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**RESEARCH ARTICLE**

# Spaced Repetition and Virtual Flashcards: Mobile-Assisted Language Learning (MALL) for English Vocabulary and Grammar

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**ABSTRACT**

With the advent of mobile learning technologies, there have been new opportunities for flexible and personalized language learning. This research investigates the efficacy of Spaced Repetition and Virtual Flashcards within a Mobile-Assisted Language Learning (MALL) setting to enhance English vocabulary and grammar among first-year Software Engineering students. Through a quasi-experimental mixed-methods design, 40 students were randomly placed in an experimental group (n=20) that used the Anki app daily over six weeks, and the control group (n=20) used conventional note-based learning. Vocabulary, grammar accuracy, and retention were measured via pre- and post-tests, learner perceptions through questionnaires and instructor evaluations assessed engagement and progress. Outcomes showed notable gains for the experimental group in vocabulary, grammar accuracy, and retention, particularly in low-frequency academic vocabulary and the use of more complex sentence structures. Learner feedback showed increased engagement, motivation, and autonomy among mobile flashcard users. These findings highlight the effectiveness of mobile-assisted spaced repetition tools in English for Specific Purposes (ESP) learning, and especially in those areas of study where the use of advanced academic English is needed.

## INTRODUCTION

The rise of mobile technology has changed our perspective towards the process of language learning paving the way to flexible, customized and accessible education (Kukulska-Hulme, 2009). With their potential of smartphones and tables, Mobile-Assisted Language Learning (MALL) builds an active, student-centered space that can be customized to cover a broad spectrum of student needs (Traxler, 2009). The paper immerses into the use of spaced repetition and digital flashcards in the context of a MALL approach that would improve English vocabulary and grammar knowledge in a group comprising first-year Software Engineering students. It is part of the English for Specific Purposes (ESP) sphere where learning of advanced academic English is not only the classroom objective but the considerations in the successful academic and professional life in the technical domain (Hyland, 2014). This study is performed through the application of the Anki app, a renowned spaced repetition software, to understand how mobile solutions can support the custom language skills of software engineering students, the success of whose lives is usually determined by their English language skills (Alrasheed et al., 2021).

Spaced repetition is a cognitive science supported learning method that monitoring the memorized data of the learners in the long-term, especially when they review at a spaced time interval to evaluate learning progress (Kang, 2016). Using virtual flashcards along with it makes it an effective way to build vocabulary effectively (Nakata, 2011). The running science involved in this strategy called the retrieval practice reveals that remembering what you have through the activity of recalling acts to enhance memory and escort improved results on learning (Karpicke & Roediger, 2008). Anki app gives us reification of those ideas, it is a diverse-friendly environment that seems to have a good balance between structure and flexibility that spurs involvement as well as independence (Godwin-Jones, 2011). Research surveys have been consistently showing that MALL methods are more effective than more traditional ones and a greater result leads to vocabulary and grammar

proficiency, which points out the paradigm revolutionizing ability of mobile tools in language learning (Burston, 2015). Also, there is a likelihood of mobile apps generating motivation and making the learner take greater control over the progress, which are essential with regard to perseverance with language learning in the long term (Dörnyei & Csizér, 1998).

The proposed research differs with this area in general language learning and concentrates on ESP, where a tailor instruction, has significant importance on meeting the needs of a particular field (Paltridge & Starfield, 2013). Among the software engineering students, technical, and academic fluency in English are essential in enabling them to comprehend complex writings, access professional communication, and excel in school works (Alrasheed et al., 2021). Paper-based methods such as note-taking are usually insufficient when it comes to the requirement of interactivity and adaptability, whereas mobile tools provide the required level of engagement and dynamism (Liaw, 2008). In recent past, there has been some emergence about the effectiveness of digital flash cards in the creation of specialized vocabulary, particularly in an educational environment where niche terms are prevalent (Koleini et al., 2024). In addition to that, mobile apps fit into established approaches to maintaining motivation among learners as pointed out in widely recognized studies on language learning methods (Oxford & Nyikos, 1989).

The other addition to this study is the contribution of gender in the usages of the technology by the students and their performance in language learning. Other studies indicate variations in participation levels with females regularly demonstrating a higher degree of regularity in the utilization of mobile technologies and males revealing more assurance in utilizing their abilities such as reciting vocabulary in the audible sound (Zhang et al., 2021; Koleini et al., 2024). These facts make it necessary to examine the relationship that learners have with MALL tools more closely. Instant feedback provided by apps (e.g. Anki) and individualized learning paths lead to an improved vocabulary practice (Stockwell, 2010). A comparison with behaviors of similar tools, such as Duolingo, would best be used to evaluate mobile-based learning, since it has been observed that behaviors of similar tools, such as Duolingo, demonstrate a proficient increase in language proficiency (Vesselinov & Grego, 2012).

This is a quasi-experimental study with a mixed-methods design that determines the effectiveness of Anki application in the area of vocabulary retention, grammar mastering, and attitude among students of software engineering. The focus on low-frequency words used in academic context and complex sentences organize a vacuum in the knowledge about the technology used by MALL to support technical education (Nation, 2001). The findings are likely to contribute to the existing range of studies focusing on mobile-assisted spaced repetition in ESP courses particularly in subjects that require a high degree of proficiency in English (Rafiq et al., 2021). This study responds to criticism to investigate long term effects of MALL and its possible implications in other areas of academics (Seibert Hanson & Brown, 2019). The prospect of digital flashcards has been emphasized more recently in studies that have evaluated the potential of such flashcards to increase engagement and retention when combined with spaced repetition (Teymouri, 2024). On a bigger scale, the study relates to changing faces of technology in language education, given the recent transformations that mobile devices are bringing to the pedagogical environment (Golonka et al., 2012; Chapelle, 2007). The emphasis on ESP and software engineering makes this study useful in providing practical directions to educators who would want to apply mobile technology in addressing language issues of specialized professions (Pyc & Rawson, 2010).

The goal of this research is to study the effect of Spaced Repetition and Virtual Flashcards, delivered through the Anki mobile application, on enhancing English vocabulary retention, grammatical accuracy, and learner motivation among first-year Software Engineering students in an English for Specific Purposes (ESP) context at University Metropolitan Tirana. This paper is organized as follows: the next section outlines the quasi-experimental mixed-methods design, describing participant recruitment, group allocation, and the materials and instruments used for data collection. The subsequent section reports quantitative findings from pre- and post-tests, instructor evaluations, and learner questionnaires, alongside qualitative insights from thematic analysis of open-ended responses. The discussion interprets these results in light of current Mobile-Assisted Language Learning (MALL) and ESP literature, addressing both pedagogical benefits and implementation challenges of adaptive spaced repetition. Recommendations for future research directions are provided. Finally, the paper concludes with a synthesis of key outcomes,

recommendations for integrating mobile-based spaced repetition into ESP curricula, strategies for equitable access and an extensive list of references for scholarly backing of this research.

# 1. METHODOLOGY

## 1.1 Research Design

The study followed a quasi-experimental mixed-methods design to measure the effect of Spaced Repetition and Virtual Flashcards in a Mobile-Assisted Language Learning (MALL) environment on English vocabulary and grammar learning. Forty first-year Software Engineering students at University Metropolitan Tirana were randomly assigned to an experimental group (n=20), which used the Anki app daily for six weeks, and a control group (n=20), which used traditional note-based learning. The effectiveness of the training was measured by quantitative means, through pre- and post-tests for vocabulary, grammar accuracy, and retention, as well as structured learner questionnaires evaluating motivation, autonomy, and engagement. Instructor ratings provided quantitative measures of student progress and engagement. Qualitative content analysis of open-ended questionnaire responses was employed to examine learners' perceptions and experiences. The mixed-methods approach generated a comprehensive picture of how mobile-assisted spaced repetition apps facilitate ESP vocabulary acquisition, grammatical accuracy, retention, and learner motivation.

## 1.2 Participants

The 40 students were randomly assigned to two groups:

- Experimental Group (n = 20): These students used the Anki mobile application daily, following a spaced repetition schedule to review ESP vocabulary and grammar materials related to software engineering.
- Control Group (n = 20): These students used conventional printed notes with the same vocabulary and grammar content with neither spaced repetition nor interactive technology.

All participants were enrolled in the first year of the Software Engineering degree at University Metropolitan Tirana, where admission requires a minimum English proficiency level of B1 according to the Common European Framework of Reference for Languages (CEFR).

## 1.3 Materials

### 1.3.1 Anki Virtual Flashcard Deck

A custom deck of 300 flashcards was created, with 200 cards devoted to ESP vocabulary words, low-frequency academic words as they relate to software engineering and 100 grammar cards in areas of sentence structure, use of tenses, conditionals, and syntax. Adaptive scheduling of reviews intervals by the Anki application ensured that reviews were made possible through authentic spaced repetition, depending on the performance of the learner.

### 1.3.2 Printed Notes

The control group was given printed vocabulary lists and grammar explanations, compared to flashcards with identical content but there were no adaptive features to the mobile application.

### 1.3.3 Pre- and Post-Tests

Two parallel tests were created to measure vocabulary knowledge (such as word meaning, collocations, and usage in context) and grammatical accuracy (such as sentence transformations and error corrections). Retention was operationalized as the proportion of correct responses in the post-test relative to the maximum possible score, indicating the extent to which vocabulary and grammar knowledge was retained immediately after the intervention. Both tests were validated by ESP professionals in terms of the relevance of their content and the appropriateness of the level of language.

### 1.3.4 Questionnaires and Instructor Evaluation Rubrics

The learner questionnaire contained Likert-scale and open-ended items for engagement, motivation, autonomy, and perceived learning benefits. Instructor ratings were conducted by three instructors, who individually used constructed rubrics to assess students' engagement and progress throughout

the coursework, observing richness in vocabulary, grammatical elements, and utilization of complex sentence forms.

### 1.4 Procedure

#### 1.4.1 Phase 1 – Pre-Test Administration

The pre-tests of vocabulary and grammar were taken by all the participants in order to identify baseline competency.

#### 1.4.2 Phase 2 – Six-Week Intervention

- Experimental Group: Utilized Anki app for 20-30 minutes per day, going through vocabulary and grammar cards with an algorithm of spaced repetition.
- Control Group: Learned from same materials through printed notes without scheduled repetition or interactive review.

#### 1.4.3 Phase 3 – Post-Test and Feedback Collection

After six weeks, participants completed the post-tests. Questionnaires were used to obtain impressions from learners, and instructors' assessments were made using constructed rubrics.

### 1.5 Data Collection

This study obtained data through:

- Pre- and post- assessment tests analyzing vocabulary knowledge, grammar accuracy, and retention of both vocabulary and grammar.
- Learner questionnaires evaluating the motivational and engagement metrics, as well as autonomy and self-directed learning during the intervention.
- Instructor feedback documented students' progress and engagement in coursework, with ratings collected from multiple instructors and averaged to provide quantitative measures of learner performance and involvement.

### 1.6 Data Analysis

Both quantitative and qualitative data were gathered and examined to provide a clear and comprehensive view of the effect of the implemented intervention.

- Quantitative Analysis: Descriptive comparison of pre- and post- test scores of both groups with respect to mean scores, improvement points, and percentage increases in vocabulary knowledge, grammar accuracy, and retention for both vocabulary and grammar was done. This facilitated direct comparison of academic vocabulary acquisition, grammar learning, and knowledge retention between the experimental and control groups. Learners' self-reported motivation, autonomy, and engagement were examined through analysis of the questionnaire data using descriptive statistics. The data analyzed by instructors concerns the engagement and progress of the students based on vocabulary richness, grammatical accuracy, and use of complex sentence structures.
- Qualitative Analysis: Open-ended responses of learners were coded thematically and examined to determine prominent themes regarding motivation, autonomy, engagement, and perceptions of learning effectiveness. Quantitative results were complemented by qualitative analysis through the provision of additional insight into learners' experience with the mobile-supported learning environment.

### 1.7 Ethical Considerations

In conducting this study, ethical regulations of research involving human participants were strictly followed. Prior to the study, all participants gave their informed consent. Confidentiality and anonymity were protected in all information collected. Ethics approval was authorized by the ethics committee at University Metropolitan Tirana.

## 2. RESULTS

This section reports the findings of the quasi-experimental mixed-methods study investigating the effects of Spaced Repetition and Virtual Flashcards through the Anki app, versus learning from notes in the traditional manner, on the English vocabulary and grammar learning of first-year Software Engineering students at University Metropolitan Tirana. Data were collected from experimental and control groups through pre- and post-tests, learner questionnaires, and instructor evaluations.

### 2.1 Pre- and Post-Test Performance on Vocabulary and Grammar

#### 2.1.1 Vocabulary Knowledge

The vocabulary tests evaluated the knowledge of specialized software engineering terms, especially the low-frequency academic vocabulary targeting collocations and the usage in the context. There was an improvement observed in both groups following the six weeks of intervention, but higher gains indicated in the experimental group (University Metropolitan Tirana, 2025).

**Table 1. Vocabulary Test Scores and Improvement (University Metropolitan Tirana, 2025)**

| Group | Pre-Test Mean | Post-Test Mean | Improvement Points | Improvement % |
|---|---|---|---|---|
| Experimental (Anki) | 56.8 | 77.2 | 20.4 | 35.9% |
| Control (Printed) | 57.1 | 64.8 | 7.7 | 13.5% |

These results show that the adaptive spaced repetition mechanism combined with interactive virtual flashcards significantly supported vocabulary acquisition, namely learning low-frequency academic vocabulary in software engineering (University Metropolitan Tirana, 2025).

#### 2.1.2 Grammar Accuracy

Grammar tests focused on sentence structure, tense, conditionals, and syntactic accuracy. The experimental group demonstrated greater improvements than the control group (University Metropolitan Tirana, 2025).

**Table 2. Grammar Test Scores and Improvement (University Metropolitan Tirana, 2025)**

| Group | Pre-Test Mean | Post-Test Mean | Improvement Points | Improvement % |
|---|---|---|---|---|
| Experimental (Anki) | 54.2 | 70.3 | 16.1 | 29.7% |
| Control (Printed) | 54.5 | 60.7 | 6.2 | 11.4% |

These findings show that adaptive schedule of reviewing provided by the Anki app facilitates more efficient version of learning and applying the grammatical rules than traditional methods of study.

### 2.2 Retention of Vocabulary and Grammar

Retention was scored as a percentage of correct responses on the post-test to the highest possible core, showing immediate retention after the six-week treatment. No delayed retention test was administered. The experimental group had both vocabulary and grammar higher retention centages than the control group (University Metropolitan Tirana, 2025) (see Fig. 1).

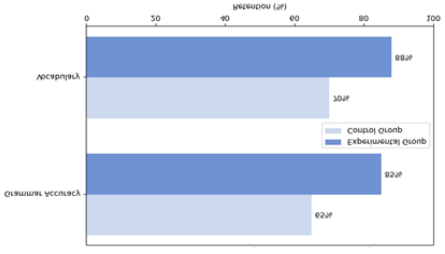

**Fig. 1. Retention of Vocabulary and Grammar Accuracy (University Metropolitan Tirana, 2025)**

These results indicate the effectiveness of the adaptive spaced repetition system in promoting initial vocabulary retention of specialized terms, specifically low-frequency words of an academic nature, as well as grammatical knowledge.

### 2.3 Instructor Evaluations of Student Progress

Three instructors independently assessed students' vocabulary richness, grammaticality, use of complex sentence structures, and learner participation on a 5-point Likert scale (1 = Low, 5 = High). These were then calculated as the mean to provide quantitative measures of learner performance and engagement (see Table 3).

**Table 3. Instructor Ratings of Student Performance and Engagement (University Metropolitan Tirana, 2025)**

| Evaluation Criteria | Experimental Group Mean | Control Group Mean |
|---|---|---|
| Vocabulary Richness | 4.4 | 3.5 |
| Grammar Accuracy | 4.2 | 3.3 |
| Use of Complex Sentences | 4.1 | 3.2 |
| Learner Engagement | 4.3 | 3.1 |

Instructors reported that the experimental group demonstrated more confidence and accuracy in the use of technical vocabulary, including low-frequency academic vocabulary and complex grammatical structures, and more engagement with coursework (University Metropolitan Tirana, 2025).

### 2.4 Learner Questionnaire: Motivation, Autonomy, and Engagement (Comparison between Groups)

Upon completion of intervention, students completed a 10-item Likert-scale questionnaire (1 = Strongly Disagree, 5 = Strongly Agree) measuring motivation, autonomy, engagement, and perceived learning benefits related to their respective study methods.

**Table 4. Learner Questionnaire Results (University Metropolitan Tirana, 2025)**

| Nr. | Survey Item | Experimental Mean | Control Mean | Mean Difference |
|---|---|---|---|---|
| 1. | I felt motivated to continue learning English using the method. | 4.5 | 3.4 | 1.1 |
| 2. | The method helped me remember vocabulary better. | 4.6 | 3.2 | 1.4 |
| 3. | I was able to study independently and manage my own learning. | 4.3 | 3.1 | 1.2 |
| 4. | The method made learning grammar easier. | 4.2 | 3.0 | 1.2 |
| 5. | I enjoyed the learning process. | 4.4 | 3.5 | 0.9 |
| 6. | I feel confident using newly learned vocabulary in context. | 4.4 | 3.3 | 1.1 |
| 7. | I am comfortable applying grammar rules when writing. | 4.1 | 3.1 | 1.0 |
| 8. | I found it easier to learn when I controlled the pace. | 4.5 | 2.9 | 1.6 |
| 9. | The method helped me stay engaged throughout the study period. | 4.3 | 3.0 | 1.3 |
| 10. | I believe this method improves my overall English skills. | 4.5 | 3.4 | 1.1 |

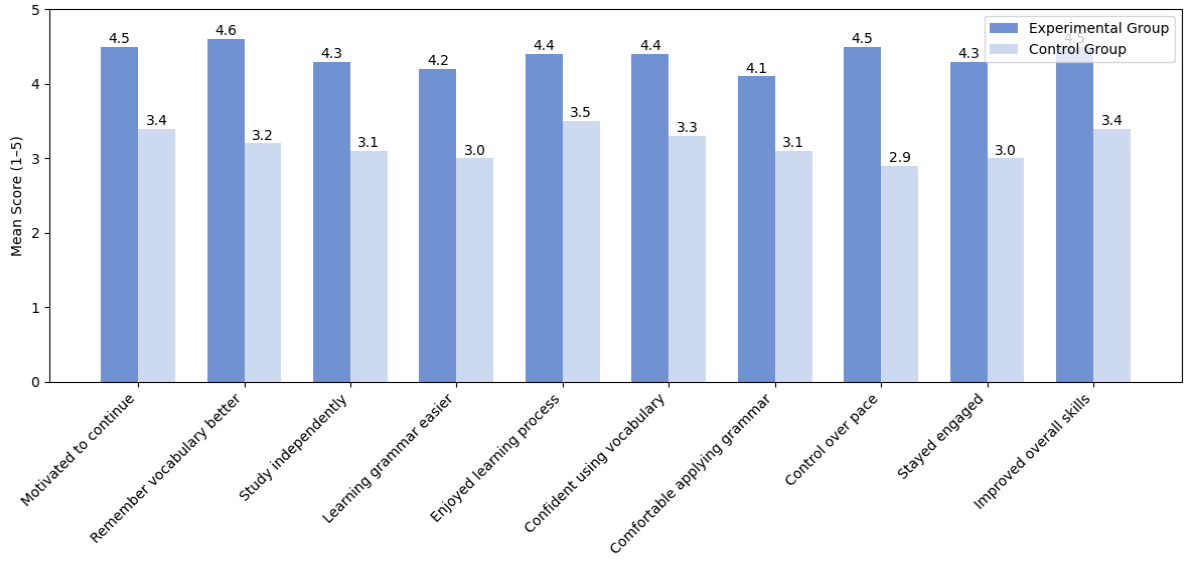


**Fig. 2. Learner Questionnaire Results (University Metropolitan Tirana, 2025)**

The experimental group also constantly reported higher levels of motivation, autonomy, and interest than the control group, with mean differences ranging between 0.9 to 1.6 (see Fig. 2). Students most notably referred to the flexibility and personalized control over their study pace afforded by the mobile-assisted approach, contributing to a more positive and autonomous learning experience (University Metropolitan Tirana, 2025).

### 2.5 Analysis of Open-Ended Responses

Students' open-ended responses were systematically analyzed using thematic coding to identify patterns recurring in relation to the learning experience. Three prominent themes emerged from the data:

#### 2.5.1 Enhanced Vocabulary Retention and Recall

Participants consistently reported that the regular, spaced repetition practice facilitated by the app helped consolidate their understanding and long-term retention of specialized technical vocabulary, particularly low-frequency academic terms. Many participants highlighted the benefit of observing a word appear repeatedly several times, which reinforced memory and build confidence in use (University Metropolitan Tirana, 2025).

*Illustrative Quotes:*

- “Using the flashcards every day really helped me remember new words and see my progress.” — Female participant, age 19.
- “I found that reviewing the same terms repeatedly helped me recall them faster during class discussions.” — Male participant, age 20.

#### 2.5.2 Increased Motivation and Autonomy

Students valued the convenience of the app, being able to study at home of their own initiative. They equated this independence with increased motivation and improved attitude towards study as they could plan their study timetables in relation to other activities. Several participants reported feeling more in charge of their own learning (University Metropolitan Tirana, 2025).

*Illustrative Quotes:*

- “I liked that I could study whenever I wanted and control the pace, which kept me motivated.” — Male participant, age 18.
- “The app gave me freedom to manage my learning time, which made me want to keep improving.” — Female participant, age 18.

#### 2.5.3 Improved Grammar Application

Repeated engagement with grammar flashcards could make learners better recognize patterns, grammatical structures and hence more self-aware of and correct errors in speech and writing. This

practice was reported to leave participants more self-assured to apply grammar rules correctly in real-life settings (University Metropolitan Tirana, 2025).

*Illustrative Quotes:*

- "The grammar cards made me aware of errors I didn't notice before, helping me write more correctly." — Female participant, age 18.
- "Going over grammar exercises multiple times made it easier to remember rules and avoid mistakes." — Male participant, age 19.

The findings indicate that integrating spaced repetition and virtual flashcards through a mobile-assisted platform significantly improves the vocabulary, grammar accuracy, and retention, including low-frequency academic vocabulary, as well as learner motivation and engagement in an ESP context for software engineering students. The experimental group performed better than the control group on all quantitative measures, instructor feedback, and consistently in self-reported learner outcomes, demonstrating the pedagogical value of adaptive mobile-assisted language learning tools.

## 3. DISCUSSION

This study demonstrated that mobile-assisted spaced repetition via the Anki app significantly enhanced vocabulary and grammar learning over traditional note-taking instruction. This result aligns with research in mobile-assisted language learning (MALL) that show how mobile technology allows learners to have individualized, flexible, and context-aware learning experiences (Viberg & Grönlund, 2012). Central to Anki's effectiveness is its adaptive scheduling algorithm, which optimizes review timing to occur just before forgetting, enhancing durable memory consolidation, a principle supported by cognitive theories emphasizing spaced exposure and repetition in second language acquisition (Laufer, 2005), (Schmitt, 2008). This approach is especially advantageous in English as a Specific Purpose (ESP) language contexts where learning low-frequency academic wording and complicated grammatical syntax could place serious mental loads on a learner that spaced repetition delivers some relief.

Anki app was specially selected to be used in this study because of its popularity among language learners and educators, its user-friendly interface, and its highly customization. Unlike several other spaced-repetition applications, Anki allows the use of multimedia (images, audio, and video), enabling richer and more engaging learning materials. It also has an offline mode where the learners are able to study anytime without the internet that is very essential in diverse learning situations. These features, along with the strong adaptive scheduling system, make Anki particularly appropriate when being tested in mobile-assisted language learning in targeted environments such as ESP.

The level of learner autonomy and motivation was also very high in the experimental group which can be explained by the results of questionnaires with higher rating of learner motivation (4.5 vs. 3.4) and involvement (4.3 vs. 3.0). The findings support the self-determination theory, which states that addressing learners' needs for autonomy, competence, and relatedness generates intrinsic motivation and enduring engagement (Deci & Ryan, 2000). The flexibility of Anki on the mobile platform, as well as the multimedia aspect and creation of user-specific decks, enables learners to gain agency in their study behaviors, which has a reinforcing effect on self-directed learning and intrinsic motivation (Viberg & Grönlund, 2012). These results were supported by the instructor feedback where the ratings of vocabulary richness (4.4 vs. 3.5) and engagement of the learners (4.3 vs. 3.1) are higher, which proves that the enhancement of the linguistic competence leads to the growth of the confidence experienced by the learners.

Despite these strengths, challenges remain. Continuous access to devices and reliable internet connectivity—especially during the initial app setup, may limit implementation in under-resourced environments. Although Anki's offline functionality mitigates ongoing connectivity needs, ensuring equitable access requires proactive institutional support. Potential measures include device lending programs, provision of pre-loaded content on portable media, and printed supplementary materials to accommodate different access levels (Garrison & Vaughan, 2008). Furthermore, reduced face-to-

face interaction inherent in mobile-assisted environments may limit opportunities for nuanced conceptual discussions and personalized feedback. To counter this, blended learning models that combine mobile-assisted spaced repetition with instructor-led sessions and peer collaboration offer valuable scaffolding and deeper cognitive engagement (Garrison & Vaughan, 2008).

While this study focused on immediate post-intervention retention, future studies should examine the long-term durability of vocabulary and grammar gains and investigate learners' sustained engagement with mobile tools beyond formal instruction. Comparative studies exploring different spaced repetition algorithms and platforms could clarify whether Anki's unique features confer distinct advantages or if similar benefits can be realized with alternative technologies (Viberg & Grönlund, 2012). Expanding research across diverse ESP domains and educational contexts would furthe help establish best practices for integrating adaptive mobile learning tools.

From a policy and curriculum perspective, embedding adaptive tools like Anki within formal ESP programs offers a scalable, efficient method to enhance language proficiency without extending classroom hours (Garrison & Vaughan, 2008). Curriculum designers and policymakers should consider blended learning frameworks that integrate mobile-assisted spaced repetition with targeted instructor support. Moreover, equitable access initiatives, such as device lending, offline resource distribution, and digital literacy workshops, are essential to maximize the reach and impact of these technologies (Garrison & Vaughan, 2008). By adopting such comprehensive strategies, educational institutions can harness the full potential of adaptive mobile technologies while addressing practical challenges faced by learners.

## 4. CONCLUSION

The integration of the Anki spaced repetition system as a routine component of ESP instruction demonstrably enhances vocabulary and grammar acquisition compared to traditional note-taking methods. Personalized review schedules based on learner performance promote efficiency, autonomy, and motivation, critical factors in adult language learning success. Challenges such as initial device access and reduced instructor contact can be mitigated through institutional support and blended learning approaches.

The implications extend beyond individual classrooms. Strategically incorporating mobile-assisted spaced repetition tools into curriculum design can transform specialized language learning, particularly in contexts with limited time and resources. By aligning adaptive technology with equitable access policies and robust pedagogical support, educational institutions can develop sustainable and scalable models that improve language learning outcomes for diverse learner populations.

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