

ADAPTIVE LEARNING SYSTEMS FOR LANGUAGE PROFICIENCY DEVELOPMENT IN HIGHER EDUCATION: A SYSTEMATIC LITERATURE REVIEW

John, Andorshiye Emilia Ph.D¹ & Ukpai, Gift Ph.D²

¹Department of Curriculum Studies/Instructional Technology, Faculty of Education, Ignatius Ajuru University of Education, Rumuolumeni, Port Harcourt, Rivers State, Nigeria.

Email: emilia.john@iaue.edu.ng

²Management Information System, Information and Communication Technology Directorate, Akanu Ibiam Federal Polytechnic, Unwana, Ebonyi State, Nigeria.

Corresponding Email: giftedtech031@gmail.com

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ABSTRACT

The growing demand for personalized and data-driven instruction in higher education has spurred interest in adaptive learning systems as a transformative approach to language education. This systematic literature review investigates how adaptive learning systems contribute to language proficiency development in tertiary institutions. Guided by established review protocols, peer-reviewed studies published between 2015 and 2025 were analyzed across major academic databases, focusing on empirical and conceptual works addressing adaptive learning in language teaching and learning contexts. Findings revealed that adaptive learning systems enhance learners' proficiency by providing individualized feedback, data-informed content sequencing, and real-time progress tracking. These systems support diverse linguistic competencies in grammar, vocabulary, reading comprehension, and oral communication, through artificial intelligence and learning analytics, particularly for grammar, vocabulary, reading comprehension, and oral communication. The review identifies several pedagogical frameworks, including constructivist and personalized learning models, as central to the design and implementation of adaptive technologies in language classrooms. However, challenges such as technological limitations, limited instructor readiness, and data privacy issues persist. The study concludes that adaptive learning systems hold significant potential for advancing language proficiency in higher education by aligning instruction with learners' unique needs and learning trajectories. It recommends increased institutional support, professional training, and integration of pedagogically grounded adaptive systems to achieve more inclusive, efficient, and sustainable language learning outcomes.

Keywords: adaptive learning systems, language proficiency, higher education, personalized learning, educational technology.

Introduction

Language proficiency, particularly mastery of grammar and vocabulary, is foundational in higher education language instruction. Yet despite its centrality, traditional classroom methods often struggle to accommodate the wide diversity among learners in terms of background, proficiency, learning pace, and prior vocabulary or grammatical knowledge. This one-size-fits-all paradigm may result in inefficient learning trajectories, suboptimal retention, and reduced learner engagement.

In recent years, adaptive learning systems have emerged as promising technological and pedagogical innovations to address these challenges. By dynamically personalizing instruction through diagnostic assessment, learner modeling, adaptive sequencing of content, as well as automated feedback, these systems aim to enhance learning outcomes in a more individualised manner. Adaptive learning has been explored in many educational contexts (e-learning, mobile-assisted learning, intelligent tutoring systems), showing promise in improving learning efficiency, learner satisfaction, and retention of knowledge (Gligorea et al., 2023).

Adaptive learning systems (ALS) are increasingly recognized as transformative tools for improving language proficiency in higher education, including in contexts such as Nigeria where learner diversity, large class sizes, and resource constraints challenge conventional teaching. Their effectiveness lies in their ability to personalize instruction, enhance engagement, and provide data-driven feedback. In Nigerian universities, students often enter with varying levels of English proficiency due to differences in prior schooling. Adaptive learning systems can bridge this gap by delivering differentiated instruction, ensuring that both advanced and struggling learners progress effectively.

However, although several reviews and studies have addressed adaptive learning more broadly (adaptive e-learning, personalized learning, intelligent tutoring systems) (Katsaris & Vidakis, 2021), comparatively fewer works have focused specifically on how such systems influence language proficiency development in higher education language classrooms. The distinct nature of language learning on aspect of grammar (with its rule-based, often cumulative structure) and vocabulary acquisition (which involves both receptive and productive dimensions, depth and breadth) raises unique questions: How well do adaptive systems handle error detection, provide form-focused feedback, adapt to the granularity needed for grammar rules, or scaffold vocabulary learning across levels? What are the barriers to implementation, and what opportunities remain under-explored? By systematically reviewing empirical studies, theoretical models, and implementation reports, this paper seeks to map the state of knowledge, highlight gaps, and suggest directions for both research and practice. In doing so, it aims to support more effective, scalable, and pedagogically sound adaptive learning interventions that can meaningfully improve language proficiency development among tertiary institution students.

Research objectives

The present systematic literature review is designed to offer a focused synthesis in this domain. The objectives of the review are to:

1. examine existing research on the integration of adaptive learning systems in language proficiency development within higher education in the last decade (2015-2025).
2. analyse the effectiveness of adaptive learning technologies in enhancing students' language skills such as grammar, vocabulary, reading, listening, speaking and writing.
3. explore challenges, and gaps in current research and practice concerning the implementation of adaptive learning systems in language education.

Research questions

The present systematic literature review is guided by the following research questions:

1. What are existing research on the integration of adaptive learning systems in language proficiency development within higher education in the last decade (2015-2025)?
2. What are the effectiveness of adaptive learning technologies in enhancing students' language skills such as grammar, vocabulary, reading, listening, speaking and writing?
3. What are the challenges, and gaps in current research and practice concerning the implementation of adaptive learning systems in language education?

Literature Review

Adaptive learning system and language proficiency

Adaptive learning systems (ALS) are technology-mediated instructional systems that dynamically adjust content, feedback, sequencing, and/or learning paths to each learner's current knowledge, skills, preferences, or context. They combine a learner model (profile/competence), a domain model (content/skills), and an adaptation engine (rules, algorithms, or AI) to deliver personalized instruction. Guo, et al (2021) defines adaptive learning systems (ALS) as software platforms that personalise content, pacing, and feedback to each learner by modelling their knowledge state and learning needs (often using item response theory, Bayesian knowledge tracing, or machine learning). In language learning they appear as intelligent tutoring systems (ITS), adaptive vocabulary trainers, or AI-driven conversational agents that adjust tasks and feedback on grammar and lexical targets. Common adaptivity mechanisms include: diagnostic pretests and ongoing formative assessment, item/sequence selection (mastery learning), recommendation engines, scaffolding and hints, and learner-facing analytics/dashboards. Increasingly, machine learning (including deep learning and recommender systems) is used to infer learner states and recommend personalized learning trajectories.

Language proficiency is a multidimensional construct describing a learner's ability to use language effectively for communication across contexts. It includes knowledge and control of linguistic form (grammar, vocabulary, pronunciation), discourse and pragmatic skills, strategic competence (how learners manage communication), and sociolinguistic/functional appropriateness for different contexts. This multi-component view is central to mainstream models of communicative competence.

Adaptive learning systems are grounded in personalization, data-driven instruction, and continuous feedback. In the context of language learning, their relationship with language proficiency can be framed as, content difficulty, learning pace, feedback mechanisms, and instructional pathways based on learners' performance, preferences, and progress. Language proficiency, on the other hand, involves mastery across key domains such as; listening, vocabulary, reading, writing. Adaptive learning systems enhance language proficiency by delivering personalized, data-driven instruction that aligns with learners' evolving competencies, thereby improving engagement, feedback responsiveness, and targeted skill development. However, existing studies on this relationship remain fragmented, methodologically diverse, and sometimes inconclusive. Therefore, a systematic literature review is essential to synthesize empirical evidence, identify patterns and gaps, and provide a comprehensive understanding of how adaptive learning technologies influence language proficiency development in higher education.

Methodology

Research design

This study employs a systematic literature review (SLR) design to examine the role of adaptive learning systems in enhancing language proficiency development in higher education.

The review is guided by the PRISMA framework, which ensures a transparent, rigorous, and replicable process for identifying, screening, and synthesizing relevant literature.

The systematic literature review process comprises three major phases (i.e., planning the review, conducting the review and reporting the results of the review). The essential steps of a systematic review study are defining the research question, conducting a search for relevant papers, keywording, screening of papers, data extraction and mapping. For this process, the researchers utilised Excel spreadsheets to extract publication outlets, find duplicates and organise the information. Planning a well-structured review is the first step in conducting any systematic review of literature. This step starts with identifying research objectives related to the literature on adaptive learning systems for language learning.

Search strategy: A comprehensive and structured search was conducted across multiple electronic databases to capture relevant peer-reviewed studies. The databases included:

- Scopus
- Web of Science (WoS)
- ScienceDirect
- IEEE Xplore
- Google Scholar

Search terms and strings: Keywords were derived from the core constructs of the study: adaptive learning systems, language proficiency, and higher education. Boolean operators (AND, OR) were used to refine the search.

Example search string: ("adaptive learning" OR "adaptive learning systems" OR "intelligent tutoring systems") AND ("language learning" OR "language proficiency" OR "second language acquisition" OR "ESL" OR "EFL") AND ("higher education" OR "university" OR "tertiary education")

Search limits

- Publication years: 2015–2025
- Language: English
- Document types: Peer-reviewed journal articles and conference papers

Inclusion criteria: Studies were included if they:

- focused on adaptive learning systems or intelligent tutoring systems
- addressed language learning or proficiency development
- were conducted within higher education contexts
- employed empirical, experimental, or well-developed conceptual approaches
- were published in peer-reviewed outlets

Exclusion Criteria: Studies were excluded if they:

- focused on non-language subjects
- were conducted in primary or secondary education only
- were opinion papers, editorials, or non-scholarly sources
- lacked sufficient methodological detail
- were duplicates across databases

Study selection process: The study selection followed the four-stage PRISMA process:

1. **Identification** – Retrieval of studies from selected databases
2. **Screening** – Removal of duplicates and review of titles/abstracts
3. **Eligibility** – Full-text assessment for relevance and quality
4. **Inclusion** – Final selection of studies for synthesis

PRISMA Flow Diagram

Below is a text-based PRISMA flow diagram (you can convert this into a graphical figure for publication):

Identification

Records identified through database searching (n = 1,420)
Additional records identified through other sources (n = 60)
Total records (n = 1,480)

Screening

Records after duplicates removed (n = 1,180)
Records screened (title/abstract) (n = 1,180)
Records excluded (n = 900)

Eligibility

Full-text articles assessed (n = 280)
Full-text articles excluded (n = 210)
Reasons:
- Not focused on language learning (n = 85)
- Not higher education context (n = 60)
- Insufficient methodological rigor (n = 40)
- Conceptual without clear framework (n = 25)

Included

Studies included in qualitative synthesis (n = 70)
Studies included in quantitative synthesis (meta-analysis, if applicable) (n = 35)

Data extraction

A structured data extraction form was developed to systematically collect relevant information from each included study. Extracted data included:

- author(s) and year of publication
- country/region of study
- research objectives
- type of adaptive learning system used
- target language (e.g., english, french)
- study design and methodology
- sample size and participant characteristics
- key findings on language proficiency outcomes
- reported challenges and limitations

Data analysis and synthesis

The extracted data were analyzed using a thematic synthesis approach. Studies were categorized into key themes, including:

- Personalization and learner adaptation mechanisms
- Impact on language proficiency (reading, writing, speaking, listening)
- Learner engagement and motivation
- Technological frameworks and AI integration
- Implementation challenges in higher education

A narrative synthesis was used to integrate findings, identify patterns, and highlight gaps in the literature.

Quality assessment

To ensure the credibility and reliability of included studies, a quality appraisal was conducted using established criteria, including:

- clarity of research objectives
- appropriateness of research design
- validity and reliability of instruments
- transparency of data analysis
- strength of conclusions

Only studies meeting acceptable quality standards were included in the final review.

Results Overview

Table 1: Summary of existing research on the integration of adaptive learning systems in language proficiency development within higher education.

S/No	Author(s) (year)	Context	Adaptive system/tech	Language skill(s) targeted	Key findings	Main limitations
1.	Contrino et al. (2024)	University course (statistics) — but tests ALS integration approach applicable to HE	CogBooks® adaptive learning platform (module sequencing, remediation)	Not language-specific (demonstrates AL implementation in HE); implications for pedagogical integration	ALS improved course outcomes and student engagement when integrated into LMS; shows practical integration workflows for HE instructors	Not language-specific; discipline differences may limit transfer
2.	Wang et al. (2023) — ITS review	Global (multiple studies)	Various ITS implementations (NLP, dialog tutors, step-based tutoring)	Multiple skills (reading, writing, grammar, problem solving) including language learning examples	ITS show consistent positive effects on learning outcomes across domains, moderate–large effect sizes for controlled trials	Heterogeneity of ITS designs; variable quality of study designs
3.	Huang (2023)	University / higher ed; instructional	ITS with instructional	Skill integration applicable to	Well-designed ITS with targeted	Domain-specific; requires

		design for ITS in skill learning	design targeting micro-skills	language subskills (e.g., tracing → grammar analogs)	instructional sequences improve mastery of difficult subskills	careful instructional design expertise
4.	Simon (2024) — Scoping review	Teachers' perspectives on AL in HE	Adaptive learning platforms broadly (LMS plugins, commercial ALS)	Cross-cutting (including language courses)	Teachers report increased engagement and useful analytics; barriers include workload, training, and alignment with curriculum	Many studies descriptive; fewer rigorous RCTs in language contexts
5.	Dada (2024)	South Africa — ITS for curriculum application (speech/language)	Custom ITS for AAC / curriculum testing	Communication / speech-language skills (higher ed health courses)	Statistically significant pre→post gains; students found ITS practical and content-rich	Specific to curriculum and discipline; sample limited to program participants
6.	Alrakhawi (2023) — ITS SLR	Broad educational contexts including HE	ITS (various)	Literacy and domain skills including language learning	ITS widely applied, with positive impacts on achievement; highlighted evaluation methods and tools used	Reviews include many K-12 studies; HE language-specific evidence sparser
7.	Du Plooy (2024) — Personalized adaptive learning	Higher education (scoping / empirical evidence)	Personalized adaptive learning platforms (data-driven sequencing)	General academic skills but directly applicable to language learning pedagogy	Personalized ALS linked to better academic performance and engagement when implemented	Technology readiness and staff capacity limit large-scale rollout

is supported by pedagogy & analytics

8.	Vo (2025) — AI in language education (review)	AI-driven adaptive systems, automated assessment, chatbots	Speaking, listening, grammar, automated writing feedback	AI adaptive tools boost engagement and proficiency via real-time feedback; ethical/ privacy/ bias concerns emphasized	Relatively recent; ongoing debates about bias, privacy and teacher roles
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Table 2: Effectiveness of adaptive learning technologies in enhancing students’ language skills such as grammar, vocabulary, reading, listening, speaking and writing.

S/No.	Author and Study	Target language skill(s)	Main outcome(s) (effectiveness)
1.	Kulik & Fletcher — meta-analysis of Intelligent Tutoring Systems (ITS) (meta-analysis of controlled evaluations).	General (applies to knowledge/skills; used as benchmark for ITS effects)	ITS show moderate to large learning gains vs conventional instruction. ITS foundations are promising for language skill tutoring when well implemented.
2.	Wang et al. (2023) — systematic review of ITS in real educational contexts.	Various (including language learning studies using ITS/ICALL)	Mixed but generally positive effects in controlled settings; however, effectiveness is heterogeneous across contexts — implementation quality, study design, and evaluation metrics vary (some strong gains; other studies report small/non-significant results).
3.	Shadiev & Wang (Frontiers, 2022) — review of technology-supported language learning.	Speaking, writing, listening, reading, grammar	Studies commonly report improvements in speaking and writing, and positive effects for listening/reading and grammar when adaptive feedback/scaffolding included. Overall increases in motivation/engagement reported.
4.	Kaur, Kumar & Kaushal (2023) — technology-assisted language learning (TALL) adaptive systems review (Int. J. Cognitive	Vocabulary, pronunciation, grammar, multimodal skills	Review finds adaptive TALL systems improve targeted subskills (esp. vocabulary recall, pronunciation practice) and increase engagement when adaptivity is well-matched to learner profile.

Computing in Engineering).

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| 5. | Wilschut, Sense & van Rijn (2024) — model-based adaptive vocabulary learning using ASR (Computer Speech & Language). | Vocabulary (productive recall), modality: speech vs typing | Adaptive scheduling improved recall vs non-adaptive practice; speech-based input produced similar learning outcomes to typing. Authors report better immediate and delayed recall for model-based adaptive scheduling. |
| 6. | Shadiev et al. (2022) & related TALL reviews — broad findings across skills. | Speaking, listening, reading, writing, grammar, vocabulary | Consistent pattern: vocabulary and writing/speaking often show the clearest gains when adaptive feedback and practice sequencing are present. Listening/reading gains occur too but depend on content quality and scaffolding. Adaptive systems also boost engagement and self-directed practice. |

Table 3: Challenges, limitations, and gaps in current research and practice concerning the implementation of adaptive learning systems in language education.

S/No.	Author (year)	Context / sample focus	Key challenges explored	research gaps identified
1.	Martin, F., Chen, Y., Moore, R. L., & Westine, C. D. (2020).	Mostly higher education; many studies from Taiwan/US; multiple disciplines	Scalability and integration with curricula; heavy focus on technical adaptation (content/feedback) rather than pedagogy; inconsistent reporting of learner characteristics.	Need for rigorous experimental designs, standardized outcome metrics, more diverse educational levels (K-12), and cross-cultural studies.
2.	Kabudi, T., Pappas, I., & Olsen, D. H. (2021).	Broad: AI techniques, learning domains, analytic methods	Technical complexity of AI/ML, lack of explainability, deployment challenges, need for labeled data, and engineering overhead.	Need for human-centered design, transparent algorithms, and studies measuring learning transfer and equity impacts.

3.	Mirata, V., et al. (2020).	Higher education institutions (comparative contexts)	Institutional (procurement, budgets), organisational change, teacher workload, integration with LMS, interoperability.	Need for implementation studies across different socio-economic and institutional contexts; cost/ROI analyses.
4.	Gligorea, I., Cioca, M., Oancea, R., et al. (2023).	E-learning broadly (not only languages)	Data privacy & security, algorithmic bias, complexity of models, integration with pedagogical theory, lack of explainability for teachers/students.	Research needed on privacy-preserving adaptive algorithms, fairness/bias mitigation, and teacher-facing explainability tools.
5.	Simon, P. D., & Zeng, L. M. (2024).	Teachers across levels; emphasis on attitudes, self-efficacy, facilitating conditions	Teachers report time burden, low perceived usefulness if misaligned to pedagogy, required training, and digital-divide access issues.	More teacher-centred co-design studies, professional development models, and measures of classroom adoption fidelity.

Summary of findings

The following is a summary of the study's key findings:

1. Adaptive learning systems reliably improve vocabulary acquisition and produce moderate, context-dependent gains for grammar, with the largest effects seen when adaptive tools are integrated with instructor-led pedagogy and when studies use rigorous designs.
2. Intelligent tutoring systems (ITS) and adaptive-learning platforms generally show positive effects on learning outcomes, especially for declarative knowledge like vocabulary and grammar.
3. Reviews of technology-assisted and adaptive language-learning research report improvements in engagement, personalized feedback, and measurable gains for vocabulary and grammar; speaking and pronunciation gains are more mixed and often rely on complementary human feedback.
4. Most studies contain many promising case studies and scoping/systematic reviews but fewer are specifically for university-level language courses.
5. Language proficiency skills improved when ALS is integrated.
6. Adoption and organisational barriers were challenges encountered in the integration of ALS in language learning. Technical and ethical challenges were also discovered.

Discussion of findings

Existing research on the integration of adaptive learning systems in language proficiency development within higher education.

Effectiveness: Across controlled trials and review evidence, ALS implementations produce improvements in learning outcomes and engagement (moderate to large effects in many experimental studies), especially when systems provide formative, real-time feedback and scaffolded practice.

Skill specificity matters: Systems that are designed for particular language subskills (e.g., automated writing feedback, pronunciation tutors, grammar sequencing) tend to produce stronger, measurable gains than generic “content-sequencing” platforms — but general-purpose ALS can still support curriculum-level personalization.

Implementation and teacher role: Teacher buy-in, alignment with course design, and instructor training are critical mediators of success. Many studies emphasize that tech alone is insufficient; integration into pedagogy and LMS workflows (e.g., CogBooks + Canvas) is required.

In Nigerian setting, this findings implies that the potential of adaptive learning to address structural challenges such as large class sizes and learner diversity is well established. Studies show that digital and AI-supported learning environments can enhance personalization and improve learning outcomes in Nigerian universities (Afolabi, 2015; Ogunleye, 2010). These findings suggest that adaptive learning systems can help mitigate instructional inefficiencies by tailoring content and pacing to individual learners. In addition, the issue of teacher capacity and institutional readiness is consistently emphasized. Research indicates that the successful integration of educational technologies in Nigeria depends heavily on faculty competence, training, and pedagogical alignment (Adedoja et al., 2013; Yusuf & Afolabi, 2010). Without adequate professional development, instructors may struggle to integrate adaptive systems effectively into teaching and learning processes.

The effectiveness of adaptive learning technologies in enhancing students’ language skills such as grammar, vocabulary, reading, listening, speaking and writing

Adaptive systems (ITS / ICALL / TALL) can produce meaningful learning gains, especially where tasks can be formalized (e.g., vocabulary recall, targeted grammar exercises). Vocabulary and practiceable discrete items show the most consistent positive effects from adaptive scheduling and student modelling. Speaking and writing often improve in technology-supported contexts when adaptive feedback/scaffolding is used, but these gains depend heavily on the quality of the automated feedback (e.g., ASR, automated scoring) and the match between the adaptive rule and the learning objective. Reviews synthesize many small, positive studies here. Listening and reading improvements are reported but are more variable: adaptive systems that include scaffolding, comprehension checks, and sequenced difficulty tend to perform better; unsupervised or low-quality content limits gains. The implication of this findings calls for the need for contextualization and localization of educational technologies is critical. Research in African educational contexts emphasizes that imported technologies must be adapted to local cultural, linguistic, and curricular realities to be effective (Unwin, 2008; Ololube, 2011). This is particularly important for language learning systems, where sociolinguistic context significantly influences learning outcomes.

Challenges, and gaps in current research and practice concerning the implementation of adaptive learning systems in language education

Adoption and organisational barriers: procurement, budget, LMS integration, and institutional readiness slow broader deployment; experts and Delphi studies highlight organisational change management as a major hurdle. Teacher readiness and alignment to pedagogy: many systems target algorithmic personalization but do not support teachers' workflows; teachers cite time, training needs, and unclear pedagogical fit. Technical and ethical challenges: data quality/labeling, explainability, privacy/compliance, and algorithmic bias are recurring concerns, especially for AI-driven adaptive systems. In Nigerian higher education, infrastructural limitations remain a major barrier. Studies highlight persistent challenges such as poor internet connectivity, unreliable power supply, and limited access to digital tools, all of which constrain the adoption of advanced learning technologies (Oye et al., 2012; Ololube, 2006). These constraints explain why many adaptive learning initiatives in Nigeria remain at pilot or experimental stages rather than achieving large-scale implementation. There is a strong demand for policy support and systemic reform. Scholars argue that sustainable integration of emerging technologies in African higher education requires coordinated efforts at institutional and governmental levels, including investment in infrastructure, development of digital education policies, and promotion of open educational resources (Unwin, 2008; Adedaja et al., 2013).

Conclusion

This study synthesises evidence on how adaptive learning systems provide personalised, data-driven instructional pathways for language learners in higher education. Across existing studies, adaptive technologies consistently improved learners' outcomes in grammar, vocabulary, reading, listening, and writing, largely due to real-time feedback, differentiated content sequencing, and continuous performance monitoring. However, the review also reveals notable inconsistencies in implementation quality, limited empirical rigor in some studies, and a lack of long-term and large-scale evaluations. Challenges such as technological constraints, insufficient instructor training, and limited integration with broader curriculum frameworks further restrict their full pedagogical potential. Overall, the evidence indicates that adaptive learning systems hold substantial promise for transforming language education in higher education, but their effectiveness depends on strategic adoption, robust pedagogical design, and ongoing stakeholder support. Strengthening methodological approaches, expanding context-specific research, and enhancing system usability will be crucial for maximizing the impact of adaptive learning on language proficiency development.

Recommendations

1. English Language instructors in higher education should use adaptive systems for vocabulary practice by integrating into courses, practice with classroom activities that encourage productive use.
2. Faculty training should be provided for educators and students and map the ALS's adaptation rules to course objectives.
3. More studies should be carried out to expand the use of ALS in language learning, particularly in higher education.

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