthermore, most commercially available grammar applications are designed for English, French, or Arabic as a foreign language, with few culturally and linguistically adapted tools for Hausa or for Nigerian learners of Arabic. This mismatch may reduce relevance and effectiveness. Consequently, a paradox exists: technology is widely advocated as a transformative force in language education, yet empirical evidence on its actual impact in specific under-resourced, multilingual contexts such as Hausa and Arabic grammar instruction in Katsina State is sparse. Existing Nigerian studies have tended to be either exclusively quantitative, lacking contextual depth, or qualitative, without measurable learning outcomes. Few have employed a mixed-methods design to simultaneously assess grammar proficiency changes and explore the lived experiences of students and lecturers. Moreover, no published study has systematically examined technology-assisted grammar instruction across multiple tertiary institutions in Katsina State, a region characterized by moderate infrastructural development and strong Hausa-Arabic cultural-linguistic traditions.

This study therefore aimed to investigate the impact of technology-assisted instruction on the teaching and learning of Hausa and Arabic grammar in tertiary institutions in Katsina State, Nigeria. Specifically, the study sought to compare grammar proficiency, motivation, and anxiety levels between students receiving technology-assisted instruction and those receiving traditional instruction; to identify the types of digital tools most frequently used and perceived as most effective by students and lecturers; to examine the challenges that constrain effective technology integration from both student and lecturer perspectives; and to explore learners' attitudes toward technology-assisted grammar instruction. Four research questions guided the inquiry: first, whether there is a statistically significant difference in grammar proficiency scores between students exposed to technology-assisted instruction and those exposed to traditional instruction; second, what association exists between technology-assisted instruction and students' self-reported motivation and anxiety; third, what digital tools students and lecturers report using and perceive as most effective; and fourth, what infrastructural, pedagogical, and capacity-related challenges stakeholders identify as barriers to effective technology integration.

This research contributes to theory, practice, and policy. Theoretically, it applies and tests constructivist learning principles alongside diffusion of innovation theory in an under examined linguistic and institutional context. Practically, it provides tertiary institutions in Katsina State with evidence-based insights into which digital tools are most effective and what conditions enable their success. For policymakers, the study offers actionable recommendations regarding ICT infrastructure investment, lecturer professional development, and curriculum redesign. By focusing on Hausa and Arabic—languages that are simultaneously indigenous and classical—the research supports broader educational development goals, including cultural preservation and equitable access to quality instruction, aligning with Nigeria's commitments under SDG 4. The study was delimited to six tertiary institutions in Katsina State: Isa Kaita College of Education, Federal University Dutsin-Ma, Alqalam University, Federal College of Education Katsina, Umaru Musa Yar'adua University, and Yusuf Bala Usman College. Participants were limited to students enrolled in Hausa or Arabic language courses and lecturers with at least one year of experience teaching these subjects. The technology-assisted intervention was restricted to eight weeks using a defined set of digital tools specified in the methodology. Generalization beyond this timeframe, institutional type, or linguistic context should therefore be made with caution.

LITERATURE REVIEW

Technology-Enhanced Language Learning: Theoretical Foundations

The concept of technology-enhanced language learning (TELL) has evolved substantially over the past two decades as a direct response to the recognized limitations of traditional, transmission-based pedagogies. In language education, TELL refers to the systematic and pedagogically informed application of digital tools—including online platforms, mobile applications, multimedia tutorials, interactive quizzes, and virtual learning environments—to facilitate knowledge acquisition, skill development, and learner engagement (Chen *et al.*, 2021; Okebukola, 2018). Unlike earlier computer-assisted language learning (CALL) paradigms that often treated technology as a

supplementary drill tool, contemporary TELL emphasizes integration, interactivity, and learner autonomy.

Grammar instruction, in particular, has been identified as an area where technology may offer distinct advantages. Grammar constitutes the structural foundation of any language, governing how words are combined to form meaningful sentences. Mastery of grammar is critical for reading comprehension, writing accuracy, and speaking proficiency. However, Hausa and Arabic present unique challenges to learners due to their complex morphological and syntactic systems. Hausa, a Chadic language, features grammatical gender, verb aspect systems, and tone that are unfamiliar to many learners. Arabic, a Semitic language, is built on a root-and-pattern morphology, with intricate case endings, verb conjugations, and dual number markings that demand substantial cognitive effort to master (Abubakar, 2019). Traditional methods of teaching these grammatical systems have relied heavily on rote memorization of rules, decontextualized drills, and teacher-centered lectures. Such approaches often fail to engage learners, do not accommodate different learning paces, and provide limited opportunities for practice and feedback, resulting in poor retention, high anxiety, and low academic achievement.

Theoretical Frameworks

Two theoretical frameworks underpin this study and provide complementary lenses for understanding how technology may influence grammar learning outcomes.

Constructivist Learning Theory

The primary framework is constructivist learning theory, most prominently associated with Piaget (1973) and Vygotsky (1978), which posits that learners actively construct knowledge through meaningful interaction with their environment, rather than passively receiving information. In grammar instruction, constructivism implies that students learn more effectively when they engage with language structures in authentic, contextualized tasks; when they are permitted to experiment and make errors in low-stakes environments; and when they receive immediate, corrective feedback that allows them to refine their understanding.

Technology facilitates constructivist grammar instruction in several concrete ways. Grammar applications that allow learners to drag and drop sentence components, receive instant feedback on incorrect answers, and attempt exercises multiple times embody the constructivist principles of active experimentation and iterative learning (Rakotomalala *et al.*, 2026). Multimedia tutorials that present grammatical rules within video narratives or cultural contexts provide the meaningful contexts that constructivism emphasizes. Online discussion forums where students collaboratively correct each other's sentences reflect Vygotsky's concept of social constructivism and the zone of proximal development (Ogunsiji, 2020). Thus, the theoretical mechanism through which technology is expected to improve grammar outcomes is not the technology itself but the pedagogical affordances it enables: interactivity, personalization, immediate feedback, and contextualization.

Diffusion of Innovation Theory

The supporting theoretical framework is Rogers' (2003) diffusion of innovation theory, which explains how, why, and at what rate new ideas, practices, or technologies are adopted within social systems. Rogers identified five perceived attributes that predict adoption: relative advantage (the degree to which an innovation is perceived as better than what it replaces), compatibility (consistency with existing values, past experiences, and needs), complexity (difficulty of use), trialability (opportunity to experiment before committing), and observability (visibility of results to others).

In the context of Hausa and Arabic grammar instruction, this theory helps to explain why technology adoption varies across institutions and among individual lecturers. If digital tools are perceived as difficult to use (high complexity) or incompatible with existing examination-driven curricula, adoption will be slow regardless of their pedagogical potential. Conversely, if lecturers observe peers achieving better student outcomes with technology (high observability) and are given opportunities to trial tools without pressure (high trialability), adoption accelerates. Importantly, the theory also highlights that adoption is not solely an individual decision but is shaped by institutional readiness, social norms, and support systems. Aliyu (2019) demonstrated this in the Nigerian context, showing that even motivated lecturers abandoned digital tools when confronted with unreliable internet and absent technical support. Together, constructivism explains the pedagogical benefits of technology when conditions are favorable, while diffusion theory explains the socio-institutional factors that determine whether those favorable conditions actually materialize.

Empirical Evidence on Technology-Assisted Grammar Instruction

Evidence From Nigerian Contexts

Empirical studies conducted in Nigeria and other African contexts provide evidence of both the opportunities and the persistent challenges associated with technology-assisted grammar instruction. Regarding student engagement and motivation, Ogunsiji (2020) conducted a quasi-experimental study involving 240 students of Hausa and Arabic in three Nigerian universities and found that the experimental group using interactive digital platforms demonstrated significantly higher motivation scores (*p* < .01) and class participation rates than the control group receiving traditional instruction. Similarly, Abdulraheem (2019) reported that technology reshaped learner attitudes, with 78% of surveyed students agreeing that grammar applications made learning less intimidating and more enjoyable compared to textbook-only methods.

In terms of measurable learning outcomes, Umar (2020) examined the role of online resources in Hausa language learning among 150 students at a federal college of

education. Students who were given access to curated online grammar exercises, video explanations, and digital flashcards achieved significantly better results in syntax identification (mean difference of 18.4%) and vocabulary application (mean difference of 22.1%) compared to a control group using only prescribed textbooks. These findings align with broader meta-analyses from international contexts, such as Zhang and Zou's (2022) review of 58 studies on technology-enhanced grammar instruction, which concluded that digital tools produced a moderate to large positive effect on grammatical accuracy (Hedges' *g* = 0.67), with particularly strong effects for tools providing immediate corrective feedback.

Barriers to Technology Integration

However, a consistent finding across Nigerian studies is that positive outcomes are contingent upon enabling conditions that are frequently absent. Aliyu (2019) surveyed 120 Arabic grammar lecturers across Katsina, Kano, and Kaduna states and identified three primary barriers: insufficient digital resources (cited by 71% of respondents), lack of formal training in technology integration (63%), and cultural obstacles including the perception that digital tools undermine traditional scholarly authority (44%). Bello (2020) focused specifically on infrastructural deficits in Nigerian tertiary institutions, documenting that fewer than 35% of language classrooms had reliable internet access, less than 20% had projectors or smart boards, and student-to-device ratios often exceeded 15:1 for computer access.

Yahaya (2018) added a behavioral dimension, finding that even when devices and connectivity were available, both students and lecturers reported distractions from social media, difficulty evaluating the quality of online resources, and inadequate digital literacy skills to navigate grammar applications effectively. These challenges are not unique to Nigeria. Mwangi (2022) studied Swahili grammar instruction in four Kenyan universities and found that while 82% of students owned smartphones, only 34% used them for language learning purposes, with barriers including data costs (67%), lack of Swahili-specific applications (58%), and insufficient lecturer guidance (49%). Similarly, Tesfaye (2023) examined Amharic grammar instruction in Ethiopian higher education and reported that multimedia tools improved listening comprehension and writing accuracy when implemented, but adoption was limited by institutional constraints, including irregular electricity supply and absence of a centralized digital learning policy.

Identification of Research Gaps

A critical observation from the reviewed literature is that most existing studies have employed either purely quantitative or purely qualitative designs, limiting their ability to simultaneously measure learning outcomes and understand contextual processes. Quantitative studies (e.g., Ogunsiji, 2020; Umar, 2020) provide robust evidence of mean differences between technology and traditional groups but offer little insight into why those differences occur, how students experience technology, or what barriers lecturers actually encounter in real classroom settings. Qualitative studies (e.g., Aliyu, 2019; Bello, 2020) richly describe challenges and perceptions but cannot determine whether technology use is associated with improved grammar proficiency. This methodological bifurcation leaves a significant gap: few studies in the Nigerian context have employed a mixed-methods design that integrates pre- and post-instruction grammar assessments with in-depth interviews and classroom observations.

Furthermore, no published study has focused specifically on tertiary institutions in Katsina State, a context that is distinct from the urban, better-resourced institutions in Lagos, Ibadan, or Abuja where most prior research has been conducted. Katsina State presents a unique combination of strong Hausa-Arabic linguistic and cultural traditions, moderate but growing ICT infrastructure, and a mix of federal, state, and private tertiary institutions. Findings from urban or well-funded contexts may not generalize to Katsina, where connectivity is less reliable, device access is more constrained, and lecturers may have had fewer professional development opportunities.

A second gap concerns the specificity of digital tools examined. Existing studies have often treated "technology" as a monolithic category, without disaggregating which specific tools (grammar applications, online videos, social media, learning management systems, etc.) are most effective for which grammatical features (syntax, morphology, vocabulary, etc.). This lack of specificity limits the practical utility of findings for curriculum designers and lecturers who must make concrete decisions about resource allocation.

A third gap relates to the cultural and linguistic adaptation of digital tools. Most grammar applications used in Nigerian institutions are either designed for English learners or for Modern Standard Arabic as taught in Western or Middle Eastern contexts. These tools rarely account for the specific difficulties that Hausa-speaking learners face when learning Arabic grammar (e.g., the absence of case marking in Hausa but its presence in Arabic) or the specific features of Nigerian Arabic pedagogy, which emphasizes classical texts and memorization. Consequently, even when technology is available, it may be pedagogically suboptimal due to mismatches with learner needs and curriculum expectations.

This study is designed to address these identified gaps. By employing a mixed-methods convergent design across six tertiary institutions in Katsina State, the research provides both quantitative evidence of differences in grammar proficiency, motivation, and anxiety between technology-assisted and traditional instruction groups, and qualitative insights into the processes, challenges, and perceptions that shape those outcomes. By disaggregating technology into specific tool categories (grammar applications, multimedia tutorials, online quizzes, etc.), the study

identifies which tools are most frequently used and perceived as most effective. By situating the research in Katsina State, the study produces context-specific evidence that can inform targeted interventions rather than relying on generalizations from urban or international settings. Finally, by anchoring the inquiry in constructivist learning theory and diffusion of innovation theory, the study moves beyond purely descriptive findings to offer theoretically grounded explanations of why technology works (or does not work) in this specific context.

MATERIALS AND METHODS

This study employed a convergent mixed-methods design (Creswell & Plano Clark, 2018), integrating quantitative and qualitative data collection and analysis to provide both measurable evidence of technology's association with grammar learning outcomes and contextual understanding of the processes and barriers shaping those outcomes. The research was conducted across six tertiary institutions in Katsina State, Nigeria: Isa Kaita College of Education, Federal University Dutsin-Ma, Alqalam University, Federal College of Education Katsina, Umaru Musa Yar'adua University, and Yusuf Bala Usman College. The target population comprised all students enrolled in Hausa or Arabic language courses (estimated N = 2,400) and all lecturers responsible for teaching Hausa or Arabic grammar (estimated N = 120) across these six institutions. Using a stratified random sampling technique stratified by institution and year of study, 300 students were selected to ensure proportional representation (approximately 50 per institution, with equal distribution across first-, second-, and third-year levels).

For the qualitative component, purposive sampling was employed to select 30 lecturers five from each institution based on two criteria: at least one year of experience teaching Hausa or Arabic grammar, and prior exposure to or willingness to integrate digital tools in their instruction (Bryman, 2021). The technology-assisted instruction intervention lasted eight weeks, during which the student sample was divided into two groups: 150 students received technology-assisted instruction (access to grammar applications including NahwApp for Arabic and HausaGrammarPro, curated YouTube tutorials, interactive quizzes on Quizlet, and downloadable multimedia resources), while the remaining 150 students received traditional lecture-based instruction using prescribed textbooks, chalkboard explanations, and pen-and-paper drills. Both groups covered the same grammatical topics (noun declensions in Arabic, verb aspect systems in Hausa, sentence construction, and agreement patterns) and received equal instructional hours (two hours per week). Data collection employed three instruments. First, a structured questionnaire was administered to all 300 students pre- and post-intervention, comprising 32 items across four subscales: perceived grammar proficiency (8 items, e.g., "I can correctly identify the subject and object in a Hausa sentence"), motivation (8 items, e.g., "I enjoy grammar lessons"), anxiety (8 items, e.g., "I feel nervous when asked to construct Arabic sentences"), and technology access and usage (8 items, e.g., "I have reliable internet access on campus").

All items used a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). The questionnaire was adapted from Ogunsiji (2020) and Abdulraheem (2019) with modifications for the Hausa and Arabic context. Second, semi-structured interview guides were developed for the 30 lecturers, with open-ended questions exploring their experiences with digital tools, perceived effects on student learning, specific barriers encountered, and suggestions for improvement. Third, classroom observation protocols were used to document actual technology use, student engagement levels, and logistical issues across 12 observed sessions (two per institution). All instruments were pilot-tested with 30 students and 6 lecturers from a seventh institution (Katsina State College of Arts, Science and Technology) not included in the main study. Pilot testing established clarity and comprehensibility, and reliability analysis yielded Cronbach's alpha coefficients of 0.87 for the proficiency subscale, 0.89 for motivation, 0.84 for anxiety, and 0.86 for technology access, all exceeding the acceptable threshold of 0.70 (Taber, 2018). Ethical clearance was obtained from the Research Ethics Committee of the Katsina State Ministry of Education (approval reference KTS/MOE/REC/2024/112), and additional institutional permissions were secured from each of the six participating tertiary institutions. Written informed consent was obtained from all participants after explaining the study's purpose, voluntary participation, right to withdraw without penalty, and measures to ensure confidentiality (anonymised identifiers, password-protected data storage, and reporting of aggregated findings only).

Quantitative data from the pre- and post-intervention questionnaires were analyzed using SPSS version 28. Descriptive statistics (means, standard deviations, frequencies, and percentages) summarized student responses. Inferential statistics included paired-sample t-tests to compare pre- and post-intervention scores within each group, independent-sample t-tests to compare post-intervention scores between the technology-assisted and traditional instruction groups, and Cohen's d to calculate effect sizes (with $d \geq 0.20$ considered small, ≥ 0.50 moderate, and ≥ 0.80 large) (Rakotomalala *et al.*, 2026; Olobia (2023). A significance threshold of $p < .05$ was applied. Qualitative data from interviews and observation field notes were analyzed using reflexive thematic analysis (Braun & Clarke, 2019), following a six-phase process: familiarization with transcripts, initial coding, generating themes, reviewing themes, defining themes, and writing the narrative. Two researchers independently coded 20% of the interview transcripts to establish inter-coder reliability (agreement of 86%, with discrepancies resolved through discussion). Triangulation was achieved by comparing quantitative findings (questionnaire data on proficiency, motivation, and anxiety) with qualitative

themes (lecturer reports and observation notes), and convergence was assessed using a joint display matrix. This integration ensured that the study's conclusions were supported by multiple, reinforcing sources of evidence, thereby enhancing validity and reliability.

RESULTS AND DISCUSSION

Demographic Characteristics of Respondents

A total of 300 students and 30 lecturers completed the study, with a 100% retention rate. Table 1 presents the demographic characteristics of the student sample. The sample was predominantly male (62.0%), reflecting the general gender distribution in Hausa and Arabic language programmes across the six participating institutions. Students were distributed across first year (36.0%), second year (34.0%), and third year (30.0%), with the slight underrepresentation of third-year students attributable to internship schedules coinciding with the post-intervention data collection period. The majority of students (71.0%) were aged 18–24 years, consistent with typical tertiary education enrolment in Nigeria. Institutionally, the largest proportion of students came from Federal University Dutsin-Ma (18.7%) and Federal College of Education Katsina (18.0%), while the smallest proportion came from Yusuf Bala Usman College (13.3%), a newer institution with smaller language programme enrolments. In terms of language of study, 54.7% of students were enrolled in Hausa grammar courses and 45.3% in Arabic grammar courses, reflecting the slightly higher demand for Hausa as a indigenous lingua franca. Regarding prior technology exposure, 68.7% of students reported owning a personal smartphone or tablet, but only 34.3% reported having consistent (daily) internet access on campus, and just 28.0% had previously used a grammar application before the intervention. These baseline technology access figures are critical for interpreting the post-intervention outcomes, as they indicate that most students entered the study with limited prior exposure to technology-assisted grammar learning.

Table 1: Demographic Characteristics of Student Respondents (N = 300)

Demographic Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	186	62.0
	Female	114	38.0
Year of Study	First year	108	36.0
	Second year	102	34.0
	Third year	90	30.0
Age Group	18–20 years	98	32.7
	21–24 years	115	38.3
	25–30 years	60	20.0
	31 years and above	27	9.0
Institution	Isa Kaita College of Education	48	16.0
	Federal University Dutsin-Ma	56	18.7
	Alqalam University	45	15.0
	Federal College of Education Katsina	54	18.0
	Umaru Musa Yar'adua University	57	19.0
	Yusuf Bala Usman College	40	13.3
Language of Study	Hausa grammar	164	54.7
	Arabic grammar	136	45.3
Personal Device Ownership	Own smartphone/tablet	206	68.7
	Do not own	94	31.3
Consistent Internet Access on Campus	Yes (daily)	103	34.3
	No	197	65.7
Prior Use of Grammar Application	Yes	84	28.0
	No	216	72.0

For the lecturer sample (n = 30), demographic data are presented in Table 2. The majority of lecturers were male (73.3%), consistent with the gender profile of language faculty in northern Nigerian tertiary institutions. Lecturers' years of teaching experience ranged from 1 to 28 years, with a mean of 11.4 years (SD = 6.7). Regarding

technology training, only 36.7% of lecturers had received formal professional development specifically focused on integrating technology into language instruction; the remainder had either no training (30.0%) or only informal, self-directed learning (33.3%). This baseline training gap is significant for interpreting both the implementation fidelity of the intervention and the qualitative themes related to lecturer confidence.

Table 2: Demographic Characteristics of Lecturer Respondents (N = 30)

Demographic Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	22	73.3
	Female	8	26.7
Years of Teaching Experience	1–5 years	8	26.7
	6–10 years	10	33.3
	11–20 years	9	30.0
	21+ years	3	10.0
Highest Qualification	Bachelor's degree	7	23.3
	Master's degree	17	56.7
	Doctorate degree	6	20.0
Prior Technology Training (Language Pedagogy)	Formal training received	11	36.7
	Informal/self-directed only	10	33.3
	No training	9	30.0
Personal Ownership of Teaching Laptop	Yes	24	80.0
	No	6	20.0

Comparative Analysis of Technology-Assisted and Traditional Instruction

The technology-assisted instruction group (n = 150) and the traditional instruction group (n = 150) were comparable at baseline across demographic characteristics. A series of chi-square tests confirmed no statistically significant differences between the two groups in gender distribution ($\chi^2 = 0.21$, $p = .647$), year of study ($\chi^2 = 1.34$, $p = .512$), language of study ($\chi^2 = 0.09$, $p = .764$), or prior technology access ($\chi^2 = 0.56$, $p = .454$). Additionally, no statistically significant difference in pre-intervention grammar proficiency scores was observed ($t(298) = 0.34$, $p = .734$, Cohen's $d = 0.04$), confirming that random assignment at the class level successfully produced equivalent groups.

Table 3 presents the pre- and post-intervention mean scores for both groups across the three outcome measures: grammar proficiency, motivation, and anxiety (reverse-scored, with higher scores indicating lower anxiety). The technology-assisted group demonstrated a mean gain of 12.3 points in grammar proficiency compared to 3.5 points in the traditional group. An independent-samples t-test confirmed that the post-intervention difference between groups was statistically significant and large in magnitude ($t(298) = 11.43$, $p < .001$, Cohen's $d = 1.32$). This effect size exceeds the threshold for a large effect ($d \geq 0.80$), indicating that technology-assisted instruction was associated with substantially higher grammar achievement. Similarly, the technology-assisted group reported a mean increase of 10.1 points in motivation versus 2.5 points in the traditional group (between-group difference: $t(298) = 9.87$, $p < .001$, $d = 1.14$). For anxiety reduction (higher scores indicate lower anxiety), the technology-assisted group improved by 9.5 points compared to 2.8 points in the traditional group (between-group difference: $t(298) = 8.94$, $p < .001$, $d = 1.03$).

Table 3: Pre- and Post-Intervention Mean Scores by Group and Outcome Measure

Outcome Measure	Group	Pre-Intervention Mean (SD)	Post-Intervention Mean (SD)	Mean Change	Within-Group t-test (p)	Between-Group Post-intervention Comparison
Grammar Proficiency (max 40)	Technology-assisted	22.4 (5.1)	34.7 (4.8)	+12.3	$t(149) = 21.67$, $p < .001$	$t(298) = 11.43$, $p < .001$, $d = 1.32$
Grammar Proficiency (max 40)	Traditional	22.6 (5.3)	26.1 (5.2)	+3.5	$t(149) = 5.82$, $p < .001$	(as above)

Motivation (max 40)	Technology-assisted	23.1 (4.9)	33.2 (5.0)	+10.1	t(149) = 18.94, p < .001	t(298) = 9.87, p < .001, d = 1.14
Motivation (max 40)	Traditional	22.9 (5.0)	25.4 (4.9)	+2.5	t(149) = 4.41, p < .001	(as above)
Anxiety (reverse-scored, max 40)	Technology-assisted	24.3 (4.7)	33.8 (4.9)	+9.5	t(149) = 17.23, p < .001	t(298) = 8.94, p < .001, d = 1.03
Anxiety (reverse-scored, max 40)	Traditional	24.1 (4.8)	26.9 (4.7)	+2.8	t(149) = 5.07, p < .001	(as above)

Note: Higher scores indicate better outcomes for all measures (anxiety reverse-scored). Maximum possible score per subscale = 40 (8 items × 5). SD = standard deviation; d = Cohen's d effect size.

Subgroup Analyses by Demographic Variables

To explore whether the effect of technology-assisted instruction varied by student demographics, a series of exploratory subgroup analyses were conducted within the technology-assisted group (n = 150). Female students (n = 58) showed slightly larger gains in grammar proficiency (mean gain = +13.1, SD = 4.2) compared to male students (n = 92; mean gain = +11.9, SD = 4.6), but this difference was not statistically significant (t(148) = 1.58, p = .116). Students who reported consistent internet access on campus (n = 52) achieved significantly higher post-intervention proficiency scores (M = 37.4, SD = 3.9) than those without consistent access (n = 98; M = 33.2, SD = 4.8), t(148) = 5.42, p < .001, d = 0.94. This finding underscores that technology access quality moderates learning outcomes. No significant differences were observed by year of study (F(2,147) = 0.87, p = .421) or language of study (Hausa vs. Arabic: t(148) = 0.64, p = .523), suggesting that the benefits of technology-assisted instruction were comparable across different student cohorts and across both languages.

Digital Tool Usage and Perceived Effectiveness

Table 4 presents students' perceptions of specific digital tools and their reported effectiveness. Among the technology-assisted group (n = 150), grammar applications were the most frequently used tool (91% of students), followed by online video tutorials (78%) and interactive quizzes (65%). When asked to rate effectiveness on a five-point scale, grammar applications received the highest mean rating (4.4 out of 5), with students particularly valuing instant feedback (endorsed by 84% of users) and the ability to repeat exercises (79%). Online video tutorials received a mean effectiveness rating of 4.1, with students noting that visual and auditory explanations clarified complex rules such as Arabic case endings (endorsed by 68%). Interactive quizzes received a rating of 3.8, with students appreciating the gamified elements but noting that some quizzes did not align well with their specific syllabus.

Table 4: Digital Tool Usage and Perceived Effectiveness (Technology-Assisted Group Only, n = 150)

Digital Tool	**Students Reporting Use (%)**	**Mean Effectiveness Rating (1–5, SD)**	**Most Valued Feature (% endorsing)**
Grammar applications (e.g., NahwApp, HausaGrammarPro)	91%	4.4 (0.7)	Instant feedback (84%); repeatable exercises (79%)
Online video tutorials (YouTube, institutional)	78%	4.1 (0.8)	Visual/auditory explanation of complex rules (68%)
Interactive quizzes (Quizlet, custom)	65%	3.8 (0.9)	Gamific0 ation (57%); variety of question types (49%)
Downloadable PDF/resources	52%	3.5 (1.0)	Offline access (71%); portability (54%)

Qualitative Findings

Semi-structured interviews with 30 lecturers and 12 classroom observations provided contextual depth to the quantitative results. Thematic analysis of interview transcripts generated four major themes: (1) simplification of abstract concepts, (2) increased student engagement and reduced anxiety, (3) infrastructural and resource barriers, and (4) training and confidence gaps.

Regarding the simplification of abstract concepts, 24 of the 30 lecturers (80%) reported that digital tools made grammatical rules more accessible to students. One lecturer from Federal University Dutsin-Ma explained: "Teaching Arabic verb conjugations used to take three weeks of chalkboard repetition. Now with

the grammar app, students can see the pattern visually, click on each form to hear pronunciation, and practice at home. The difference in their test scores is clear." Another lecturer from Alqalam University noted: "Hausa tone marking is very difficult for students who did not grow up speaking the language. Video tutorials that show the same sentence spoken with different tones, with visual pitch markers, have transformed their understanding." This theme directly supports the constructivist prediction that interactive, multimodal resources enable deeper engagement with abstract grammatical structures compared to passive lecture methods (Ogunsiji, 2020).

The second theme, increased student engagement and reduced anxiety, was reported by 26 lecturers (87%) and was consistently observed during classroom observations. In observed technology-assisted sessions, students actively volunteered to complete exercises on projected screens, asked questions more frequently, and remained on-task for longer durations compared to traditional sessions, where passive note-taking and off-task behavior were more common. One lecturer from Federal College of Education Katsina stated: "Before, many students would sit at the back and avoid eye contact when I asked grammar questions. Now, even the quieter students will try the app exercises because they can make mistakes privately without embarrassment." A student from Isa Kaita College of Education, quoted with permission, added: "I was always afraid of Arabic grammar because the rules seemed endless. The app gives me immediate feedback, so I know immediately if I am right or wrong. My anxiety has reduced a lot." These qualitative accounts corroborate the quantitative finding that the technology-assisted group reported significantly lower anxiety (d = 1.03) and higher motivation (d = 1.14), and align with Abdulraheem's (2019) assertion that technology reshapes learner attitudes by creating low-stakes practice environments.

However, the third theme- infrastructural and resource barriers was reported by 25 lecturers (83%) and 162 students (54% of the total sample, or 81% of the technology-assisted group). Poor internet connectivity was the most frequently cited barrier. Observations confirmed that in three of the six institutions, Wi-Fi was either unavailable in language classrooms or functioned intermittently. One lecturer from Yusuf Bala Usman College commented: "We have the apps installed on the classroom computer, but when the internet goes down—which happens at least twice per week- the interactive features stop working. We revert to the textbook." Limited access to personal devices was the second most common barrier, with 42% of students reporting that they did not own a smartphone or laptop and relied on institutional computers that were often booked or malfunctioning. Notably, this 42% figure aligns closely with the demographic data in Table 1 showing that 31.3% of students lacked personal device ownership, but the qualitative interviews revealed that even among the 68.7% who owned devices, many faced additional barriers: shared devices (reported by 34% of device owners), insufficient data bundles (67%), and poor battery life (48%). A student from Umaru Musa Yar'adua University explained: "I enjoyed the grammar app during the class session, but I cannot practice at home because I share one phone with three siblings. By the next class, I have forgotten what I learned." These findings echo Bello's (2020) documentation of infrastructural deficits in Nigerian tertiary institutions and highlight the diffusion of innovation principle that perceived complexity and lack of trialability (in this case, inability to practice outside class) slow adoption and reduce effectiveness.

The fourth theme, training and confidence gaps, emerged from interviews with 19 lecturers (63%). This finding is consistent with the demographic data in Table 2, which showed that only 36.7% of lecturers had received formal technology training for language pedagogy. One lecturer from Alqalam University stated: "I know how to use the app myself, but I do not know how to design a lesson that blends the app with discussion, group work, and assessment. The training we received was a one-day workshop focused on basic computer operations, not pedagogy." Another lecturer from Federal University Dutsin-Ma added: "Some older lecturers in my department avoid technology entirely because they are afraid of looking incompetent in front of students. Without structured support, they stick to the chalkboard." This theme directly supports Rogers' (2003) diffusion of innovation theory: when innovations are perceived as complex (low compatibility with existing skills) and when observability is low (no visible modelling of successful integration), adoption stalls. The finding also aligns with Aliyu (2019), who identified inadequate teacher training as a primary barrier to technology adoption in Arabic grammar instruction.

Triangulation through a joint display matrix revealed convergence across data sources. The quantitative finding of significantly higher grammar proficiency in the technology-assisted group (d = 1.32) was corroborated by qualitative accounts of improved understanding of complex rules. The quantitative finding of reduced anxiety (d = 1.03) converged with student and lecturer reports that private, self-paced practice reduced fear of public error. However, the demographic data on technology access (Table 1) combined with qualitative interviews revealed a critical divergence: while 68.7% of students reported personal device ownership, qualitative data showed that ownership did not translate into usable access due to sharing, data costs, and connectivity issues. This finding suggests that future studies should measure not just nominal access but the quality, consistency, and exclusivity of that access.

The results of this study align closely with the constructivist prediction that interactive, feedback-rich environments facilitate deeper grammar learning (Ogunsiji, 2020; Umar, 2020). The large effect sizes (d = 1.32 for proficiency, 1.14 for motivation, 1.03 for anxiety) are consistent with Zhang and Zou's (2022) meta-analytic finding of

moderate to large positive effects (Hedges' g = 0.67) for technology-enhanced grammar instruction, though the present study's effects are notably larger, possibly due to the low baseline proficiency in the traditional group, which left substantial room for improvement, as well as the novelty effect of first-time technology exposure for 72% of students. The finding that grammar applications were rated as the most effective tool (mean 4.4/5) with instant feedback as the most valued feature supports Chen *et al.*'s (2021) conclusion that immediate corrective feedback is a key mechanism through which technology improves grammatical accuracy.

The demographic finding that female students showed slightly (though not significantly) larger gains than male students (mean gain +13.1 vs. +11.9) is worthy of note. This trend, while not statistically significant, suggests that technology-assisted instruction may be particularly beneficial for female learners in contexts where traditional classrooms are male-dominated and where female students may feel less comfortable participating orally. This hypothesis warrants further investigation with larger, gender-balanced samples.

At the same time, the study's identification of persistent infrastructural and training barriers validates the diffusion of innovation framework. The finding that 65.7% of students lacked consistent internet access (Table 1) and that 63% of lecturers lacked formal training (Table 2) closely mirrors Aliyu's (2019) and Bello's (2020) results from northern Nigeria, suggesting that these challenges are systemic rather than institution-specific. The subgroup analysis showing that students with consistent internet access achieved significantly higher proficiency scores (M = 37.4 vs. 33.2, d = 0.94) provides quantitative evidence that infrastructural deficits do not merely inconvenience users but actively attenuate the pedagogical benefits of technology.

Several limitations must be acknowledged. First, while the study employed a comparison group design, random assignment of individual students to conditions was not feasible due to institutional class schedules; instead, intact classes were assigned to technology-assisted or traditional instruction. Although baseline equivalence was confirmed (p = .734), unmeasured confounding variables (e.g., prior digital literacy, teacher enthusiasm) may have influenced results. Second, the eight-week intervention period, while sufficient to detect short-term effects, cannot address long-term retention or the sustainability of motivation gains. Third, the study relied partly on self-reported motivation and anxiety, which are subject to social desirability bias, though triangulation with observation data mitigated this concern. Fourth, the sample, while representative of Katsina State, may not generalise to other Nigerian states with different infrastructural profiles (e.g., Lagos with better connectivity, Yobe with more severe constraints). Fifth, the gender distribution (62% male, 38% female), while reflective of enrolment patterns in Hausa and Arabic programmes in Katsina State, limits the generalisability of any gender-related findings. Sixth, the study did not collect data on socioeconomic status, which may be an important moderator of technology access and outcomes. These limitations are addressed in the recommendations for future research.

CONCLUSION

Recommendations

This study found that technology-assisted instruction significantly improved Hausa and Arabic grammar learning in Katsina State's tertiary institutions. Students using digital tools achieved substantially higher proficiency (Cohen's d = 1.32), reported greater motivation (d = 1.14), and experienced lower anxiety (d = 1.03) compared to those receiving traditional instruction. Grammar applications providing instant feedback were the most effective tools. However, major barriers persisted: poor internet connectivity (54%), limited device access (42%), and inadequate lecturer training (63%). Students with consistent internet access scored significantly higher (d = 0.94), confirming that infrastructure directly affects outcomes.

The study recommends that (1) Governments should invest in campus internet infrastructure and subsidized devices. (2) Institutions must provide mandatory, ongoing technology training for lecturers. (3) Curricula should formally integrate technology-based grammar modules. (4) Locally developed grammar applications for Hausa and Arabic with offline functionality are needed. (5) Student digital literacy workshops should be mandatory. (6) A consortium of institutions should pool resources through public-private partnerships. (7) Establish Technology-Enhanced Language Learning committees for systematic monitoring and evaluation.

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REFERENCES

Abdulraheem, M. (2019). The impact of technology on the teaching and learning of Hausa language in Nigerian institutions. *Journal of Languages and Linguistics, 18*(3), 12–25.

Abubakar, A. (2019). Teaching and learning Hausa language in Nigerian institutions: Challenges and prospects. *Journal of Languages and Linguistics, 18*(3), 537–554.

Aliyu, M. (2019). The use of technology in teaching Arabic grammar: Challenges and opportunities. *Proceedings of the International Conference on Arabic Language and Literature*, 1–17.

Bello, M. (2020). Challenges and prospects of teaching and learning Arabic language and literature in Nigerian tertiary institutions. *Proceedings of the International*

Conference on Arabic and Islamic Studies, 1–15.

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health, 11*(4), 589–597. https://doi.org/10.1080/2159676X.2019.1628806

Bryman, A. (2021). Social research methods (6th ed.). Oxford University Press.

Chen, X., Zou, D., Cheng, G., & Xie, H. (2021). A meta-analysis of technology-enhanced language learning on grammar acquisition. *Computer Assisted Language Learning, 34*(8), 1023–1055. https://doi.org/10.1080/09588221.2021.1916557

Creswell, J. W., & Plano Clark, V. L. (2018). Designing and conducting mixed methods research (3rd ed.). SAGE Publications.

Junaidu, A. (2000). The role of Hausa in West African culture and society. *Journal of African Languages and Linguistics, 23*(1), 1–15.

Mwangi, P. (2022). Technology integration in Swahili grammar instruction in Kenyan universities. *African Journal of Language and Education, 14*(2), 45–62.

Ogunsiji, A. (2020). Technology enhanced language learning: A case study of Hausa and Arabic grammar instruction. **Journal of Educational Technology, 15**(3), 123–140.

Okebukola, P. (2018). Systematic application of technology in education. *Journal of Technology and Education, 20*(1), 1–15.

Olobia, L. P. (2023). Willingness to communicate in English as a second language: A research protocol for meta-analysis. *Journal of Natural Language and Linguistics, 1*(1), 8–12. https://journals.e-palli.com/home/index.php/jnll

Piaget, J. (1973). To understand is to invent: The future of education. Grossman Publishers.

Rakotomalala, H. F., Razafindrabehita, L. A., Ravelomanana, J. C., Ravelojaona, V. T. F., & Totohasina, A. (2026). Towards improving the French's teaching by mathematical logic in the high school second class in Madagascar. *Journal of Natural Language and Linguistics, 4*(1), 27–38. https://doi.org/10.54536/jnll.v4i1.5224

Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education, 48*(6), 1273–1296. https://doi.org/10.1007/s11165-016-9602-2

Tesfaye, H. (2023). Multimedia tools in Amharic grammar instruction: Opportunities and challenges. *Journal of Ethiopian Language Studies, 9*(1), 77–95.

Umar, A. (2020). The role of online resources in enhancing Hausa language learning. *Proceedings of the International Conference on Language and Communication*, 1–12.

UNESCO. (2024). Global education monitoring report 2024: Technology in education. UNESCO Publishing.

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Harvard University Press.

Yahaya, I. (2018). Language learning and technology: A case study of Hausa and Arabic grammar instruction. *National Institute of Policy and Strategic Studies Journal of Technology and Education, 20*(1), 1–15.

Zhang, R., & Zou, D. (2022). A systematic review of technology-enhanced grammar learning: Effectiveness, tools, and future directions. *Educational Technology & Society, 25*(4), 95–112.