DIGITAL TECHNOLOGY INTEGRATION IN EFL CLASSROOMS: EFFECTS OF AI-ASSISTED LANGUAGE LEARNING TOOLS ON VOCABULARY ACQUISITION AND LEARNER

Autonomy in Technical College Settings

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Abstract

The proliferation of artificial intelligence-driven language learning applications has created new possibilities for EFL instruction in resource-constrained technical college environments. This mixed-methods study examined the effects of systematic integration of AI-assisted language learning (AIALL) tools — specifically adaptive vocabulary platforms and automated speech recognition (ASR)-based pronunciation feedback — on vocabulary acquisition and learner autonomy among 76 EFL students at a technical college in Uzbekistan over 12 weeks. A quasi-experimental design compared an AIALL-integrated group (n=38) with a conventional instruction control group (n=38). Vocabulary knowledge was measured using the Vocabulary Levels Test (VLT) and a domain-specific technical vocabulary assessment. Learner autonomy was evaluated using a validated 24-item questionnaire. Post-test analyses revealed significantly superior vocabulary gains in the AIALL group ($p < .001$, $d = 0.79$) and meaningfully higher learner autonomy scores ($p < .01$, $d = 0.63$). Semi-structured interviews and learning log analysis provided qualitative evidence of increased self-directed learning behavior and metacognitive engagement. Findings are discussed in relation to self-regulated learning theory, the SAMR model of technology integration, and practical implications for EFL curriculum design in technical education.

Keywords: *AI-assisted language learning, vocabulary acquisition, learner autonomy, EFL, digital technology, technical college, Uzbekistan*

1. Introduction

The rapid development of digital technologies has fundamentally reshaped pedagogical landscapes across educational contexts globally (Crompton & Burke, 2018; Puentedura, 2006). Within English as a Foreign Language (EFL) instruction, technology-enhanced language learning (TELL) has evolved from simple computer-assisted drills to sophisticated artificial intelligence (AI)-driven adaptive platforms capable of personalizing learning trajectories, providing instantaneous corrective feedback, and generating authentic communicative contexts (Golonka et al., 2014; Godwin-Jones, 2017).

Vocabulary acquisition represents a foundational dimension of language development, with research consistently demonstrating that lexical knowledge serves as a primary predictor of reading comprehension, writing quality, and oral communication proficiency (Nation, 2001; Schmitt, 2008). For EFL learners in technical and vocational education settings, vocabulary challenges are compounded by the need to acquire both general academic vocabulary and specialized technical lexis relevant to their professional domains (Hyland, 2006; Coxhead, 2000). Conventional instructional approaches — typically reliant on decontextualized word lists and translation — have demonstrated limited effectiveness in supporting deep, durable vocabulary acquisition (Laufer & Hulstijn, 2001).

Simultaneously, learner autonomy — defined as the capacity and willingness to take responsibility for one's own learning (Holec, 1981; Little, 1991) — has been identified as a critical educational outcome in 21st-century skills frameworks. Autonomous learners demonstrate superior metacognitive regulation, sustain motivation over time, and exhibit greater transfer of learning to novel contexts (Benson, 2011; Zimmerman, 2002). Technology integration, when pedagogically purposeful, has been theorized to scaffold the development of learner autonomy by enabling self-paced learning, facilitating self-monitoring, and expanding learning beyond classroom boundaries (Reinders & White, 2016).

Despite these theoretical synergies, empirical research on AIALL tool integration in technical college EFL contexts — particularly in Central Asian post-Soviet educational systems — remains limited. Most existing studies examine university or secondary school populations in East Asian or Western contexts (e.g., Chen & Chung, 2008; Ranalli, 2013), leaving questions about generalizability to Uzbek technical education largely unaddressed.

This study aims to fill this gap by investigating whether systematic AIALL tool integration produces demonstrable gains in vocabulary acquisition and learner autonomy among technical college EFL students in Uzbekistan. The following research questions guided the investigation:

1. Do AIALL-integrated learners demonstrate significantly greater vocabulary acquisition than conventionally instructed learners?
2. Does AIALL tool integration lead to significantly higher learner autonomy compared to conventional instruction?
3. What qualitative evidence exists regarding learners' self-directed engagement with AIALL tools outside formal instructional time?

2. Literature Review

2.1 AI-Assisted Language Learning: Theoretical and Empirical Background

Artificial intelligence applications in language education have expanded dramatically since the mid-2010s, encompassing adaptive learning systems, natural language processing-based writing feedback, ASR-driven pronunciation training, and conversational AI interfaces (Godwin-Jones, 2017; Huang et al., 2020). Adaptive vocabulary platforms employ spaced repetition algorithms (SRS) — grounded in Ebbinghaus's (1885) forgetting curve — to optimize review scheduling and maximize retention. Meta-analytic evidence strongly supports SRS-based vocabulary learning (Nakata, 2011), with studies demonstrating superiority over massed practice across diverse learner populations.

Automated speech recognition (ASR) technology has advanced to enable real-time pronunciation feedback previously requiring teacher mediation (Neri et al., 2002). ASR-based applications provide immediate corrective information on segmental and suprasegmental features, potentially overcoming limitations of large-class instruction where individual pronunciation feedback is impractical (Liakin et al., 2015).

The SAMR model (Puentedura, 2006) provides a useful analytical framework for evaluating technology integration quality. SAMR distinguishes four levels: Substitution (technology replicates existing practice), Augmentation (technology adds functional improvement), Modification (technology significantly redesigns tasks), and Redefinition (technology enables previously inconceivable tasks). Meaningful pedagogical benefits are most consistently associated with Modification and Redefinition levels of integration.

2.2 Vocabulary Acquisition through Technology

Chen and Chung (2008) demonstrated that adaptive computer-assisted vocabulary instruction produced significantly higher retention than paper-based learning among EFL learners. Ranalli (2013) investigated the effectiveness of SRS platforms and found large effect sizes for incidental vocabulary learning when learners engaged with contextualized digital encounters. More recently, Klimova and Pikhart (2021) reviewed 15 studies on mobile-assisted vocabulary learning and reported consistently positive effects, though with considerable variation in effect size depending on implementation quality.

Domain-specific technical vocabulary poses distinct acquisition challenges due to its specialized semantic content and low frequency in general input (Hyland, 2006). Schmitt (2008) argues that deliberate learning — including repetitive, spaced exposure — is particularly important for low-frequency technical vocabulary, making SRS platforms theoretically well-suited for this learning objective.

2.3 Technology Integration and Learner Autonomy

Self-regulated learning theory (Zimmerman, 2002) describes autonomous learning as a cyclical process of goal-setting, strategic planning, self-monitoring, and self-evaluation. Technology tools that make learning progress transparent — through dashboards, performance analytics, and progress tracking — can scaffold this regulatory cycle (Reinders & White, 2016). Benson (2011) identifies technical, psychological, and political dimensions of learner autonomy and argues that technology can facilitate autonomy primarily when learners are granted agency over their learning processes rather than merely substituting teacher control with machine control.

Empirical evidence on technology and learner autonomy is mixed. While several studies report positive associations between TELL and autonomous behavior (Lai & Gu, 2011; Reinders & White, 2016), others note that passive, unreflective technology use fails to develop genuine autonomy (Blin, 2004). Pedagogical scaffolding — guiding learners in goal-setting, reflection, and strategic technology use — appears to be a critical mediating variable.

2.4 Technology Integration in Post-Soviet EFL Contexts

Post-Soviet educational systems present distinctive implementation challenges for technology integration, including infrastructure constraints, teacher digital literacy deficits, and learner unfamiliarity with self-directed learning paradigms (Kachru, 1992; Karimov, 2019). Nonetheless, smartphone penetration rates in Uzbekistan have increased substantially (exceeding 70% among urban youth by 2022), creating feasible platforms for mobile-assisted language learning (MALL) initiatives (Agency for Statistics of Uzbekistan, 2022).

3. Methodology

3.1 Research Design

A convergent parallel mixed-methods design (Creswell & Plano Clark, 2018) was employed, integrating quasi-experimental quantitative data with qualitative interview and learning log data collected concurrently and merged at the interpretation stage.

3.2 Participants

Seventy-six second-year students (age M = 18.3, SD = 0.9; 55 male, 21 female) enrolled in an information technology program at a technical college in Samarkand, Uzbekistan, participated in the study. Participants were classified at A2-B1 proficiency level based on placement test results and were randomly assigned to groups at the class level. Pre-test VLT scores confirmed group equivalence ($t(74) = 0.31$, $p = .76$).

3.3 Instructional Treatment

AIALL group (n=38): Received conventional English instruction supplemented by three integrated digital tools: (1) Quizlet (SRS-based adaptive vocabulary platform) with instructor-curated technical vocabulary sets (30 minutes daily self-directed use); (2) ELSA Speak (ASR-driven pronunciation application); (3) a structured weekly reflection protocol guiding metacognitive engagement with learning logs. Instructor modeled strategic tool use during weekly 20-minute technology integration sessions.

Control group (n=38): Received the standard curriculum without technology supplementation, covering equivalent vocabulary content through conventional coursebook activities.

3.4 Instruments

Vocabulary Levels Test (VLT): Nation's (2001) VLT assessed general vocabulary knowledge at 2,000- and 3,000-word levels ($\alpha = 0.82$). A researcher-

developed 40-item Technical Vocabulary Assessment (TVA) targeting IT and engineering lexis was validated through expert review and item analysis (α = 0.86).

Learner Autonomy Questionnaire (LAQ): A 24-item instrument adapted from Spratt et al. (2002) and validated for the Uzbek context through confirmatory factor analysis (CFI = 0.94, RMSEA = 0.06; α = 0.87). Subscales measured goal-setting, self-monitoring, and self-evaluation dimensions.

Learning logs: AIALL group participants completed structured weekly learning log entries documenting out-of-class technology use, challenges encountered, and self-assessed progress.

Semi-structured interviews: Sixteen participants (8 AIALL, 8 control) were interviewed at study conclusion regarding technology use patterns, perceived learning benefits, and autonomous study behavior.

3.5 Data Analysis

Quantitative data were analyzed using SPSS 27. ANCOVA controlled for pre-test vocabulary scores in between-group comparisons. Effect sizes (Cohen's d) were reported for all significant comparisons. Qualitative data were analyzed using reflexive thematic analysis (Braun & Clarke, 2006); learning log data underwent content analysis using a deductive coding framework derived from self-regulated learning theory.

4. Results

4.1 Vocabulary Acquisition

ANCOVA revealed a significant main effect of condition on post-test general vocabulary scores (VLT: $F(1,73) = 38.74$, $p < .001$, $\eta^2 = 0.35$; $d = 0.79$) and technical vocabulary scores (TVA: $F(1,73) = 41.12$, $p < .001$, $\eta^2 = 0.36$; $d = 0.83$). AIALL group participants demonstrated superior gains on both instruments, with notably stronger technical vocabulary advantages consistent with the domain-specific task design of the vocabulary platform sets.

Within-group analysis showed that AIALL participants' VLT scores increased from M = 24.3 (SD = 4.1) to M = 31.7 (SD = 3.8) — a gain of 7.4 words per 10-item level — compared to control group gains of 3.1 words (from M = 24.1, SD = 4.3 to M = 27.2, SD = 4.0). TVA gains paralleled this pattern: AIALL M gain = 12.4 items vs. control M gain = 5.8 items.

4.2 Learner Autonomy

Post-test LAQ scores were significantly higher in the AIALL group (M = 4.21, SD = 0.52) than the control group (M = 3.78, SD = 0.58) after covariate adjustment ($F(1,73) = 18.43$, $p < .001$, $d = 0.63$). Subscale analysis indicated the largest AIALL advantages on self-monitoring ($d = 0.71$) and goal-setting ($d = 0.68$) subscales, with a smaller but still significant effect on self-evaluation ($d = 0.48$).

4.3 Learning Log Analysis

Content analysis of 304 learning log entries (AIALL group, 8 entries per participant over 4 weeks) revealed that 87% of participants engaged with AIALL tools outside scheduled class time, with reported average out-of-class usage of 34 minutes per day. Five primary autonomous behavior categories emerged: deliberate vocabulary review (100% of participants), pronunciation self-testing (78%), personal goal-setting (61%), performance progress monitoring (73%), and reflective strategy adjustment (54%).

4.4 Qualitative Findings

Interview thematic analysis identified three dominant themes: (1) Immediacy of feedback — participants valued instant, non-judgmental corrective feedback as reducing performance anxiety while accelerating learning; (2) Personalization — adaptive difficulty adjustment was perceived as maintaining optimal challenge levels; (3) Expanded learning space — participants reported extending learning meaningfully beyond classroom boundaries, describing technology as enabling

learning "anytime, anywhere." One participant articulated: "Before, I only studied when teacher said. Now I study on the bus, before sleeping. The app tells me what I need to practice — I don't have to wait for class."

5. Discussion

The present findings demonstrate that systematic AIALL tool integration produces substantial gains in vocabulary acquisition (d = 0.79–0.83) and learner autonomy (d = 0.63) compared to conventional instruction, extending existing meta-analytic evidence (Klimova & Pikhart, 2021; Nakata, 2011) to the underexplored Uzbek technical college context.

Vocabulary gains appear attributable to multiple reinforcing mechanisms. SRS-based adaptive scheduling maximizes review efficiency by targeting items at optimal forgetting-curve intervals, while the instructor-curated technical vocabulary sets ensured domain-relevant lexical input aligned with participants' vocational learning needs (Hyland, 2006; Nation, 2001). The particularly large technical vocabulary effect (d = 0.83) suggests that digital platforms may be especially valuable for deliberate, spaced learning of low-frequency specialized lexis requiring extended exposure (Schmitt, 2008).

Learner autonomy gains are interpretable through both self-regulated learning (Zimmerman, 2002) and self-determination theory (Deci & Ryan, 1985) lenses. Platform analytics and personalized feedback appeared to scaffold the goal-setting and self-monitoring components of self-regulation, consistent with Reinders and White (2016). The structured weekly reflection protocol — designed to prevent passive, unreflective technology use (cf. Blin, 2004) — likely played a critical mediating role. This suggests that AIALL effectiveness depends not merely on tool availability but on pedagogical scaffolding supporting genuine metacognitive engagement.

Qualitative data illuminate the mechanisms underlying quantitative gains. The immediacy and non-evaluative nature of AI feedback appeared particularly significant in reducing the performance anxiety that commonly impedes EFL

learners' willingness to practice speaking (Horwitz et al., 1986). The extension of learning beyond classroom boundaries, documented through learning logs, represents a meaningful shift from teacher-directed to self-directed learning — a core indicator of developing autonomy (Holec, 1981; Little, 1991).

Placed within the SAMR framework (Puentedura, 2006), the AIALL integration in this study operated primarily at the Modification and Redefinition levels — enabling personalized adaptive learning trajectories and real-time pronunciation feedback that were previously inconceivable within the resource constraints of technical college instruction in Uzbekistan. This aligns with research associating higher SAMR levels with stronger learning outcomes (Hamilton et al., 2016).

Limitations: The single-institution design, self-reported learning log data, and 12-week timeframe limit generalizability. The absence of a delayed post-test limits conclusions regarding vocabulary durability. Future research should employ multi-site randomized designs, include delayed retention measures, and investigate teacher professional development as a moderating variable.

6. Conclusion

This study provides compelling evidence that systematic AI-assisted language learning tool integration, supported by structured metacognitive scaffolding, yields significant and practically meaningful improvements in EFL vocabulary acquisition and learner autonomy in technical college settings. The findings challenge assumptions that resource and infrastructure constraints in post-Soviet educational contexts preclude effective technology integration, demonstrating that mobile-accessible adaptive tools can transform learning opportunities when implemented with pedagogical intentionality. Teacher educators, curriculum developers, and policy makers in Uzbekistan and comparable contexts are encouraged to invest in AIALL integration frameworks alongside targeted digital literacy development for both instructors and learners.

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