

Research paper

Mobile-Assisted Language Learning (MALL) and its Effectiveness in Enhancing Vocabulary Acquisition

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Abstract

This study investigates the effectiveness of Mobile-Assisted Language Learning (MALL) in enhancing vocabulary acquisition among second language learners. Employing a mixed-methods approach, the research combined quantitative assessments of vocabulary gains with qualitative insights into learner experiences. A sample of 60 intermediate-level learners was divided into an experimental group, which utilized MALL applications (e.g., Duolingo, Quizlet) for eight weeks, and a control group, which engaged in traditional classroom-based instruction. Quantitative data from pre- and post-tests revealed a statistically significant improvement in vocabulary retention within the MALL group, with a moderate effect size (Cohen's $d = 0.45$), outperforming the control group. Qualitative analysis of surveys and interviews highlighted key advantages of MALL, including personalized pacing, interactive exercises, instant feedback, and heightened learner motivation. However, challenges such as digital distractions, uneven internet access, and occasional technical barriers were also reported. The findings suggest that MALL serves as a valuable complement to conventional methods, particularly by fostering engagement and autonomy. This study advocates for a blended pedagogical approach that integrates mobile technologies while addressing infrastructural and instructional limitations. Implications for educators, app developers, and policymakers are discussed, alongside recommendations for future research on long-term retention and MALL's efficacy across diverse learner demographics.

Keywords: Language learning, Learner autonomy, Mobile-assisted language learning (MALL), Vocabulary acquisition.

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Introduction

In the contemporary educational landscape, the integration of mobile technologies has redefined pedagogical approaches, offering unprecedented opportunities for flexible and personalized learning experiences. Mobile-Assisted Language Learning (MALL) has emerged as a prominent paradigm within this digital transformation, leveraging the ubiquity of mobile devices to facilitate language acquisition beyond the confines of traditional classroom settings (Ji & Aziz, 2021; Regina & Devi, 2022). The exponential growth of mobile applications has not only expanded access to language learning resources but also fostered dynamic, context-rich interactions that challenge conventional instructional norms (Kukulska-Hulme & Bull, 2009; Sakkir & Syamsuddin, 2023). This shift is particularly significant in the domain of vocabulary acquisition, a cornerstone of language proficiency that underpins communicative competence and linguistic fluency (Fernando, 2022; Mijan & Hashim, 2023).

Vocabulary mastery remains a persistent challenge for second language learners, often hindered by contextual variability and the limitations of traditional rote memorization techniques (Fernando, 2022; Mijan & Hashim, 2023). MALL presents a compelling alternative by providing learners with repetitive exposure, contextual reinforcement, and interactive engagement—features essential for long-term retention (Fernando, 2022; Regina & Devi, 2022). Empirical evidence suggests that MALL can significantly enhance vocabulary retention and overall language competence, with studies demonstrating its potential to outperform conventional methods through personalized pacing and multimedia resources (Hashemifardnia et al., 2020; Mijan & Hashim,

2023; Sakkir & Syamsuddin, 2023; Seif & Najafi Sarem, 2024). However, the effectiveness of MALL is not without contention, as research reveals mixed outcomes, with some studies citing substantial gains while others point to challenges such as digital distractions and infrastructural disparities (Fu, 2021; Metruk, 2020).

Despite its promise, the literature reveals a critical gap: a lack of comprehensive studies that integrate quantitative measures of vocabulary retention with qualitative insights into learners' experiences within MALL frameworks. This paucity underscores the need for a nuanced evaluation of MALL's impact, one that accounts for both its measurable outcomes and the subjective perceptions of learners. The present study addresses this gap by adopting a mixed-methods approach to investigate the effectiveness of MALL in enhancing vocabulary acquisition among second language learners. Specifically, it seeks to bridge the divide between empirical outcomes and experiential dimensions, offering a holistic perspective on MALL's role in language education.

The primary objective of this research is to evaluate the efficacy of MALL in improving vocabulary acquisition among second language learners. The study pursues the following specific aims:

1. To compare the vocabulary retention rates of learners using MALL applications with those engaged in traditional classroom instruction.
2. To investigate learners' attitudes, motivation, and perceived efficacy regarding MALL as a tool for vocabulary learning.
3. To identify the challenges and limitations associated with implementing MALL in diverse educational settings.

By addressing these objectives, this research aims to elucidate how MALL can optimize vocabulary acquisition while mitigating its inherent drawbacks. Through this investigation, the study seeks to contribute to the growing body of knowledge on MALL, providing evidence-based recommendations for educators, app developers, and policymakers to enhance language learning outcomes in the digital age. The findings are expected to inform pedagogical practices that harmonize the strengths of mobile technologies with traditional methods, fostering a blended approach that maximizes learner engagement and proficiency.

Literature Review

Mobile-assisted language learning has emerged as a transformative approach in second language education, leveraging the portability, connectivity, and interactivity of mobile devices to enhance vocabulary acquisition among learners. This literature review synthesizes theoretical foundations, empirical evidence, and practical implications from existing research, highlighting MALL's effectiveness, its benefits, challenges, and pedagogical recommendations.

Emergence and Theoretical Foundations of MALL

MALL represents a significant evolution from computer-assisted language learning (CALL) to a more flexible, learner-centered paradigm enabled by the widespread adoption of smartphones and improved internet connectivity (Ji & Aziz, 2021; Regina & Devi, 2022). This shift has moved language instruction from traditional, teacher-centered methods to environments that foster autonomy and engagement (Ali et al., 2019; Nurhayati & Suryaman, 2024). The theoretical underpinnings of MALL are rooted in socio-cognitive, constructivist, and self-directed learning theories, which emphasize active learner involvement, contextualized practice, and the supportive

role of technology in scaffolding learning tasks (Ji & Aziz, 2021; Regina & Devi, 2022; Yue, 2022). These frameworks suggest that mobile devices facilitate meaningful communication, personalized feedback, and self-paced learning, aligning with principles of learner autonomy critical for vocabulary acquisition (Jeong, 2022; Lai et al., 2013).

Empirical Evidence on MALL's Effectiveness

A robust body of empirical research supports MALL's efficacy in enhancing vocabulary acquisition. Systematic reviews and meta-analyses have consistently demonstrated significant improvements in vocabulary retention and recall. For instance, Ji and Aziz (2021) found that mobile platforms significantly enhance vocabulary retention, a finding echoed by Yue (2022), who highlighted the benefits of ubiquitous access to linguistic content. A meta-analysis by Hao et al. (2021) reported a large effect size for technology-assisted vocabulary learning compared to traditional methods, while Lin and Lin (2019) noted substantial positive effects across 33 studies, moderated by factors like treatment duration and learner autonomy. Specific studies, such as those by Fernando (2022) and Ahmad et al. (2017), documented statistically significant vocabulary gains with moderate to large effect sizes, reinforced by quantitative pre- and post-testing methodologies (Chen et al., 2019; Zhou et al., 2023). Qualitative data from learner surveys further corroborate these findings, emphasizing the engaging nature of MALL (Vega et al., 2023; Wiyati & Amelia, 2022).

Learner Engagement and Motivation

MALL enhances learner motivation and engagement through interactive features such as gamification, personalized feedback, and adaptive instruction. Applications like Duolingo and

Quizlet incorporate challenges, points, and rewards, transforming vocabulary learning into an enjoyable activity (Fernando, 2022; Javady, 2022; Risnawati et al., 2023; Wiyati & Amelia, 2022). These gamified elements sustain learner interest and encourage daily practice, as noted in studies by Moodley et al. (2015) and Fahmy & Ghoneim (2011). Personalized pacing and instant feedback further promote self-monitoring and motivation, with learners reporting high satisfaction and perceived efficacy (Nurhayati & Suryaman, 2024; Viberg & Grönlund, 2013). The interplay between engagement and motivation is critical, as it correlates directly with improved vocabulary retention (Amīn et al., 2021; Yang, 2017).

Technological Approaches and Features

MALL applications leverage diverse technological tools to enhance vocabulary learning. Digital flashcards, supported by spaced repetition and gamification, promote long-term retention and engagement (Teymouri, 2024). Multimodal glossing and visual aids, as explored by Chen et al. (2019) and Al-Sabbagh (2023), strengthen vocabulary retention by engaging multiple cognitive channels. Features like interactive exercises, digital storytelling, and learning analytics provide tailored experiences that address individual learner needs (Fernando, 2022; Ji & Aziz, 2021; Regina & Devi, 2022). These innovations, combined with user-friendly interfaces, reduce cognitive load and enhance the learning experience (Perez-Sanagustín et al., 2014; Wiyati & Amelia, 2022).

Challenges and Limitations

Despite its benefits, MALL faces several challenges. Digital distractions from notifications or multitasking, technical issues such as app malfunctions, and unreliable internet connectivity can

disrupt learning (Agbo, 2023; Fernando, 2022; Wiyati & Amelia, 2022). Equity of access remains a concern, particularly in regions with limited technological infrastructure, potentially disadvantaging some learners (Helwa, 2017; Sun et al., 2024). Additionally, the varying quality of mobile applications necessitates careful selection to ensure pedagogical soundness (Ledy et al., 2023; Rahman & Iwan, 2019). These barriers highlight the need for strategic design and implementation to maximize MALL's effectiveness.

Pedagogical Implications and Blended Learning

The literature advocates for integrating MALL into language curricula as a complement to traditional methods, creating a blended learning environment (Regina & Devi, 2022; Wang & Gunaban, 2023; Yu et al., 2022). This approach combines the flexibility and personalization of mobile tools with the structure of classroom instruction, enhancing vocabulary acquisition through contextualized practice and guided feedback (Muxtorjonovna, 2020; Xiao & Jiang, 2023). Innovative strategies like digital storytelling and collaborative learning further enrich MALL interventions (Morchid, 2020; Wiyati & Amelia, 2022). Educators are encouraged to provide guidance on effective use, leverage learning analytics for tailored instruction, and address distractions to optimize outcomes (Ji & Aziz, 2021; Maulina et al., 2022).

In summary, MALL offers significant advantages for vocabulary acquisition, providing flexible, engaging, and personalized learning experiences that improve retention and recall (Fernando, 2022; Ji & Aziz, 2021; Regina & Devi, 2022; Wiyati & Amelia, 2022; Yue, 2022). However, challenges such as digital distractions, technical barriers, and access inequities must be addressed to fully realize its potential (AM et al., 2022; Nida, 2023). Future research should explore long-term retention effects, psychological factors like motivation and self-efficacy, and

MALL's applicability across diverse learner demographics (Chaoping et al., 2024; Mujiono, 2023; Zhang et al., 2018). By integrating MALL thoughtfully into blended frameworks and addressing infrastructural limitations, educators and policymakers can enhance language learning outcomes, making MALL a vital tool in contemporary education (Liu & Long, 2017; Obari & Lambacher, 2014).

Methodology

This study employed a mixed-methods, quasi-experimental design to rigorously evaluate the effectiveness of MALL in enhancing vocabulary acquisition among second language (L2) learners. The selection of this research design was deliberate, aiming to combine the strengths of quantitative and qualitative approaches to provide a multifaceted analysis of MALL's pedagogical impact. Quantitative assessments measured tangible vocabulary gains, while qualitative insights illuminated learners' subjective experiences, perceptions, and challenges. This integrated framework allowed for a comprehensive exploration of how MALL influences vocabulary learning compared to traditional methods. The quasi-experimental aspect involved comparing an experimental group, which utilized MALL applications, with a control group, which received conventional classroom instruction. Both groups underwent pre- and post-intervention assessments to track changes in vocabulary knowledge and to determine the relative efficacy of the two instructional modalities over the study period.

Participants

The study involved a total of 60 intermediate-level L2 learners, aged between 18 and 25, recruited from a reputable language institute specializing in second language education. Participant

selection was based on their proficiency levels, which were objectively assessed using the Oxford Placement Test, a widely recognized standardized tool designed to measure language competence. This ensured that all participants possessed a comparable intermediate proficiency, providing a consistent baseline for the intervention. To enhance the study's internal validity and minimize selection bias, participants were randomly assigned to one of two groups: the experimental group ($n = 30$), which engaged with MALL tools, or the control group ($n = 30$), which followed traditional classroom-based instruction. Randomization was conducted using a computer-generated allocation sequence, ensuring equitable distribution of demographic characteristics and prior vocabulary knowledge across groups. Baseline equivalence was further confirmed through pre-test scores, which demonstrated no significant differences in vocabulary proficiency between the two groups prior to the intervention, thus establishing a solid foundation for subsequent comparisons.

Intervention

The intervention spanned an eight-week period, during which the experimental and control groups were exposed to distinct instructional approaches, each carefully structured to ensure equivalent time commitment and learning opportunities, differing only in delivery mode.

Experimental Group: Participants in the experimental group utilized two prominent MALL applications—Duolingo and Quizlet—for 25 to 30 minutes daily. These tools were selected based on their evidence-based features tailored to vocabulary acquisition. Duolingo offers a gamified learning environment with interactive exercises, adaptive difficulty levels, and spaced repetition algorithms, all of which are designed to enhance engagement and long-term retention of lexical items. Quizlet, meanwhile, provides digital flashcards, customizable quizzes, and collaborative

learning options, enabling learners to personalize their study routines. Daily activities included interactive flashcards for word recognition, gamified quizzes to test comprehension and recall, and spaced repetition exercises to reinforce memory. The applications also provided instant feedback on performance and progress tracking, allowing learners to monitor their development and adjust their efforts accordingly. This adaptive, technology-driven approach aligns with contemporary theories of self-regulated learning and motivation in language education.

Control Group: In contrast, the control group received traditional, non-digital instruction for an equivalent duration of 25 to 30 minutes daily. This consisted of structured, teacher-led activities rooted in conventional pedagogical practices. Learners engaged in textbook-based exercises, such as matching words to definitions and completing cloze passages, alongside vocabulary drills facilitated by instructors through oral repetition and contextual usage. Weekly in-class assessments, including written quizzes and oral recitations, were administered to reinforce retention and provide feedback. These activities mirrored the experimental group's time commitment but relied solely on analog resources and direct teacher interaction, offering a baseline against which to evaluate MALL's effectiveness.

By maintaining parity in duration and focus, the intervention design ensured that any observed differences in outcomes could be attributed to the instructional modality rather than disparities in exposure or effort.

Quantitative Data Collection and Analysis

Vocabulary acquisition was quantitatively assessed using parallel pre- and post-tests, each consisting of 40 items that combined multiple-choice questions and fill-in-the-blank exercises. These tests were meticulously developed to measure the retention of target words introduced

during the intervention, selected for their relevance to the learners' intermediate proficiency level and alignment with the curriculum's lexical objectives. The target vocabulary comprised high-frequency words commonly encountered in intermediate L2 contexts, ensuring ecological validity. Test reliability was established through pilot testing with a comparable learner population, yielding a Cronbach's alpha of 0.82, which indicates strong internal consistency and supports the instruments' dependability.

Data analysis proceeded in two phases. First, paired t-tests were conducted to evaluate within-group improvements, comparing pre- and post-test scores for each group separately to determine the extent of vocabulary gains over the intervention period. Second, independent t-tests were used to assess between-group differences, comparing the post-test scores of the experimental and control groups to ascertain whether MALL yielded superior outcomes. To provide a deeper understanding of the practical significance of these findings, effect sizes were calculated using Cohen's d, quantifying the magnitude of any differences observed. Statistical significance was established at a threshold of $p < 0.05$, ensuring robust conclusions about the reliability of the results. This analytical approach allowed for a clear delineation of both the individual progress within each group and the comparative effectiveness of MALL versus traditional instruction.

Qualitative Data Collection and Analysis

To complement the quantitative findings, qualitative data were gathered post-intervention to explore learners' perceptions of their experiences with either MALL or traditional instruction. All 60 participants completed open-ended surveys, which included carefully crafted questions designed to elicit detailed reflections on usability, motivation, and any challenges encountered. Additionally, semi-structured interviews were conducted with a purposefully selected subset of 15

participants, representing a cross-section of experiences from both the experimental and control groups. Selection for interviews was based on survey responses, ensuring diversity in perspectives—ranging from highly engaged learners to those reporting difficulties—to capture a broad spectrum of insights.

The surveys and interviews targeted key themes, including learner engagement, perceived autonomy, and technical or pedagogical barriers. Sample questions included: “How did the learning method influence your motivation to study vocabulary?” and “What challenges, if any, did you face in using the assigned approach?” Responses were analyzed using thematic analysis, following an iterative coding process as outlined by Koowuttayakorn and Taylor (2022). Initial codes were generated from the data (e.g., “personalized pacing,” “digital distractions”), then refined into broader themes through repeated review and discussion among the research team. This method provided a nuanced understanding of how learners perceived the usability of MALL tools versus traditional methods, as well as the motivational and practical implications of each approach, enriching the study’s overall findings.

Ethical Considerations

The study adhered strictly to ethical guidelines governing research with human participants, prioritizing participant welfare and data integrity. Participation was entirely voluntary, and informed consent was secured from all individuals prior to their involvement. During the consent process, participants were thoroughly briefed on the study’s purpose, procedures, potential benefits, and their unconditional right to withdraw at any point without repercussions. To safeguard privacy, all data were anonymized by replacing personal identifiers with unique codes, and confidentiality was maintained throughout the research process, from data collection to

reporting. Findings were presented in aggregate form to prevent the identification of individual respondents.

The intervention posed minimal risk, as it involved standard educational practices, but contingency measures were in place to address any technical difficulties (e.g., app malfunctions) or discomfort reported by participants. These steps ensured that the study was conducted ethically, respecting participants' autonomy and well-being while upholding the integrity of the research outcomes.

Results

This section presents the findings from the mixed-methods study evaluating the effectiveness of MALL in enhancing vocabulary acquisition among L2 learners. Quantitative results from pre- and post-tests are detailed with statistical analyses, followed by qualitative insights derived from surveys and interviews.

Quantitative Results: Vocabulary Gains

The pre- and post-test scores for both the experimental (MALL) and control (traditional instruction) groups were analyzed to assess vocabulary retention. Descriptive statistics are summarized in Table 1.

Table 1
Descriptive Statistics of Pre- and Post-Test Scores

Group	Test	Mean (M)	Standard Deviation (SD)
Experimental (MALL)	Pre-Test	24.50	3.82
Experimental (MALL)	Post-Test	32.10	4.15
Control	Pre-Test	24.70	3.95
Control	Post-Test	28.40	4.02

Figure 1 compares the pre-test and post-test scores for both the experimental (MALL) and control groups, showing that the MALL group had a greater improvement in vocabulary retention.

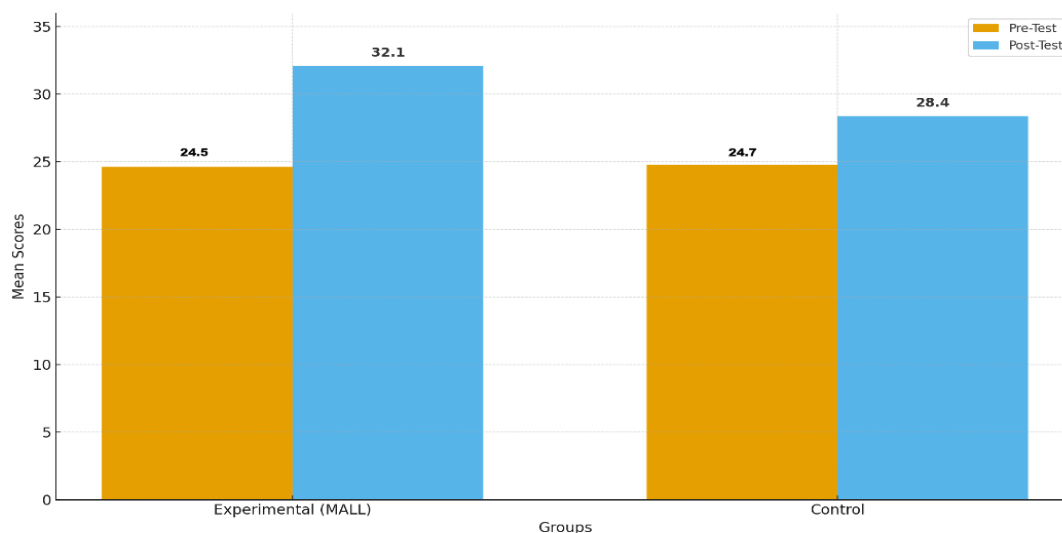


Figure 1. *Pre-Test and Post-Test Scores Comparison*

Both groups demonstrated improvement from pre- to post-test, but the experimental group exhibited a larger mean increase ($M = 7.60$) compared to the control group ($M = 3.70$). To evaluate within-group improvements, paired t-tests were conducted (Table 2).

Table 2
Paired T-Test Results for Within-Group Vocabulary Gains

Group	Mean Difference (Post - Pre)	t-value	df	p-value	Cohen's <i>d</i>
Experimental (MALL)	7.60	9.84	29	<0.001	1.80
Control	3.70	5.12	29	<0.001	0.93

The paired t-tests revealed statistically significant improvements in both groups ($p < 0.001$). However, the experimental group's effect size (Cohen's $d = 1.80$) was notably larger than that of the control group (Cohen's $d = 0.93$), indicating a substantial impact of MALL on vocabulary retention. Figure 2 illustrates the mean vocabulary gains for both groups, highlighting the greater improvement in the experimental (MALL) group compared to the control group.

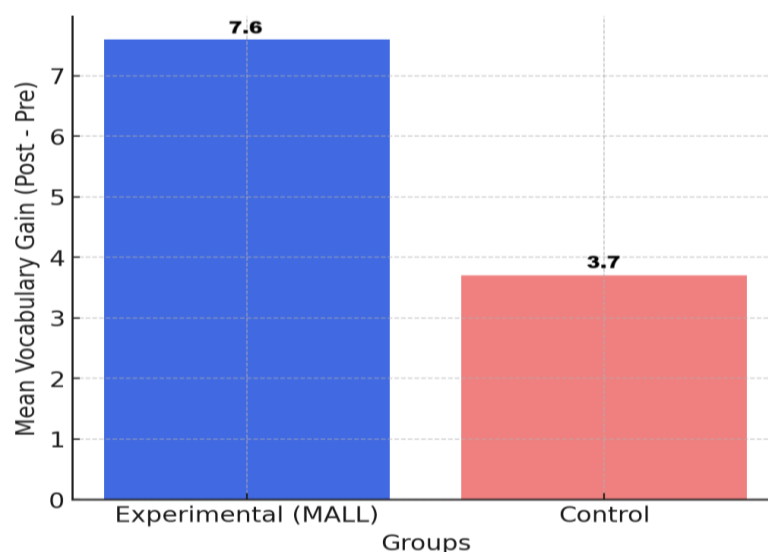


Figure 2. *Mean Vocabulary Gain Comparison*

To compare between-group differences, an independent t-test was performed on the post-test scores (Table 3).

Table 3

Independent T-Test Results for Post-Test Scores

Comparison	Mean Difference	t-value	df	p-value	Cohen's <i>d</i>
Experimental vs. Control	3.70	3.45	58	0.001	0.45

The independent t-test confirmed a statistically significant difference between the experimental and control groups' post-test scores ($t(58) = 3.45$, $p = 0.001$), with the MALL group outperforming the control group. The effect size (Cohen's $d = 0.45$) suggests a moderate practical significance, supporting the hypothesis that MALL enhances vocabulary acquisition more effectively than traditional methods.

Qualitative Results: Learner Experiences

Thematic analysis of surveys and interviews identified four key themes regarding the MALL experience: (1) personalized pacing, (2) interactive engagement, (3) instant feedback, and (4) challenges. Table 4 summarizes the frequency of these themes across responses.

Table 4

Frequency of Qualitative Themes from Surveys and Interviews

Theme	Survey Mentions (n = 60)	Interview Mentions (n = 15)	Example Quote
Personalized Pacing	42 (70%)	12 (80%)	"I could learn at my own speed, which helped a lot."
Interactive Engagement	38 (63%)	11 (73%)	"The games made it fun, not like boring drills."
Instant Feedback	35 (58%)	10 (67%)	"I liked knowing right away if I got it wrong."
Challenges	29 (48%)	9 (60%)	"Sometimes the app crashed or I got distracted."

Positive Aspects

Participants frequently praised MALL for its flexibility, with 70% of survey respondents and 80% of interviewees noting that personalized pacing allowed them to revisit difficult words at their convenience. Interactive engagement, cited by 63% of survey respondents, was linked to gamified elements (e.g., Quizlet flashcards, Duolingo rewards), which heightened motivation. Instant feedback was valued by 58% of survey participants, as it enabled immediate correction and reinforced learning.

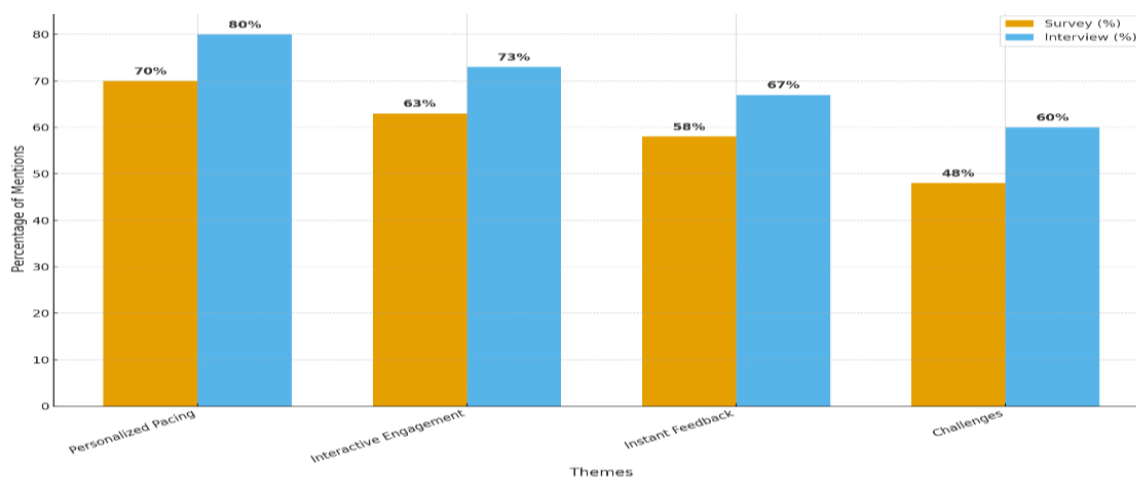


Figure 3. *Frequency of Qualitative Themes from Surveys and Interviews*

Figure 3 highlights the percentage of participants mentioning each theme, showing that personalized pacing was the most frequently cited benefit, while challenges were the least mentioned but still significant.

Reported Challenges

Despite its benefits, MALL presented challenges. Nearly half of the participants (48% in surveys, 60% in interviews) reported issues such as digital distractions (e.g., notifications from other apps), inconsistent internet access, and occasional technical glitches (e.g., app crashes). These barriers occasionally disrupted the learning process, particularly for learners in areas with limited connectivity.

Summary of Findings

The quantitative data demonstrated that the MALL group achieved significantly greater vocabulary gains than the control group, with a moderate effect size (Cohen's $d = 0.45$) highlighting its practical advantage. Qualitatively, learners appreciated MALL's adaptability and interactivity, though infrastructural and technical limitations tempered its effectiveness for some. Together, these results underscore MALL's potential as a complementary tool in L2 vocabulary acquisition, contingent on addressing reported challenges.

Discussion

The present study examined the effectiveness of MALL in enhancing vocabulary acquisition among second language learners, utilizing a mixed-methods approach that combined quantitative

assessments and qualitative insights. The results indicated that the experimental group, which engaged with MALL applications such as Duolingo and Quizlet over an eight-week period, achieved a statistically significant improvement in vocabulary retention compared to the control group, which received traditional classroom-based instruction. The quantitative analysis revealed a moderate effect size (Cohen's $d = 0.45$), underscoring a meaningful advantage of MALL over conventional methods. Qualitative findings complemented this by highlighting key benefits, including personalized pacing, interactive exercises, instant feedback, and increased learner motivation, though challenges such as digital distractions, uneven internet access, and technical barriers were also reported.

These findings align with and extend existing research on MALL's role in language education. The significant vocabulary gains observed in the experimental group corroborate prior studies that emphasize MALL's capacity to enhance retention through repetitive exposure, contextual reinforcement, and interactive engagement (Fernando, 2022; Mijan & Hashim, 2023). The moderate effect size suggests that while MALL provides a notable benefit, it does not wholly supplant traditional instruction but rather complements it effectively. This observation supports the growing advocacy for blended learning approaches that integrate mobile technologies with conventional pedagogy to optimize outcomes (Regina & Devi, 2022; Wang & Gunaban, 2023). The consistency between this study's results and the broader literature reinforces MALL's potential as a transformative tool in vocabulary acquisition, leveraging the ubiquity and interactivity of mobile devices (Ji & Aziz, 2021).

The qualitative data provide deeper insight into how MALL facilitates vocabulary learning. Learners frequently cited personalized pacing as a key advantage, enabling them to tailor their study to individual needs and revisit challenging content at their own speed. Interactive exercises,

often gamified, were praised for making learning engaging and enjoyable, aligning with socio-cognitive theories that highlight the importance of active participation (Yue, 2022). Instant feedback further supported retention by allowing real-time correction, a feature that traditional methods often lack in immediacy. These elements collectively fostered heightened motivation, a critical factor in sustaining language learning efforts (Wiyati & Amelia, 2022). Together, these qualitative findings illustrate the mechanisms through which MALL enhances vocabulary acquisition, offering a learner-centered experience that traditional classroom settings may struggle to replicate fully.

However, the study also revealed challenges that temper MALL's effectiveness. Digital distractions, such as notifications from other applications, disrupted focus for some learners, while uneven internet access and technical glitches (e.g., app crashes) posed barriers, particularly in less-connected areas. These issues echo concerns raised in prior research, which notes that infrastructural disparities and technological reliability can undermine MALL's benefits (Fu, 2021; Metruk, 2020). These challenges suggest that while MALL holds significant promise, its implementation requires careful consideration to ensure equitable and uninterrupted access for all learners.

The implications of these findings are relevant to multiple stakeholders. For educators, the study advocates integrating MALL into language curricula as a complementary tool, enhancing vocabulary acquisition through its flexibility and interactivity. However, teachers should provide guidance on managing distractions and maximizing engagement, perhaps through structured usage protocols. For app developers, the reported technical barriers underscore the need to design reliable, user-friendly applications that function effectively across diverse devices and connectivity levels. Policymakers, meanwhile, should prioritize investments in technological infrastructure to

address access disparities, ensuring that MALL's benefits reach all learners equitably. Collectively, these actions can harness MALL's potential while mitigating its drawbacks, fostering a more inclusive and effective language learning environment.

In sum, this study provides robust evidence that MALL enhances vocabulary acquisition among second language learners, offering a flexible, engaging, and personalized complement to traditional instruction. The combination of significant quantitative gains and detailed qualitative insights underscores its value in fostering retention and motivation. However, realizing MALL's full potential requires addressing challenges such as distractions and access inequities through thoughtful integration and infrastructural support. By building on these findings, future research can refine MALL's role in language education, ensuring it contributes to more effective, inclusive, and learner-centered practices in the digital age.

Conclusion

This study underscores the potential of MALL as an effective tool for enhancing vocabulary acquisition among second language learners. Quantitative results demonstrated that learners who engaged with MALL applications achieved statistically significant vocabulary gains compared to those in traditional classroom settings, while qualitative findings illuminated the mechanisms behind these gains. In particular, personalized pacing, interactive exercises, and instant feedback emerged as key features that not only facilitated deeper retention but also increased learner motivation and autonomy.

However, the study also revealed important challenges. Digital distractions, uneven internet access, and occasional technical malfunctions were noted as barriers that could limit the full effectiveness of MALL. These findings suggest that while MALL can serve as a valuable

complement to traditional instruction, its success largely depends on addressing infrastructural and pedagogical limitations. A blended learning approach that integrates the strengths of mobile technologies with the structure and guidance of conventional methods appears to be a promising strategy for optimizing language learning outcomes.

Despite its contributions, the study has limitations that warrant consideration. The eight-week intervention period, while sufficient to detect initial gains, may not reflect MALL's long-term impact on vocabulary retention. Extended studies could reveal whether benefits persist or if diminishing returns emerge over time. Additionally, the focus on intermediate-level learners limits the generalizability of findings to beginners or advanced learners, whose needs and responses to MALL may differ. The reliance on specific applications (Duolingo and Quizlet) further constrains the results, as other MALL tools might yield varying outcomes depending on their design and features. These limitations highlight areas where the study's scope could be expanded to provide a more comprehensive understanding of MALL's efficacy.

Based on these limitations, several directions for future research emerge. Longitudinal studies could investigate the sustained effects of MALL on vocabulary acquisition, tracking retention over months or years to assess its durability. Exploring MALL's effectiveness across different proficiency levels—beginners, intermediate, and advanced learners—would clarify its applicability to diverse learner profiles. Comparative analyses of various MALL applications could also identify which features (e.g., gamification, spaced repetition) most effectively support vocabulary learning, guiding the development of optimized tools. Additionally, examining MALL in varied linguistic and cultural contexts could reveal how contextual factors influence its outcomes, further enriching the evidence base. In light of these insights, educators, app developers, and policymakers are encouraged to collaborate on creating more robust, user-friendly, and

accessible MALL environments. By refining the integration of mobile learning tools into language curricula, stakeholders can harness MALL's transformative potential, contributing to more effective, inclusive, and learner-centered educational practices in the digital age.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

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