

Combating Ebbinghaus' Forgetting Curve with Lexigo: A Multimodal and Gamified Mobile Application for Vocabulary Enhancement

*¹Lindey Easter Apolonius ²Shirleen Octavia Austin, ³Melissa Sen Mei Mei

^{1 2 3} Universiti Teknologi MARA, Kota Kinabalu, Sabah

*Corresponding Author

DOI: <https://dx.doi.org/10.47772/IJRISS.2025.925ILEIID000048>

Received: 23 September 2025; Accepted: 30 September 2025; Published: 05 November 2025

ABSTRACT

LexiGo is a prototype mobile application designed for the improvement of English vocabulary grounded in Ebbinghaus' forgetting curve, which incorporates multimodal and gamified learning experiences. Through the integration of spaced repetition, interactive challenges and multimedia input, form–meaning connections are reinforced and cognitive processing is enhanced. Adopting the Technology Acceptance Model (TAM), this study investigates learners' perception of usefulness, ease of use, attitude toward use and behavioural intention toward LexiGo. Findings indicate high user acceptance ($M > 4.0$; $\alpha = .884-.981$), and all constructs significantly predicted behavioural intention ($p < .001$). The regression model was significant, $F(3, 56) = 48.72$, $p < .001$, which accounted for 72.8% of the variance in behavioural intention ($R^2 = .728$). The results affirm its value as an adaptable learner-centred tool for vocabulary retention in higher education environments. These findings imply that LexiGo could be adopted as a tool for integrating AI-based adaptive learning in a mobile-assisted language learning (MALL) environment with broad scalability.

Keywords: vocabulary, memory retention, gamification, multimodal learning, mobile-assisted language learning (MALL)

INTRODUCTION

Vocabulary acquisition is a cornerstone of English language proficiency and plays a decisive role in mastering the four core skills of speaking, listening, reading, and writing. Empirical studies consistently demonstrate that vocabulary size strongly correlates with overall language competence and academic achievement (Brooks et al., 2021; Alsahafi, 2023). Despite its importance, many Malaysian tertiary students continue to face challenges in retaining newly learned vocabulary, primarily due to limited exposure and ineffective memorisation techniques (Mohammadi et al., 2024). Traditional methods such as rote learning and word-list drills often lead to rapid forgetting, aligning with Ebbinghaus' (1913) forgetting curve, which posits that memory decays sharply without timely review. As vocabulary knowledge fades quickly, repeated and meaningful exposure is necessary to consolidate long-term retention (Teymouri & Teng, 2024).

Recent research has highlighted the role of mobile-assisted language learning (MALL) in promoting contextualised and adaptive vocabulary reinforcement (Benlaghrissi and Ouahidi, 2023). Mobile applications with gamified and multimodal features have been shown to enhance engagement and retention by integrating auditory, visual, and interactive elements that stimulate deeper cognitive processing (Li & Hafner, 2022). In Malaysia, gamified mobile-assisted tools showed positive effects on ESL learners' lexical gains and motivation (Al Shihri, 2025). Such tools align with the growing educational shift towards learner-centred, technology-driven environments that address the limitations of conventional instruction.

In this context, LexiGo was conceptualised as a mobile-assisted vocabulary learning application grounded in three pedagogical foundations: spaced repetition, multimodal input, and gamification. Drawing upon the Technology Acceptance Model (TAM), the study evaluates learners' perceived ease of use (PEOU), perceived usefulness (PU), attitude toward use (ATT), and behavioural intention to use (BI) LexiGo in vocabulary learning.

The research aims to bridge theory and practice by providing empirical insights into how mobile technologies can counteract vocabulary attrition and support sustainable language learning among Malaysian undergraduates.

Problem Statement

Vocabulary retention is an ongoing conundrum for second language acquisition (SLA) learners, especially ESL learners who experience difficulty with retaining newly learned words. Based on Ebbinghaus' (1913) forgetting curve, some 75% of new information is forgotten within days without repetition. Despite progress in the field of pedagogy, Rosetta's downfall is that many students still need to memorise and learn by rote individual sounds, words, or sentences, which are not grounded in context or form (Teng 2023). It is reported that deliberate vocabulary learning within context with interactive support results in fast attrition, while incidental acquisition through real tasks, multimedia exposure, or game-based interaction increases motivation and retention (Li & Hafner, 2022; Teymouri & Teng, 2024). Cognitive and experimental investigations also support the effectiveness of spaced repetition systems (SRS) to boost memory retention via distributed and adaptive practice (Chen & Chung, 2008; Liu & Hsiao, 2021). Despite MALL having been exploited thoroughly as an area of ESL learning, there are few integrated solutions available which offer a combination of spaced repetition, multimodal input and gamified reinforcement in a single learner-centred platform (Mohammadi et al., 2024).

Accordingly, this study aims to:

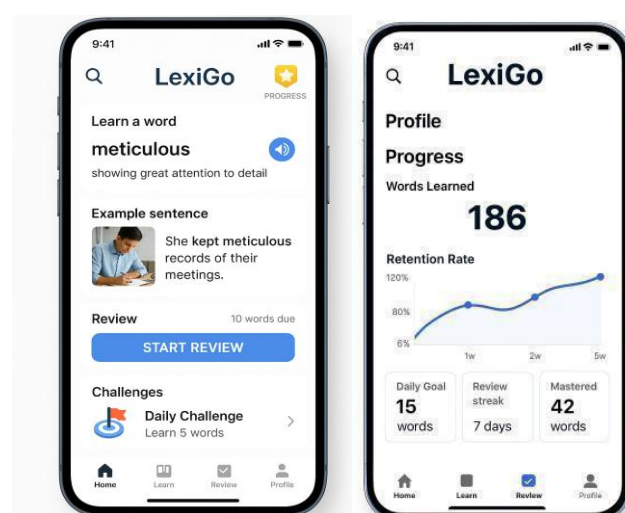
1. Provide language learners with a highly effective and engaging platform for vocabulary acquisition.
2. Ensure long-term retention through spaced repetition, interactive multimedia, and data-driven personalised practice.

Product Description

With the app's simple, user-friendly and intuitive interface, learners can easily search unfamiliar words and get prompt feedback that includes definitions, example sentences, and pronunciation. Below is the list of the app's features:

1. Search Feature: Users can search for unknown words and receive definitions, example sentences, and pronunciation.
2. Progress Tracking: The app records every word the learner searches and provides personalised revision schedules based on spaced repetition theory.
3. Interactive Practice: Vocabulary quizzes and exercises are generated based on the user's word history.
4. Gamification: Quizzes, rewards, and badges are incorporated to maintain motivation.
5. Multimedia Learning: The app uses text, audio, and visuals to reinforce word meanings.

Figure 1: Interface and search features



METHODOLOGY

Design: The study used a quantitative survey design to test the acceptance of the LexiGo concept with target users. The questionnaire was developed from the Technology Acceptance Model (TAM), and it is a well-established framework widely applied in technology adoption and educational research (Davis, 1989; Venkatesh & Davis, 2000). TAM focuses on four main constructs: Perceived Ease of Use (PEOU), Perceived Usefulness (PU), Attitude toward Use (ATT), and Behavioural Intention to Use (BI).

Participants: A total of 60 participants ($N = 60$) were included in the study. The respondents were second-language students in higher education with various linguistic backgrounds. Convenience sampling was used for recruitment, and voluntary participation was sought. Though the sample has offered an initial glimpse, the small size precludes generalisability.

Instruments: The questionnaire was based on the TAM (Davis, 1989; Venkatesh & Bala, 2008) and it measured PEOU, PU, ATT, and BI by using a five-point Likert type scale (1 = strongly disagree to 5 = strongly agree). Items reflected participants' perceptions of LexiGo features such as AI-driven personalisation, adaptive spaced repetition, interactive quizzes, and multimedia vocabulary learning tools. Internal consistency for each dimension was measured with Cronbach's alpha.

Procedure: The online survey was administered via institutional communication channels. Participants were introduced to LexiGo's conceptual features before completing the questionnaire. They rated their perceptions of usefulness, ease of use, and behavioural intention. **Informed consent** and **anonymity** were ensured throughout the process.

Data Analysis: Data were analysed using **SPSS (Version 29)**. Descriptive, reliability, and inferential statistics were computed for all TAM constructs.

RESULTS AND DISCUSSION

The LexiGo app was assessed for acceptance by the learners following the Technology Acceptance Model (TAM). As indicated in Table 1, all factors were rated highly ($M = 4.11 - 4.39$) with excellent internal reliability ($\alpha = .884 - .981$), indicating positive perceptions. All variables were positively related to BI ($p < .001$). The regression model was statistically significant, $F(3, 56) = 48.72$, $p < .72$, which accounted for 72.8% of variance in BI ($R^2 = .728$). The variables with major influence being Perceived Ease of Use (PEOU) and Attitude Toward Use (ATT) that reinforce learners' intention to use LexiGo are most affected by the ease of use and positive attitude. These results are congruent with the Technology Acceptance model (Venkatesh & Davis, 2000) and MALL literature where easy-to-use user-friendly appealing mobile tools can increase learner motivation and continued usage (Teng, 2023; Zou & Xie, 2023).

Table 1
Descriptive Statistics, Reliability, Correlations, and Regression Results for TAM Constructs ($N = 60$)

TAM Construct	Mean	SD	α	r with BI	β
PEOU	4.29	0.78	.941	.00***	.00
PU	4.39	0.63	.884	.00***	.00
ATT	4.38	0.68	.981	.00***	.00
BI	4.11	0.84	.931	—	—

Model Summary: $R^2 = .728$, $F(3, 56) = 48.72$, $p < .001$

Note. *** $p < .001$

Next Phase: Pilot Study

A pilot study will assess the pedagogical value and usability of LexiGo in actual classroom environments based on an agile, feedback-oriented design process. The research goals are to evaluate the effectiveness of LexiGO to increase ELLS's retention rate, monitor levels of participation through mechanisms for data collection in-app, determine satisfaction levels via indicators from TAM, and provide qualitative feedback on app interface and usability. A quasi-experimental pre-test–post-test design will be employed with three groups of participants in terms of the learners' proficiency level, that's based on collecting data using vocabulary tests, user log files and post-use questionnaires. In particular, it's hypothesised that participants will produce large vocabulary gains ($p < .05$), greater motivation, and positive acceptance, indicating that LexiGo has potential for wider MALL adoption.

POTENTIAL FINDINGS

It is anticipated that there will be positive results with LexiGo in MALL, especially in terms of enhanced learner motivation, recall of vocabulary and use of technology. With the inclusion of spaced repetition, multimodal glossing, and gamification to help with vocabulary acquisition at a research-based MALL application's best practices. Research has demonstrated that mobile-based spaced repetition is beneficial for recall and long-term retention (Teymouri & Teng, 2024; Mihaylova et al., 2022; Lin & Lin, 2019). LexiGo's reinforced algorithm operationalises these principles for distributed learning and memory consolidation. Likewise, evidence on multimodal glossing proves that text with the aid of pictures and audio increases depth of processing and vocabulary retrieval (Ramezanali et al., 2021; Teng, 2023; Bukhari & Dewey, 2023).

With respect to gamification, studies have proved that reward-based tasks and feedback result in increasing motivation and perseverance (López-Cirugeda & López-Cirugeda, 2021; Zou & Xie, 2023). LexiGo's rewards and corrective feedback systems are intended to maintain engagement and improve retention. Furthermore, prior research underscores that a learner's outcome can be attributed to factors such as autonomy, self-regulation and user interface design (Guo et al., 2022), implying the effectiveness of LexiGo with respect to being adaptive to various kinds of users' needs and proficiency levels.

Market Opportunity & Scalability

The need for digital language learning in Malaysia and Southeast Asia is on the rise, drawing a significant change in the practice of English language learning (ELL). In 2024, Malaysia's EdTech market reached a value of USD 270 million and is expected to surpass USD 500 million by 2030, whereas the regional online language learning market may reach USD 1.3 billion by 2032 (IMARC Group, 2024; Sable et al., 2024). This growth reflects the region's increasing demand for mobile-facilitated and AI-supported learning tools that enable greater accessibility, personalization, and independent engagement. Building on this foundation, LexiGo combines technological advancement and language pedagogy through its AI-based framework for vocabulary acquisition, employing a freemium, cloud-based system to ensure access across educational institutions. Moreover, partnerships with universities and education authorities contribute to its sustainability and adoption within the growing digital learning ecosystem. Crucially, this venture responds to Malaysia's Digital Economy Blueprint (Ministry of Economy [Malaysia], 2021) and UNESCO's Education 2030 Framework for Action (UNESCO, 2016), thereby achieving both commercial scalability and educational impact. Within the broader framework of the Global South, where digital access and pedagogical innovation remain unevenly distributed, LexiGo represents a contextually grounded and socially responsive effort to promote equitable and lifelong digital language learning.

Novelty

The majority of vocabulary applications focus on a single method. For instance, Duolingo highlights gamification, whereas Memrise uses spaced repetition or mnemonic devices (Hasif & Darmi, 2024). LexiGo combines three research-supported techniques: spaced repetition, gamification, and multimodal learning, within a single mobile platform. Previous research has analysed these characteristics individually. For example, Chen et al. (2019) found that learning vocabulary through mobile games boosted motivation and performance, whereas Teng (2023) reported that multimodal input improved vocabulary retention. A systematic review conducted by Lin and Lin (2019) similarly demonstrated that mobile-assisted vocabulary learning (MALL) notably enhances language results in comparison to conventional methods.

This research is unique as it investigates the interaction among these three methods, rather than solely their individual impacts. By emphasizing both educational results and user experience in independent mobile learning, LexiGo offers a thorough and inspiring framework for vocabulary development.

CHALLENGES, LIMITATIONS AND RECOMMENDATIONS

Although it possesses strong pedagogical strength, the LexiGo framework encounters various practical challenges during implementation. The digital divide continues to be a significant obstacle, as unequal access to technology and internet connectivity threatens to increase educational inequalities (Tang et al., 2025). Moreover, mobile distractions can impair attention, as students might multitask or interact superficially instead of maintaining deep focus (Yu & Lee, 2022). Additionally, the possible excessive dependence on

technology might diminish chances for cultivating critical thinking and innovative problem-solving (Poom-Valickis & Matre, 2023).

To address these problems, a number of suggestions are put forward:

1. Educators ought to incorporate LexiGo as an additional resource in blended or flipped learning environments, guaranteeing guided use and pedagogical balance (Andujar, et al., 2020).
2. Developers should enhance AI-powered personalisation for adaptive learning pathways (Chen, et al., 2023) and integrate social gamification elements to maintain motivation (Zou & Xie, 2023).
3. Researchers are urged to undertake longitudinal and mixed-method studies examining long-term vocabulary retention (Tseng, 2020), as well as to pinpoint specific gamification elements (e.g., feedback, rewards, leaderboards) to discern their distinct motivational impacts.

CONCLUSION

With the integration of spaced repetition, gamification, and multimodal learning, LexiGo contributes to Malaysia's education aspirations and UNESCO's SDG 4 by enabling inclusive and quality learning as a result of AI guided design. Future studies should investigate its longer-term effects and ways it could be personalised.

ACKNOWLEDGEMENTS

The authors would like to express their sincere gratitude to all respondents who participated in the survey. This project would not have been possible without their contribution.

REFERENCES

1. Al Shihri, H. B. S. G. (2025). Examining the effect of the integration of multiple MALL applications (Kahoot, Quizlet, WhatsApp) on academic vocabulary learning. *Cogent Education*, 12(1). <https://doi.org/10.1080/2331186X.2025.2473229>
2. Alsahafi, M. A. (2023). The relationship between depth of academic English vocabulary knowledge and academic success of second language learners in an English-medium instruction university. *Journal of Language Teaching and Research*, 14(3), 733–741. <https://doi.org/10.1177/2158244023115334>
3. Andujar, A., Salaberri-Ramiro, M. S., & Cruz-Martínez, M. S. (2020). Integrating flipped foreign language learning through mobile devices: Technology acceptance and flipped learning experience. *Sustainability*, 12(3), 1110. <https://doi.org/10.3390/su12031110>
4. Benlaghrissi, H., & Ouahidi, L. M. (2023). The impact of mobile-assisted language learning on developing EFL learners' vocabulary knowledge. *International Journal of Interactive Mobile Technologies (iJIM)*, 17(22), 38–51. <https://doi.org/10.3991/ijim.v17i22.41665>
5. Brooks, G., Clenton, J., & Fraser, S. (2021). Exploring the importance of vocabulary for English as an additional language learners' reading comprehension. *Studies in Second Language Learning and Teaching*, 11(3), 351–376.
6. Bukhari, A., & Dewey, D. (2023). Multimodal glosses in mobile-assisted Arabic vocabulary learning. *Language Learning & Technology*, 27(2), 115–136. <https://doi.org/10.10125/73415>
7. Chen, C.-M., & Chung, C.-J. (2008). Personalized mobile English vocabulary learning system based on item response theory and learning memory cycle. *Computers & Education*, 51(2), 624-645. <https://doi.org/10.1016/j.compedu.2007.06.011>
8. Chen, C.-M., Liu, H., & Huang, H.-B. (2019). Effects of a mobile game-based vocabulary learning app. *Smart Learning Environments*, 6(1), 4. <https://doi.org/10.1186/s40561-019-0086-0>
9. Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319–340. <https://doi.org/10.2307/249008>
10. Ebbinghaus, H. (1913). Memory: A contribution to experimental psychology. *Annals of Neurosciences*, 20(4), 155.
11. Guo, Q., Sun, P., & Wei, R. (2022). Peer scaffolding and self-regulation in mobile-assisted vocabulary learning: Evidence from the Shanbay app. *Frontiers in Psychology*, 13, 993224. <https://doi.org/10.3389/fpsyg.2022.993224>

12. Hasif, A. F., & Darmi, R. (2024). Comparative analysis of Duolingo and Memrise for English language learning. *Conference on English Language Teaching*, 137–145. <https://doi.org/10.24090/celti.2024.1017>
13. IMARC Group. (2024). Malaysia EdTech market: Industry trends, share, size, growth, opportunity, and forecast 2024–2030. IMARC Group. <https://www.imarcgroup.com/malaysia-edtech-market>
14. Li, K., & Hafner, C. A. (2022). Mobile-assisted language learning for vocabulary development: Learner engagement and strategy use. *Language Learning & Technology*, 26(3), 1–17.
15. Lin, J. J., & Lin, H. (2019). Mobile-assisted ESL/EFL vocabulary learning: A systematic review and meta-analysis. *Smart Learning Environments*, 6(1), 4. <https://doi.org/10.1186/s40561-019-0086-0>
16. Liu, Q., & Hsiao, I. Y. T. (2021). Spaced repetition for authentic mobile-assisted word learning. *Computer Assisted Language Learning*, 34(7), 874–895. <https://doi.org/10.1080/09588221.2021.1888752>
17. López-Cirugeda, I., & López-Cirugeda, D. (2021). Gamification and vocabulary acquisition in foreign language learning. *Computer Assisted Language Learning*, 34(7), 858–878. <https://doi.org/10.1080/09588221.2019.1654399>
18. Mihaylova, I., Vashieva, D., & Moiseeva, M. (2022). Effectiveness of mobile-assisted language learning: A meta-analysis. *Frontiers in Psychology*, 13, 947975. <https://doi.org/10.3389/fpsyg.2022.947975>
19. Ministry of Economy (Malaysia). (2021). Malaysia Digital Economy Blueprint [Policy document]. Government of Malaysia. Retrieved from <https://ekonomi.gov.my/sites/default/files/2021-02/malaysia-digital-economy-blueprint.pdf>
20. Mohammadi, M., Valizadeh, M., Zohdi Jalal, P., & Xodabande, I. (2024). University students' academic vocabulary development through mobile-assisted learning. *Heliyon*, 10(7), e28103. <https://doi.org/10.1016/j.heliyon.2024.e28103>
21. Poom-Valickis, K., & Matre, S. (2023). Beyond technology: Rethinking digital competence for critical and creative learning. *British Journal of Educational Technology*, 54(6), 1521–1538. <https://doi.org/10.1111/bjet.13367>
22. Ramezanali, N., Uchiyara, T., & Faez, F. (2021). Efficacy of multimodal glossing on L2 vocabulary learning: A meta-analysis. *Language Teaching Research*, 25(6), 861–883. <https://doi.org/10.1177/1362168819883451>
23. Sable, U., Hade, A., & Bhawal, R. (2024). South East Asia online language learning market by learning mode, age group, language, end user & country – Forecast to 2032 [Market research report]. Meticulous Research. Retrieved from <https://www.meticulousresearch.com/product/south-east-asia-online-language-learning-market-5631>
24. Tang, Q., Kamarudin, S., Abdul Rahman, S. N., & Zhang, X. (2025). Bridging gaps in online learning: A systematic literature review on the digital divide. *Journal of Education and Learning*, 14(1), 161–175. <https://doi.org/10.5539/jel.v14n1p161>
25. Teng, M. F. (2023). The effectiveness of multimedia input in mobile-assisted vocabulary learning. *Innovation in Language Learning and Teaching*, 17(1), 24–40. <https://doi.org/10.1080/17501229.2022.2131791>
26. Teymouri, F., & Teng, M. F. (2024). Mobile-assisted vocabulary learning: Effects of spacing and repetition on L2 retention. *ReCALL*, 36(2), 145–162.
27. Tseng, W.-T. (2020). Effects of gamified learning on vocabulary retention and motivation in mobile-assisted language learning. *Computer Assisted Language Learning*, 33(7), 746–770. <https://doi.org/10.1080/09588221.2019.1654792>
28. UNESCO. (2016). Education 2030: Incheon Declaration and Framework for Action – Towards inclusive and equitable quality education and lifelong learning for all [Policy document]. UNESCO. Retrieved from <https://unesdoc.unesco.org/ark:/48223/pf0000245656>
29. Venkatesh, V., & Bala, H. (2008). Technology acceptance model 3 and a research agenda on interventions. *Decision Sciences*, 39(2), 273–315. <https://doi.org/10.1111/j.1540-5915.2008.0092.x>
30. Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the Technology Acceptance Model: Four longitudinal field studies. *Management Science*, 46(2), 186–204. <https://doi.org/10.1287/mnsc.46.2.186.11926>
31. Yu, L., & Lee, C. (2022). The influence of mobile distraction on students' sustained attention and learning performance. *Computers & Education*, 190, 104604. <https://doi.org/10.1016/j.compedu.2022.104604>
32. Zou, D., & Xie, H. (2023). Digital gamification and feedback for vocabulary learning in MALL environments: A systematic review. *British Journal of Educational Technology*, 54(3), 1012–1032. <https://doi.org/10.1111/bjet.13282>