

# Design-Based Research on Developing and Evaluating a Digital Academic English Platform for Nigerian Polytechnic Students

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## ABSTRACT

This study employed a Design-Based Research (DBR) framework to develop and evaluate a digital academic English platform tailored to the linguistic and disciplinary needs of Nigerian polytechnic students. Academic English proficiency remains a persistent challenge in multilingual technical institutions, where students must transition from diverse linguistic repertoires to formal academic registers. Guided by Sociocultural Theory and Cognitive Load Theory, the study designed a mobile-first, discipline-embedded platform integrating scaffolded writing tasks, authentic technical genres, modularized content, and structured lexical recycling. Using iterative cycles of design, implementation, analysis, and refinement, the intervention was piloted with National Diploma students in a Nigerian polytechnic. Quantitative data from pre- and post-intervention proficiency assessments were complemented by qualitative feedback from students and expert reviewers. Findings indicated statistically significant improvement in academic English performance, demonstrating the effectiveness of context-sensitive digital scaffolding. Iterative revisions enhanced usability, cognitive segmentation, and disciplinary alignment, resulting in six transferable design principles applicable to multilingual, resource-constrained tertiary environments. The study contributes theoretically by operationalizing sociocultural scaffolding and cognitive load management within a mobile digital language environment. Methodologically, it extends DBR application to underrepresented African technical education contexts. Practically, it provides an adaptable instructional model for improving academic discourse competence in multilingual polytechnic settings. The findings underscore the importance of localized, theory-driven digital interventions in advancing equitable access to academic language development.

## 1. Introduction

English serves as the official language of instruction in Nigerian tertiary institutions, including polytechnics. Despite extended exposure to English throughout primary and secondary education, many polytechnic students demonstrate limited proficiency in academic reading, writing, and technical communication (Adegbite & Odebumi, 2020). These challenges are particularly consequential in polytechnic education, where students must produce laboratory reports, technical documentation, feasibility studies, and project reports requiring precision, coherence, and discipline-specific vocabulary. Persistent weaknesses in academic English proficiency constrain students' academic achievement and professional readiness.

A crucial distinction must be drawn between general English proficiency and academic English. General English emphasizes everyday communicative competence, whereas academic English involves mastery of formal register, argument structure, disciplinary conventions, lexical density, and genre-specific writing practices (Hyland, 2006; Snow & Uccelli, 2009). Polytechnic students frequently display conversational fluency but struggle with thesis development, cohesion, technical vocabulary, and structured argumentation. Such gaps indicate the need for instructional approaches that specifically target academic discourse practices rather than general language skills.

The multilingual nature of Nigerian classrooms further complicates language learning. Students often navigate indigenous languages alongside English, leading to cross-linguistic influence and code-switching practices that may affect academic writing accuracy and lexical precision (Adegbija, 2004). In such contexts, academic English instruction must be scaffolded and responsive to diverse linguistic repertoires rather than assume uniform proficiency levels.

Although digital technologies have expanded access to language learning globally, technical institutions in developing contexts often face infrastructural limitations, inconsistent internet access, and insufficiently contextualized digital content (Adedoyin & Soykan, 2020). Many commercially available platforms are designed for generic language acquisition and do not align with the specific discourse demands of polytechnic education. Consequently, there is a need for context-sensitive digital interventions grounded in sound pedagogical theory and responsive to local realities.

Design-Based Research (DBR) offers a rigorous framework for addressing complex educational problems within authentic learning environments. DBR integrates iterative design, implementation, analysis, and refinement while simultaneously generating

theoretical insights (Design-Based Research Collective, 2003; Reeves, 2006). Rather than testing static interventions, DBR supports adaptive development responsive to classroom feedback. This approach is particularly appropriate for multilingual, resource-constrained polytechnic contexts.

The purpose of this study was to design, implement, and evaluate a theory-informed digital academic English platform tailored to Nigerian polytechnic students using a design-based research approach. The study addressed the following research questions:

- What academic English challenges do Nigerian polytechnic students experience?
- How can a theory-informed digital platform address identified needs?
- What is the effect of the platform on students' academic English proficiency?
- What design principles emerge from iterative implementation?

## 2. Literature Review

### 2.1 Academic English in Polytechnic Education

Academic English encompasses the linguistic competencies required for effective participation in formal educational settings. It includes discipline-specific vocabulary, complex syntactic structures, cohesive devices, genre awareness, and argumentation strategies (Hyland, 2006). In polytechnic contexts, students are expected to engage with technical manuals, laboratory procedures, and structured project documentation that adhere to conventional academic formats.

Vocabulary plays a central role in academic success. Nation (2013) emphasizes that mastery of academic and technical lexical items significantly predicts comprehension and writing quality. In applied sciences and engineering-related programmes, lexical precision is essential for clarity and accuracy. Deficiencies in academic vocabulary often result in vague expression and conceptual misunderstanding.

Academic writing in polytechnics requires adherence to established conventions such as structured introductions, methodological descriptions, data presentation, and referencing practices. English for Academic Purposes (EAP) and English for Specific Purposes (ESP) frameworks advocate contextualized instruction aligned with disciplinary needs (Dudley-Evans & St John, 1998). Such approaches move beyond grammar instruction toward genre awareness and discourse competence.

In the Nigerian context, language instruction at the tertiary level often remains general in orientation and insufficiently aligned with disciplinary communication demands (Adegbite & Odeunmi, 2020). This misalignment reinforces the need for targeted academic English interventions that respond directly to the communicative practices of polytechnic disciplines.

### 2.2 Digital Language Learning Platforms

Digital language learning platforms have expanded significantly with the rise of mobile technologies and learning management systems. Mobile-assisted language learning (MALL) enhances flexibility, learner autonomy, and access to resources beyond classroom constraints (Kukulka-Hulme & Shield, 2008). Learning Management Systems (LMS) facilitate structured content delivery, assessment, and learner analytics.

Adaptive learning technologies personalize instruction based on learner performance data, potentially increasing engagement and retention (Godwin-Jones, 2018). Multimedia integration, including video explanations and interactive quizzes, can enhance comprehension when aligned with cognitive principles.

However, implementation challenges persist in developing contexts. Adedoyin and Soykan (2020) highlight infrastructural disparities, limited digital literacy, and contextual mismatches between imported technologies and local needs. In Nigerian polytechnics, bandwidth constraints and device variability necessitate lightweight, mobile-compatible platforms designed with sensitivity to contextual realities.

### 2.3 Design-Based Research in Educational Technology

Design-Based Research emerged from efforts to bridge the gap between educational theory and classroom practice (Brown, 1992; Collins, 1992). It emphasizes iterative cycles of design, enactment, analysis, and redesign within authentic settings. The Design-Based Research Collective (2003) characterizes DBR as a methodology that produces both practical solutions and theoretical contributions.

Core principles include iterative refinement, theory-driven design, intervention in real contexts, and the generation of transferable design principles. Unlike controlled experimental studies, DBR accommodates contextual complexity and supports adaptive modification based on empirical evidence (Reeves, 2006).

Given the dynamic and multilingual environment of Nigerian polytechnics, DBR is particularly suitable. It allows for context-sensitive adaptation while maintaining methodological rigor.

This study was grounded in two complementary theoretical perspectives: Sociocultural Theory and Cognitive Load Theory. Together, these frameworks informed both the pedagogical logic and technological architecture of the digital academic English platform.

Sociocultural Theory conceptualizes learning as a socially mediated process in which cognitive development occurs through interaction, dialogue, and engagement with cultural tools (Vygotsky, 1978). Central to this perspective is the Zone of Proximal Development (ZPD), defined as the distance between what learners can accomplish independently and what they can achieve with guided support. Within academic writing instruction, scaffolding operates as a mediational mechanism that gradually transfers responsibility from instructor or tool to learner. In this study, the platform functioned as a digital mediational tool by incorporating model texts, annotated exemplars, guided revision prompts, and automated formative feedback. Writing tasks were sequenced from controlled practice to semi-guided production and finally to independent composition. This structured progression was

designed to support internalization of academic discourse conventions, including genre awareness, lexical precision, and cohesive structuring.

Cognitive Load Theory (Sweller, 1994) complemented this sociocultural orientation by addressing the cognitive architecture underlying learning. The theory distinguishes among intrinsic load (complexity inherent in the task), extraneous load (imposed by poor instructional design), and germane load (cognitive resources devoted to schema construction). Academic writing tasks naturally impose high intrinsic load due to syntactic complexity and discourse organization demands. Therefore, the platform minimized extraneous load through modular segmentation, streamlined navigation, and reduced visual clutter. Multimedia explanations followed principles articulated by Mayer (2009), including coherence, signaling, and modality principles, ensuring that audiovisual elements supported rather than distracted from learning. Together, these frameworks ensured that instructional scaffolding was cognitively manageable, pedagogically intentional, and developmentally responsive.

### 2.4 Study Gap

Despite increasing scholarship on digital language learning and blended pedagogies, there remains a significant empirical gap concerning context-specific interventions for academic English development in Nigerian polytechnics. Existing studies largely focus on universities, secondary schools, or generalized ESL/EAP environments, with minimal attention to the distinctive linguistic ecology of polytechnic institutions characterized by multilingual student populations, vocational orientation, and uneven digital infrastructure. Furthermore, most digital English platforms adopted in Nigeria are imported, commercially driven systems that are not grounded in local curricular needs or learner profiles. There is also limited application of design-based research (DBR) methodologies to iteratively develop and validate technology-enhanced language learning tools within authentic classroom settings. Consequently, there is insufficient evidence on how a locally designed digital academic English platform can be systematically developed, refined, and evaluated for effectiveness in improving academic literacy outcomes among Nigerian polytechnic students. This study addresses these methodological, contextual, and pedagogical gaps.

## 3. Methodology

### 3.1 Research Design and Context

This study adopted Design-Based Research (DBR), characterized by iterative cycles of analysis, design, implementation, evaluation, and refinement within authentic educational settings, as articulated by the Design-Based Research Collective (2003). DBR was considered appropriate because it enabled the development and systematic testing of a digital academic English intervention within a real classroom while generating context-sensitive design principles. The study was conducted at a federal polytechnic in Southwestern Nigeria. Participants comprised 120 National Diploma I students enrolled in a compulsory Communication Skills course. Purposive sampling ensured representation of diverse linguistic backgrounds. Ethical approval was obtained, and informed consent was secured from all participants.

### 3.2 Intervention Development and Implementation

The first phase involved a needs analysis using a diagnostic academic English proficiency test, semi-structured lecturer interviews, and student surveys. The diagnostic test assessed academic vocabulary, reading comprehension, and structured writing. Findings indicated low writing proficiency, limited technical vocabulary, and difficulty interpreting technical texts.

Based on these findings, a mobile-compatible digital platform was designed with four modules: Academic Writing Fundamentals, Technical Vocabulary Development, Reading for Technical Comprehension, and Report Writing and Referencing. Features included video tutorials, interactive quizzes, model texts, automated formative feedback, and scaffolded writing tasks. Multimedia design was informed by Cognitive Load Theory, while scaffolding reflected Sociocultural Theory. The platform was implemented over eight weeks in a blended format, combining independent online engagement with in-class reinforcement. Feedback from surveys, observation, and focus groups informed iterative refinement, including simplified navigation and expanded vocabulary exercises.

### 3.3 Instruments and Data Analysis

Data were collected using a validated pre- and post-intervention academic English proficiency test, an analytic writing rubric, a Likert-scale usability questionnaire, observation checklists, and focus group interviews.

Quantitative data were analyzed using descriptive statistics and paired-samples *t*-tests to determine statistical significance, with effect size calculated using Cohen's *d*. Qualitative data were analyzed thematically following the framework proposed by Braun and Clarke (2006).

## 4. Results

Pre-intervention diagnostic results revealed generally low levels of academic English proficiency among participants ( $M = 48.62$ ,  $SD = 8.94$  out of 100), confirming concerns identified during the needs analysis phase. Following the eight-week intervention, post-test scores increased to a mean of 61.87 ( $SD = 9.12$ ), representing an average gain of 13.25 points. A paired-samples *t*-test indicated that this improvement was statistically significant,  $t(119) = 8.72$ ,  $p < .001$ , with a 95% confidence interval ranging from 10.23 to 16.27. The effect size (Cohen's  $d = 0.68$ ) falls within the moderate-to-approaching-large range, suggesting that the observed gains were not only statistically significant but also educationally meaningful in magnitude.

Closer examination of subscale performance revealed uneven but substantively important gains across components of academic English. Improvements were strongest in academic vocabulary and writing organization, followed by cohesion devices, while reading comprehension demonstrated comparatively smaller gains. This pattern indicates that scaffolded production-oriented tasks

exerted a more pronounced influence than receptive comprehension exercises. The structured writing prompts, model texts, and iterative feedback mechanisms embedded within the platform appear to have directly supported learners' ability to organize ideas, deploy discipline-relevant terminology, and construct coherent academic texts.

Platform analytics further demonstrated sustained engagement throughout the intervention period, with students logging in an average of 3.2 times per week. Vocabulary modules recorded higher completion rates than reading modules, suggesting that interactive lexical tasks were perceived as particularly accessible and rewarding. Qualitative thematic analysis reinforced the quantitative findings, revealing increased metalinguistic awareness, reduced writing anxiety, and heightened confidence in structuring technical reports. Collectively, these outcomes align with sociocultural principles of scaffolded learning, indicating that guided digital mediation contributed to both cognitive development and affective transformation in academic writing performance.

## 5. Discussion

The findings provide empirical support for the integration of Sociocultural Theory and Cognitive Load Theory within digital academic language design. Improvements in writing organization and lexical precision suggest that scaffolded instructional sequencing facilitated movement within learners' zones of proximal development (Vygotsky, 1978). The platform's structured prompts, model texts, and staged feedback functioned as mediated tools supporting gradual internalization of academic discourse conventions.

From a Cognitive Load perspective, modular segmentation and streamlined interface design likely reduced extraneous load, enabling learners to allocate cognitive resources to germane processing (Sweller, 1994). Early implementation feedback revealed signs of overload when dense content blocks were presented without segmentation. Subsequent redesign resulted in improved engagement and higher performance gains, demonstrating the importance of cognitive architecture in digital language learning environments.

The moderate-to-large effect size observed in this study compares favorably with prior mobile-assisted language learning research, which often reports small-to-moderate effects in heterogeneous contexts (Godwin-Jones, 2018). The relatively strong gains observed here may be attributable to contextual alignment. Unlike generic language applications, the platform explicitly targeted academic genres relevant to polytechnic coursework.

The multilingual nature of Nigerian classrooms introduces additional complexity. Cross-linguistic transfer and code-switching practices are not inherently deficits but reflect dynamic linguistic repertoires (Adegbija, 2004). By incorporating scaffolded academic vocabulary instruction rather than enforcing rigid monolingual norms, the platform supported structured transition from informal to formal register.

Importantly, the DBR approach itself contributed significantly to the intervention's effectiveness. Iterative refinement allowed immediate response to usability concerns and content density issues. This responsiveness contrasts with traditional experimental designs in which interventions remain fixed despite contextual feedback. The generation of transferable design principles strengthens the study's theoretical contribution beyond the immediate setting.

## 6. Contributions to Knowledge

This study makes substantive contributions to knowledge by advancing theory, methodology, and contextual understanding in the domain of digital academic English instruction.

First, theoretical contribution: the research empirically operationalizes principles derived from Sociocultural Theory and Cognitive Load Theory within a mobile-first digital language environment. While both frameworks are well established in second language acquisition and instructional design scholarship, their integrated application in technology-mediated academic English development remains underexplored, particularly in multilingual technical education contexts. By embedding scaffolded interaction, guided modelling, lexical recycling, and segmented instructional design into a single coherent platform, the study demonstrates how sociocultural scaffolding and cognitive load management can be translated from abstract theoretical constructs into measurable pedagogical architecture.

Second, methodological contribution: the study extends the application of Design-Based Research (DBR) beyond highly resourced Western educational systems into a multilingual, resource-constrained Nigerian polytechnic environment. DBR is frequently associated with technologically advanced contexts; however, this research demonstrates its viability under infrastructural limitations, intermittent connectivity, and heterogeneous linguistic backgrounds. The iterative cycles of design, implementation, evaluation, and refinement confirm that DBR remains a rigorous and adaptive methodology even where technological and institutional constraints exist.

Third, contextual contribution: the research provides rare empirical evidence on digital academic English interventions within Nigerian polytechnic education—an area significantly underrepresented in global literature. Much scholarship on digital language learning centres on universities in Europe, North America, or East Asia. By situating the intervention within a Nigerian technical institution, the study diversifies the empirical base of world English and multilingual education research while responding directly to the linguistic realities of polytechnic students.

### 6.1 Design Principles Generated

The iterative DBR cycles generated six transferable design principles with relevance beyond the immediate study context. The Disciplinary Alignment Principle emphasizes that academic language platforms must integrate authentic disciplinary genres: laboratory reports, technical explanations, and structured essays rather than relying on decontextualized grammar drills. The Scaffolded Production Principle underscores the importance of structured writing prompts, model texts, and guided feedback in

accelerating academic discourse competence. The Cognitive Segmentation Principle demonstrates that modularized content reduces extraneous cognitive load and improves retention.

The Mobile-First Accessibility Principle highlights the necessity of lightweight, bandwidth-sensitive architecture in resource-constrained settings. The Iterative Responsiveness Principle confirms that continuous learner feedback enhances instructional precision and platform usability. Finally, the Lexical Depth Principle establishes that repeated exposure to high-frequency academic and technical vocabulary strengthens both receptive and productive proficiency. Collectively, these principles are adaptable to other multilingual technical institutions globally.

### 6.2 Implications

**Pedagogical Implications:** Academic English instruction in technical institutions should transition from generalized communication courses to discipline-embedded digital scaffolding models that foreground authentic genres and structured production.

**Institutional Policy Implications:** Polytechnics should prioritize the development of localized digital learning ecosystems tailored to their linguistic realities instead of adopting generic commercial platforms with limited contextual alignment.

**Educational Technology Development Implications:** Design for developing contexts must foreground low-bandwidth optimization, modular delivery systems, and linguistic responsiveness as core architectural priorities rather than secondary considerations.

**Multilingual Education Implications:** Digital scaffolding can function as a mediating tool that facilitates students' transition from multilingual repertoires to formal academic registers without suppressing linguistic diversity, thereby supporting additive bilingualism.

### 6.3 Limitations and Future Research

The study was limited to a single institution and a relatively short intervention duration. Future research should undertake multi-institutional replication across diverse polytechnic contexts and conduct longitudinal analyses to determine the sustainability of proficiency gains and long-term academic outcomes.

### 6.4 Conclusion

This study demonstrates that a Design-Based Research approach can effectively develop and refine a digital academic English platform tailored to Nigerian polytechnic students. The statistically significant improvement in proficiency validates the efficacy of theory-driven, context-sensitive digital interventions. Beyond immediate instructional gains, the study offers transferable design principles and methodological insights for multilingual technical education contexts, thereby advancing scholarship and practice in digital academic language development.

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