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GAMIFYING MALAY VOCABULARY LEARNING: DESIGN, DEVELOPMENT, AND USABILITY EVALUATION OF A GAME-BASED MOBILE APPLICATION

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ABSTRACT

As global student mobility increases, acquiring the host nation's language is vital. At Universiti Utara Malaysia (UUM), non-native beginners in compulsory Malay courses frequently encounter learning bottlenecks, including limited vocabulary retention and low motivation. To address these issues, this study aimed to design, develop, and evaluate the usability of *MalayLearning*, a game-based mobile application. The project integrated the ADDIE framework with Game-Based Learning (GBL) mechanics and Mayer's Principles of Multimedia Learning. Following a formative expert review that resolved heuristic and cognitive load issues, a summative usability evaluation was conducted with international student users (n=5) via WebGL. The findings provide preliminary evidence of high usability and acceptance, achieving a mean System Usability Scale (SUS) score of 85.5/100 ("Excellent"), a 92.0% task performance accuracy on matching quizzes, and a 100% peer recommendation rate. This study contributes practical insights into designing intuitive mobile interfaces, suggesting that strategic gamification may serve as a useful tool to support vocabulary practice and cultural integration.

Keywords: Game-Based Learning, Malay Language, Malay Vocabulary Learning, Mobile-Assisted Language Learning, Usability Evaluation.

INTRODUCTION

Mobile technology, including smartphones and tablets, has revolutionised education and led to Mobile-Assisted Language Learning (MALL). While not replacing formal instruction, mobile learning enhances student engagement by providing flexible access to educational materials anytime and anywhere (Demir & Akpinar, 2018). Integrating Game-Based Learning (GBL) and gamification within mobile environments has proven effective for second language acquisition.

(SLA). Gamification transforms abstract linguistic exercises into interactive, rewarding experiences that reduce learning anxiety, promote flow states, and boost intrinsic motivation among adult learners (Phuc & Nghi, 2023).

Language is crucial for communication, cultural preservation, and social cohesion. As global student mobility increases, second language learning among international higher education students is vital for cultural sustainability and cross-cultural adaptation (Lut & Starenkova, 2022). In Malaysia, the Malay language is the official language and primary medium of education. Consequently, national higher education policy requires all foreign students enrolled in Malaysian public universities to complete compulsory Malay language courses (Abdul Rahman et al., 2023).

Facilitating Malay vocabulary acquisition for foreign students goes beyond academic requirements; it contributes to cultural sustainability by enabling meaningful interactions with local communities, preserving linguistic heritage, and promoting intercultural harmony. At Universiti Utara Malaysia (UUM), international students face challenges in learning Malay, including limited vocabulary retention, pronunciation difficulties, listening comprehension barriers, and low motivation during rote memorisation.

To address these challenges, the *MalayLearning* mobile application was developed as an interactive, gamified tool for learning Malay vocabulary. The application follows the five-phase ADDIE model for macro-level instruction. It incorporates GBL elements like interactive word-matching puzzles and score tracking, along with Mayer's Principles of Multimedia Learning to manage visual cognitive load.

To ensure usability and quality, a two-stage evaluation was conducted: a formative expert review to identify and correct heuristic gaps, followed by a WebGL-hosted summative evaluation combining qualitative diagnostics with quantitative SUS benchmarks.

The research aimed to achieve four key objectives (Hamzah et al., 2025):

- To assess the educational, practical, and user needs for a gamified Malay vocabulary learning app.
- To create and build the game-based mobile app using Unity.
- To review and improve the app through a multidisciplinary expert review (Formative Evaluation).
- To test the app's usability, learner confidence, and acceptance through target student testing (Summative Evaluation).

While our previous work (Hamzah et al., 2025) focused primarily on the conceptual acceptance modeling of the *MalayLearning* app, this current manuscript provides the complete macro-level ADDIE developmental framework and empirical findings from our formative cognitive multimedia evaluation.

LITERATURE REVIEW

Mobile-Assisted Language Learning (MALL) and Vocabulary Acquisition

Mobile technology is increasingly integrated into Second Language Acquisition (SLA). Mobile-Assisted Language Learning (MALL) uses digital affordances like portability, immediacy, and novelty to extend language instruction beyond classrooms. Poláková (2022) found that mobile

vocabulary apps in blended learning improve student vocabulary retention, comprehension, and precision. Similar findings by Habbash (2015) and Basal (2016) showed that digital vocabulary tools boost student attitudes and reduce the cognitive burden of rote memorisation.

Empirical evidence supports the positive impact of mobile platforms on educational outcomes. Lai and Lai (2021) found a strong correlation between mobile language app usage and overall academic performance and learner satisfaction. In second language learning, vocabulary acquisition is crucial for communicative competence. Structured mobile applications provide adult non-native learners with autonomous, self-paced opportunities to expand their target lexicon.

Game-Based Learning (GBL) and Gamification Mechanics in SLA

Mobile platforms offer accessibility, but Game-Based Learning (GBL) and gamification provide the motivation needed for sustained language engagement. Serious game architectures transform abstract learning tasks into interactive experiences that offer cognitive, motivational, and affective benefits (Demmel et al., 2011; Gee, 2003; Granic et al., 2014). In second language education, gamifying vocabulary through interactive word-matching puzzles and score-based challenges creates a state of flow, reduces language learning anxiety, and stimulates active lexical retrieval (Hsieh et al., 2015; Latha et al., 2015; Wiwat, 2013).

Phuc and Nghi (2023) found that embedding explicit game mechanics, such as instant score feedback, visual reward loops, and progressive difficulty, into university-level mobile language applications increases learner immersion and retention. Localised studies, like Zaini and Yaacob (2023), confirm that gamified mobile interfaces effectively support second language vocabulary acquisition. By combining play with targeted lexical drill exercises, gamified systems shift learners from passive receivers to active problem-solvers.

Despite the availability of gamified apps, there remains a critical gap in tools tailored specifically for international university students navigating Malaysian higher education. For instance, while prior systems like Zaini and Yaacob (2023) utilize gamification, they lack the integration of Mayer's Temporal Contiguity and Segmenting principles to explicitly manage the cognitive load of non-native adult beginners.

Flow Theory and Learner Engagement in Gamified Pedagogy

Researchers often use Flow Theory (Csikszentmihalyi, 1990) to explain why gamified mechanics promote cognitive retention. Flow is a psychological state of deep immersion where a learner is fully absorbed in an activity due to an optimal balance between task challenge and skill level. In game-based learning, maintaining this balance prevents learner anxiety (caused by difficult tasks) and boredom (caused by repetitive drills).

Interactive mechanics, such as time-bounded word matching, real-time auditory feedback, and visual score progression, induce a state of flow that enhances cognitive absorption and reduces performance anxiety. Empirical studies by Hamari et al. (2016) confirm that flow engagement correlates with perceived learning effectiveness and knowledge retention in digital educational applications.

Embedding structured puzzle loops into *MalayLearning* serves as a psychological catalyst, enabling international students to practice vocabulary autonomously without experiencing cognitive fatigue.

Cognitive Multimedia Design Principles for Gamified Interfaces

To prevent interactive and gamified elements from overwhelming learners' visual and auditory processing, game design should be balanced with cognitive multimedia principles. Mayer's Principles of Multimedia Learning provide a crucial framework for managing cognitive load in digital learning environments (Mayer, 2001). Wong and Lim (2022) emphasise the importance of applying Mayer's principles for optimising mobile language apps. This study primarily incorporated three core multimedia principles:

- The Multimedia Principle states that people learn more deeply from combined words and graphics than from words alone (Mayer, 2001). Pairing target Malay vocabulary with descriptive visuals strengthens dual-channel cognitive processing.
- The Coherence Principle requires excluding extraneous visual, textual, or auditory material to protect limited working memory capacity (Mayer, 2001). Eliminating redundant buttons and decorative clutter achieves this.
- The Temporal Contiguity Principle asserts that corresponding visual and auditory cues must be presented simultaneously, not sequentially (Mayer, 2001). In listening quizzes, syncing audio playback with interactive card choices prevents temporal overlap and reduces cognitive confusion.

Technology Acceptance Model (TAM) in Educational Mobile Media

The success of educational software depends on its design, user adoption, and system acceptance. The Technology Acceptance Model (TAM), developed by Davis (1989) and expanded by Venkatesh and Bala (2008), suggests that user intention to adopt a new digital system is mainly influenced by two cognitive determinants: Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). PU reflects a user's belief in the application's ability to enhance learning, while PEOU represents the perceived ease of using the application.

In Mobile-Assisted Language Learning (MALL), PEOU is crucial. A cluttered, confusing, or visually unappealing interface can suppress user engagement and hinder educational gains (Liaw & Huang, 2013; Venkatesh & Bala, 2008). Conversely, intuitive UI design, responsive touch controls, and clean visual layouts increase PEOU, which in turn reinforces PU and drives sustained usage intentions (Liaw & Huang, 2013). By applying TAM principles, *MalayLearning*'s evaluation ensures that both usability and learning utility are systematically measured during summative testing.

Note that Flow Theory and TAM are utilized in this study strictly as foundational design frameworks guiding the application's development, rather than as empirically measured constructs during the summative testing.

Digital Media, Cultural Sustainability, and Intercultural Adaptation

In the age of rapid higher education globalisation, digital media tools are crucial for preserving intangible linguistic heritage and promoting cultural sustainability (Kramsch, 2014; UNESCO, 2021). Cultural sustainability involves intentionally preserving, transmitting, and evolving

cultural practices, languages, and identity markers within changing social contexts (UNESCO, 2021). Language is deeply connected to culture; learning a host nation's official language empowers international students to navigate local social structures, appreciate cultural nuances, and build respect with host communities (Kramsch, 2014; Lut & Starenkova, 2022).

Language barriers can hinder cross-cultural adaptation and academic integration for international university students (Smidt et al., 2017). Creative industry digital media, such as mobile apps, interactive simulations, and serious games, offer an accessible and non-threatening way for non-native speakers to learn regional languages (Phuc & Nghi, 2023; Smidt et al., 2017). *MalayLearning*, a digital mobile application that digitises Malay language instruction, contributes to cultural sustainability by preserving local linguistic heritage, reducing social integration barriers, and fostering intercultural harmony on international higher education campuses.

Formative Heuristic Evaluation and Usability Metrics

Creating effective game-based courseware involves rigorous usability evaluation at both development and post-development stages (Dauchot, 2019; Kurasinska, 2024). Formative evaluation during design and development identifies interface bugs, flaws, and inconsistencies before public release (Harley, 2018). Expert reviews are an effective formative method, allowing domain experts to evaluate prototypes and recommend structural improvements (Tractinsky et al., 2000).

Summative evaluation measures user experience, acceptance, and functionality after system refinement (Mertasari, 2022). Visual clarity, spatial balance, and responsive feedback are crucial for usability (Tractinsky et al., 2000). Standardised instruments like the System Usability Scale (SUS) benchmark courseware against industry standards (Brooke, 1996; Bangor et al., 2008). Usability testing with five representative users is a validated method, exposing up to 85% of core usability errors (Nielsen, 2012).

SMMTC Research Context and Qualitative Evaluation Framework

This study is based on a multimedia and instructional technology research framework developed at the School of Multimedia Technology and Communication (SMMTC), Universiti Utara Malaysia. Salam et al. (2019) justified dual-perspective requirement gathering during the ADDIE Analysis phase by combining instructor insights with target user surveys to uncover critical user traits and content preferences. Abdul Mutalib et al. (2018) highlighted the need for a detailed initial investigation into user awareness and contextual learning barriers when transitioning from traditional face-to-face instruction to mobile digital platforms.

The navigational architecture and modular lesson layout of *MalayLearning* implemented the Segmenting Principle. Mutalib and Jaafar (2018) proved that chunking interactive learning content into small, user-paced segments enhances learner engagement, allowing students to practice and master educational content with heightened confidence.

The qualitative evaluation methodology employed during summative testing directly adapted the Qualitative Multimedia Project Evaluation Framework established by Razak et al. (2024). Their framework provides rich diagnostic data across three essential vectors: usability (system stability and fluid control), user experience (affective motivation and confidence-building), and suggestions for future improvement. Designing for high emotional resonance and intuitive

usability reflects the core design paradigms established across recent SMMTC multimedia research (Salam et al., 2025; Sarif et al., 2020).

METHODOLOGY

The *MalayLearning* mobile app's design, development, and evaluation followed the structured ADDIE framework (Analysis, Design, Development, Implementation, and Evaluation). The macro-level instructional engineering was governed by the ADDIE model, while the micro-level visual and layout elements were guided by Mayer's Principles of Multimedia Learning to manage cognitive load. Game-Based Learning (GBL) principles provided the foundational motivational architecture for interactive vocabulary acquisition.

Conceptual and Theoretical Framework

MalayLearning bridges instructional technology theory and interactive software usability through a tripartite conceptual architecture, as shown in Figure 1.

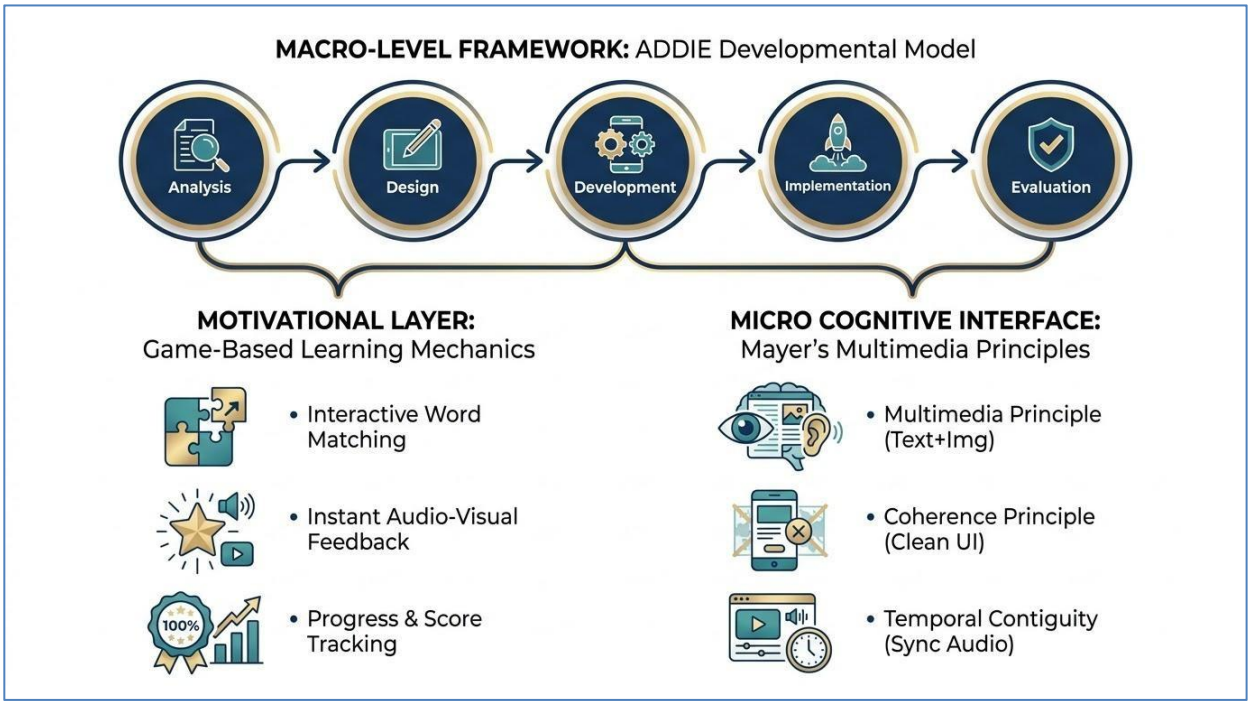


Figure 1

Tripartite conceptual framework of MalayLearning

Execution of the ADDIE Phases

Analysis Phase

The analysis phase aimed to identify the functional, pedagogical, and system requirements for a gamified Malay vocabulary app for non-native beginners. Using the dual-perspective requirement-gathering approach by Salam et al. (2019) and Abdul Mutalib et al. (2018), a targeted needs analysis was conducted:

- Conducted a semi-structured qualitative interview with a senior Malay language instructor at UUM to identify institutional course objectives and common student learning barriers.
- Distributed a quantitative and qualitative needs survey to 42 international students (demographics: aged 19–26, representing 8 different countries, currently in their first year of undergraduate studies) enrolled in compulsory Malay language courses at UUM to capture self-reported learning obstacles. The survey data were analyzed using descriptive statistics (frequencies and percentages) via SPSS software.

The findings revealed significant socio-linguistic challenges, such as limited vocabulary retention, pronunciation mistakes, listening comprehension problems, and low motivation during traditional paper-based memorisation.

Design Phase

During the design phase, Figma was used to create the conceptual architecture, game mechanics, and screen wireframes. To address the vocabulary and motivation issues identified in the Analysis phase, the application's content was divided into four distinct modules using the Segmenting Principle (Mutalib & Jaafar, 2018).

- Grammar: Chunked explanations of basic sentence structures.
- Vocabulary: Gamified word-matching puzzles with high-frequency themes (greetings, numbers, pronouns, and common questions).
- Pronunciation: Interactive phonics guides with audio playbacks.
- Listening: Audio-based comprehension exercises.

A persistent bottom navigation bar enables seamless transitions between learning modules and a dedicated Score Page, providing visual score feedback to reinforce learner autonomy and goal orientation.

Development Phase

In the development phase, low-fidelity Figma blueprints were translated into an interactive, high-fidelity application using Unity (Hamzah et al., 2025). Unity was chosen for its robust 2D development capabilities, cross-platform compilation (WebGL), and flexible event system for game mechanics. Mayer's Multimedia Principles were systematically incorporated into the micro-level visual choices.

- The multimedia principle was applied by pairing target Malay words with illustrative graphics to support dual-channel cognitive processing.
- The coherence principle was applied by excluding cluttered backgrounds and decorative visual assets to minimise visual cognitive load.
- The vocabulary module was compiled as an interactive word-matching puzzle game with immediate audio-visual feedback loops (success/error sound effects and visual animations) upon correct card matching.

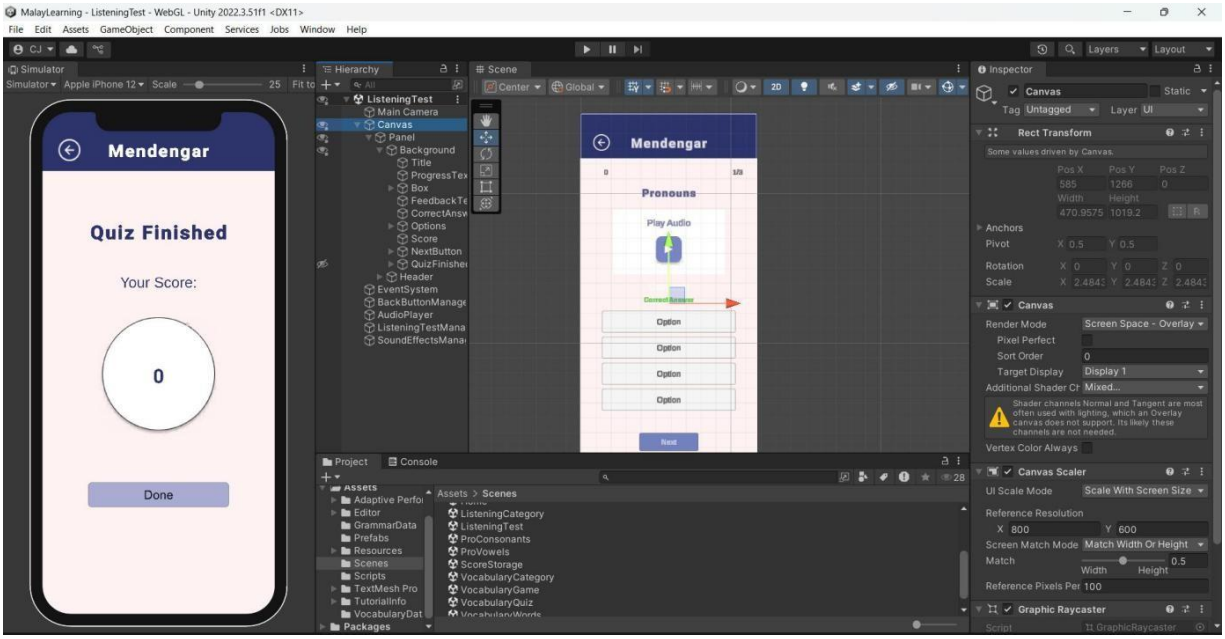


Figure 2

High-fidelity interface design and WebGL development environment in the Unity game engine.

Implementation Phase (Formative Evaluation)

The implementation phase was a formative verification stage to identify heuristic flaws, layout errors, and usability issues in the high-fidelity Unity prototype before public release. Evaluation involved a structured Expert Review protocol with a project briefing, guided hands-on testing, and semi-structured qualitative interviews.

Four UUM academic experts were selected, comprising three UX/UI experts, including lecturers from SMMTC specialising in human-computer interaction (Dr. Ruziana Mohamad Rasli, Dr. Aeni Zuhana Saidin, and Dr. Nur Sauri Yahaya), and one subject-matter expert, a Malay language instructor from SLCP specialising in non-native language instruction (Dr. Nasrol Hadi Ahmad Shukeri).

Interview protocols were adapted from the Nielsen Norman Group heuristic evaluation framework (Harley, 2018) to assess Usability Strengths, Problems, and Recommendations in Usability, Visual Layout, and Content domains.

Evaluation Phase (Summative Evaluation & Participant Profile)

The final phase validated system usability, user experience, quantitative performance metrics, and overall motivational acceptance among target end-users. A lightweight WebGL build of the Unity prototype was hosted on Itch.io, allowing n=5 international student participants to evaluate the application directly in their mobile web browsers without installation barriers. This is a standard, mathematically validated usability paradigm (Nielsen, 2012). Data were gathered via an open-ended survey and a standardised System Usability Scale (SUS) questionnaire (Brooke, 1996). The demographic breakdown of the participant panel is detailed in Table 1.

This phase was designed as a small-scale pilot usability evaluation rather than a broad validation of educational effectiveness. Task Completion Time (TCT) was calculated by timing users from

the start to the completion of a single vocabulary module, while Quiz Accuracy Rate (QAR) was calculated based on the percentage of correct initial matches during the quiz phase. It is noted that Participant 3 (P3) possessed an Elementary/Conversational baseline proficiency, which may have positively influenced the overall accuracy mean.

Table 1
Demographic Profile of International Student Participants ($n = 5$*)*

Participant ID	Country of Origin	Academic Program / Field of Study	Age	Baseline Malay Proficiency
P1	China	B.Sc. Information Technology	21	Beginner (VKMB1011 enrolled)
P2	Nigeria	B.A. Creative Industry Management	23	Beginner (VKMB1011 enrolled)
P3	Indonesia	B.B.A. International Business	20	Elementary / Conversational
P4	Pakistan	B.Sc. Multimedia	22	Beginner (VKMB1011 enrolled)
P5	Yemen	B.Sc. Economics	24	Beginner (VKMB1011 enrolled)

Ethical Considerations

All human subject evaluations were conducted in line with institutional research standards, adhering to strict research ethics. Before participating in the formative expert review and summative user evaluation, participants received a clear explanation of the research objectives and gave written informed consent. Participation was voluntary, and all collected diagnostic data, qualitative feedback, and survey metrics were anonymised to protect participant privacy.

RESULTS AND ANALYSIS

Formative Expert Review Results

The qualitative feedback from the formative expert review was tabulated to analyse the system's heuristics, interface layout, gamification balance, and content accuracy. The core interview prompts, adapted from the Nielsen Norman Group heuristic evaluation framework (Harley, 2018), are summarised in Table 2.

Table 2
Expert Review Heuristic Interview Questions for Formative Evaluation

Core Component	Interview Questions (Adapted from Nielsen Norman Group Heuristics)

Usability Strengths	What do you think are the primary usability and visual strengths of this application? Which gamified elements and interface components are particularly well designed?
Usability Problems	Are there any heuristic or usability issues present in the interactive interface? Where do these layout or media issues appear during interaction? Did you experience any friction or confusion while navigating the modules?
Recommendations for Improvement	How would you suggest resolving these specific usability or visual issues? What modifications would improve the overall gamified learning experience?

A qualitative analysis of the feedback showed that the application's visual design and gamified structure were well-received, but there were specific cognitive and interface issues that needed to be addressed. The detailed assessments from the SMMTC UX and SLCP content experts are summarised in Table 3.

Table 3
Qualitative Expert Review Feedback Across UX Design and Content Domains

Academic Expert	Usability & Gamification Strengths	Usability Problems Identified	Recommendations for Refinement
Expert 1 (UX Design, SMMTC)	Highly intuitive and user-friendly Vibrant color palette and functional controls Fully functional button transitions	None identified.	Add a persistent score tracking screen Implement user login profiles to store performance data
Expert 2 (UX Design, SMMTC)	Visually engaging and attractive UI Clear control feedback loops	Redundant "Next" button visible at final card limits Centered block text causes reading fatigue Auto-play listening audio overlaps with	Remove redundant navigation controls at final limits Adjust centered grammar explanations to left-aligned text

		feedback sound effects	Convert auto-play listening questions to user-controlled Play triggers
Expert 3 (UX Design, SMMTC)	High visual contrast and legibility Clear auditory and visual score feedback	Visual similarity between category selection and quiz cards causes confusion	Differentiate visual card borders for learning vs. quiz modes Standardize graphic art style (use cartoon graphics consistently) Add a persistent consonant tray in pronunciation mode
Expert 4 (Malay Instruction, SLCP)	Interface layout is welcoming and age-appropriate Vocabulary selection is highly suitable for non-native beginners	None identified.	Increase the ratio of Malay text across UI labels to foster passive language immersion

To improve system usability and cognitive clarity before end-user deployment, these expert recommendations were implemented in the Unity game engine. Table 4 and Figure 3 show the changes to the Before-and-After interface.

Table 4
Heuristic-Guided Interface Refinements Executed in the Unity Game Engine

Interface Module	Guiding Design & Cognitive Principle	Baseline Design (Before Formative Review)	Refined Interface (After Unity Refinements)
Navigation Controls	Mayer's Coherence Principle	Redundant "Next" buttons remained visible on terminal lesson cards, causing user confusion.	Redundant navigation buttons were programmatically hidden at card limits to eliminate visual clutter.
Grammar Layout	Aesthetic & Legibility Heuristics	Grammar explanations were center-aligned in block paragraphs, making text scanning difficult.	Paragraph text was left-aligned for natural reading flow, and clear "Examples:" labels were introduced.
Listening Quiz	Mayer's Temporal	Auditory test questions played automatically on-	Audio playback was converted to manual, user-controlled

	Contiguity Principle	screen load, overlapping with feedback audio.	triggers via an interactive Play button.
Gamified Progress	User Control & Goal Orientation	No score tracking screen was available to review completed quiz performance.	Integrated a dedicated "Score" page accessible via the persistent bottom navigation bar.
Pronunciation Guide	Flexibility & Interaction Efficiency	Switching letters required users to navigate back to the main menu each time.	Added a horizontal consonant selection tray at the bottom screen for direct letter switching.
Linguistic UI	Passive Immersion & Contextual Learning	High reliance on English labels across primary interactive menus and UI buttons.	Increased the proportion of Malay words across buttons and headers to promote passive vocabulary learning.

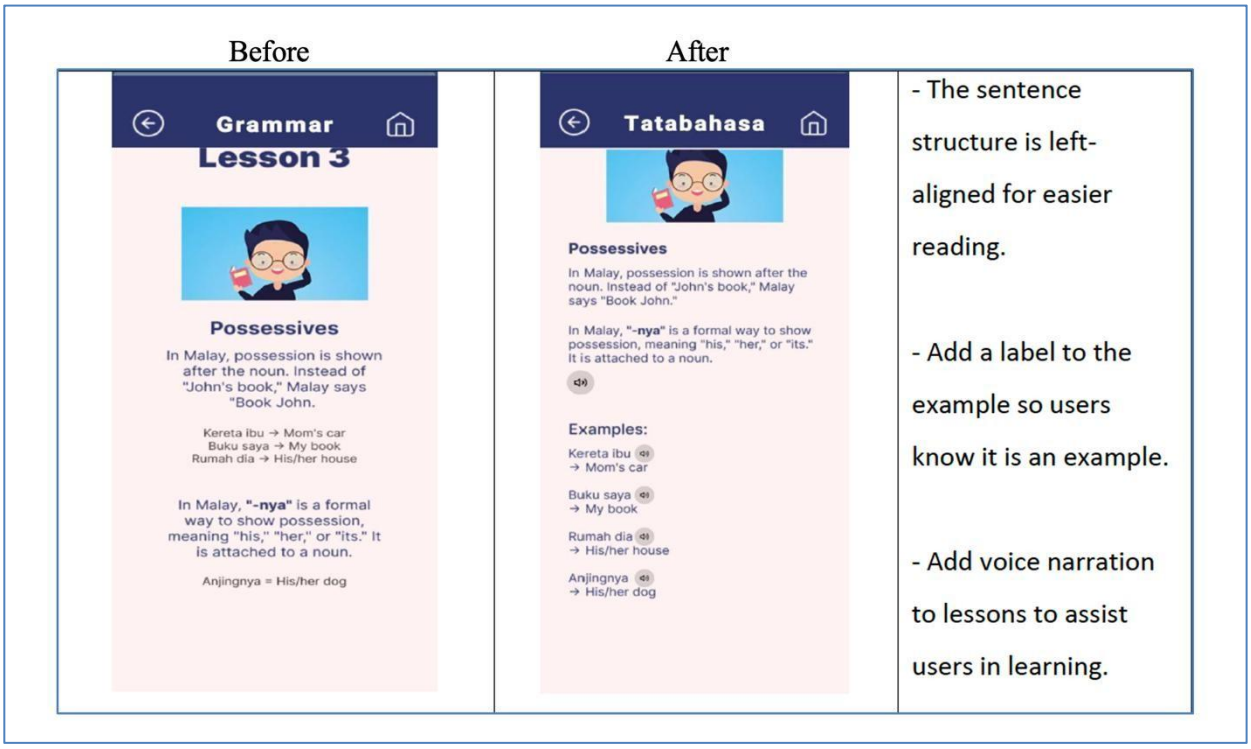


Figure 3

Comparison of initial (left) and improved (right) interface screens after expert review feedback (e.g., left-aligning text, removing unnecessary controls, and converting audio to user-controlled triggers)

Summative User Testing & Quantitative Usability Metrics

To enhance qualitative diagnostic feedback with empirical data, quantitative metrics were collected during summative WebGL user testing, including Task Completion Time (TCT), Quiz Accuracy Rate (QAR), and the System Usability Scale (SUS) (Brooke, 1996). The 10-item Likert-scale SUS questionnaire generates a composite usability score between 0 and 100.

Table 5
Quantitative Usability Performance and SUS Benchmarks (n = 5)

Metric / Evaluation Index	P1	P2	P3	P4	P5	Mean / Total	Standard Benchmark
Mean Task Completion Time (min)	3.4	3.1	2.5	3.2	3.5	3.14 min	Optimal (< 5.0 min)
Matching Quiz Accuracy Rate (%)	90%	95%	100%	85%	90%	92.0%	Mastery (> 80%)
System Usability Scale (SUS Score)	82.5	87.5	92.5	80.0	85.0	85.5 / 100	Grade A / "Excellent"

MalayLearning's SUS composite score of 85.5 out of 100 places it in the 90th percentile for user acceptance, according to established SUS usability benchmarks (Bangor et al., 2008). The mean task completion time of 3.14 minutes per vocabulary set and an overall quiz accuracy rate of 92.0% demonstrate that gamifying word-matching exercises effectively facilitates rapid comprehension and high lexical accuracy without inducing cognitive fatigue.

Qualitative feedback captured across the three core SMMTC evaluation vectors (Razak et al., 2024) is synthesised in Table 6.

Table 6
Qualitative User Feedback Synthesis Across SMMTC Evaluation Vectors

SMMTC Evaluation Vector	Qualitative Synthesis of Target International Student Feedback (n=5)
Usability	The system interaction was seamless, intuitive, and fluid. All five participants confirmed encountering no navigation errors or operational confusion. They praised the UI as ”clear, straight to the point,” and ”extremely easy to navigate.”
User Experience & Gamification	Learners showed high concentration and engagement due to the vibrant visual design and interactive matching puzzles. The gamified reward mechanics reduced language learning anxiety and boosted confidence in acquiring Malay words, resulting in a 100% peer-to-peer recommendation rate.
Suggestions for Improvement	Suggestions for improvement include integrating short situational animation clips for real-world campus context and incorporating an instant, interactive dictionary look-up feature during independent study.

Figure 4 shows the final WebGL application build of *MalayLearning*, with its main user interfaces on the Home dashboard, Kosa Kata (Vocabulary), Sebutan (Pronunciation), and Mendengar (Listening) interactive modules.

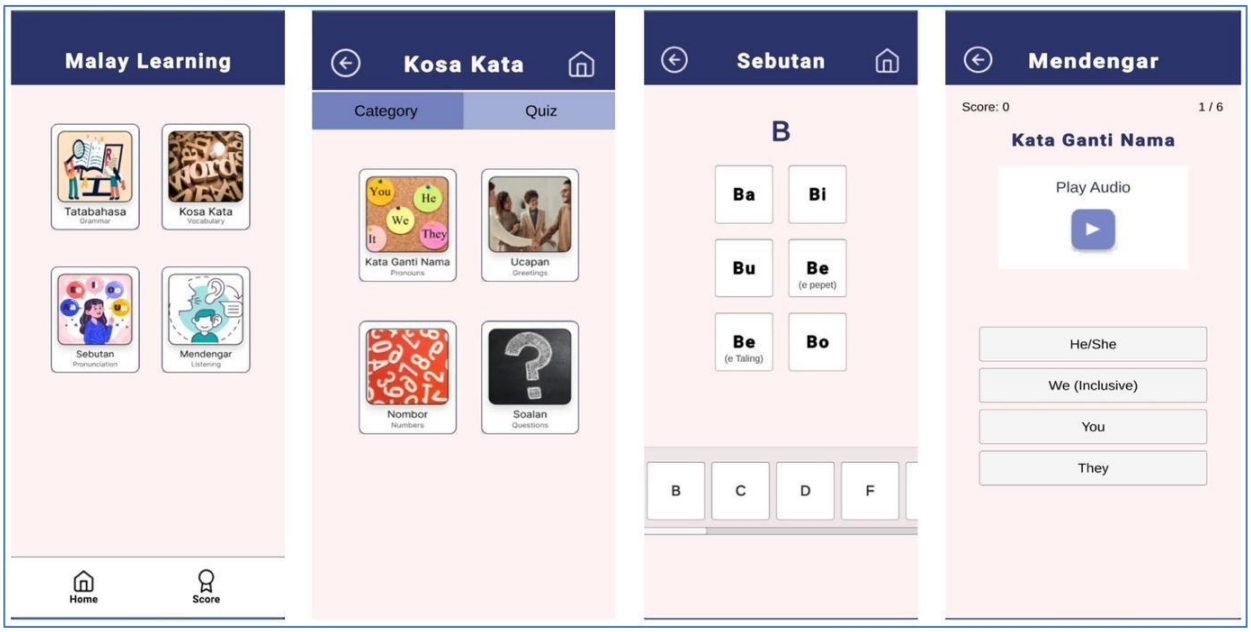


Figure 4

The final WebGL application build shows the main user interfaces on the Home dashboard, including Kosa Kata (Vocabulary), Sebutan (Pronunciation), and Mendengar (Listening) interactive modules.

DISCUSSION

Combining systematic instructional engineering (ADDIE) with Game-Based Learning mechanics, Flow Theory, and Mayer's Multimedia Principles creates an effective framework for mobile language learning. The mean SUS score of 85.5/100 and a 92.0% quiz accuracy rate prove this. Interactive word-matching puzzles and immediate feedback reduce cognitive load and promote autonomous vocabulary acquisition.

Formative evaluation identified and resolved cognitive and heuristic mismatches before deployment. Converting the listening quiz from automatic audio playback to user-controlled triggers satisfied Mayer's Temporal Contiguity Principle. Eliminating overlapping audio cues and allowing users to control playback timing reduced cognitive load and prevented divided attention. Hiding redundant navigation controls at card limits adhered to the Coherence Principle, removing extraneous visual information that could distract working memory.

The summative evaluation results validate the gamified mobile application. Unanimous positive feedback regarding system usability and zero reported operational friction confirm that *MalayLearning* resolves the core learning bottlenecks identified among international students at UUM. The high levels of engagement and user satisfaction align with findings by Lai and Lai (2021) and Phuc and Nghi (2023), confirming that embedding gamification mechanics, such as interactive word matching and instant score feedback, fosters intrinsic motivation, lowers learning anxiety, and stimulates active lexical retrieval.

The high ratings for usability and usefulness align with the Technology Acceptance Model (TAM), which suggests that ease of use and usefulness are key drivers of system adoption and continued use (Davis, 1989; Liaw & Huang, 2013; Venkatesh & Bala, 2008). A clean aesthetic balance and responsive UI feedback enhance ease of use, leading to deeper task concentration, flow states, and learning satisfaction (Csikszentmihalyi, 1990; Hamari et al., 2016; Tractinsky et al., 2000). Evaluating the prototype with five users satisfies established usability testing paradigms, as mathematical models show that a five-user panel can uncover up to 85% of core system usability and navigational defects (Nielsen, 2012).

Beyond technical performance, the findings have significant implications for cultural sustainability in higher education. The intuitive and engaging tool for learning Malay addresses communication barriers, helping international students adapt to campus life in Malaysia (Abdul Rahman et al., 2023; Lut & Starenkova, 2022; Smidt et al., 2017). By leveraging creative industry technology, specifically 2D game engines and mobile multimedia, the application bridges technology and heritage, promoting cultural preservation while supporting sustainable international education (Kramsch, 2014; UNESCO, 2021).

LIMITATIONS

This study provides promising preliminary usability data; however, several limitations must be acknowledged. The summative evaluation utilized a small sample size (n=5) suitable for heuristic and usability discovery, but insufficient for broad quantitative claims regarding long-term second-language acquisition. Furthermore, the study lacked a pre-test/post-test control group, occurred in a short-term testing environment, and featured heterogeneous baseline Malay proficiency among participants.

CONCLUSION AND FUTURE WORK

This study successfully designed, developed, and evaluated *MalayLearning*, a game-based mobile app to help international students at Universiti Utara Malaysia (UUM) overcome challenges in learning Malay vocabulary. By combining macro-level instructional engineering (ADDIE) with Game-Based Learning (GBL) mechanics, Flow Theory, and micro-level cognitive principles (Mayer's Principles of Multimedia Learning), this project demonstrates a robust framework for developing mobile-assisted language learning tools.

The two-stage evaluation paradigm validated the software.

- Formative Expert Review: Identified and resolved cognitive, heuristic, and interface mismatches in the Unity game engine to reduce cognitive load.
- Summative User Evaluation: Validated system acceptance among international students, achieving an 85.5/100 SUS score, a 92.0% quiz accuracy rate, zero operational friction, and a 100% peer-to-peer recommendation rate.

The research confirms that embedding gamified word-matching puzzles and immediate feedback loops into mobile language learning environments reduces learning anxiety, improves task concentration, and promotes autonomous second language acquisition.

To build upon these findings and meet user suggestions, the development roadmap for *MalayLearning* Version 2.0 focuses on the following strategic enhancements:

- Richly animated and contextualised animations and scenarios that represent real-world campus interactions, such as ordering food or requesting books, to contextualise vocabulary usage.
- An instant, interactive lookup feature that allows learners to tap unknown Malay words during independent practice without leaving the gamified environment.
- Secure individual student profiles and cloud database logging to record game scores, track learning curves, and provide personalised study recommendations.
- Transitioning from usability-focused testing to large-cohort, experimental research designs (pre-test/post-test control groups) over a full academic semester to quantitatively measure long-term vocabulary retention and spoken proficiency gains among international students.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHOR CONTRIBUTIONS

All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by all authors.

CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

Informed consent was obtained from all individual participants included in the study.

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REFERENCES

Abdul Mutalib, A., Sarif, S. M., & Rosmani, A. F. (2018). A preliminary investigation towards development of Islamic mobile application. Opcion, 34(86), 1184–1199.

Abdul Rahman, N. H., Ahmad, N. F., & Azman, F. N. (2023). Role of Bahasa Melayu as a compulsory course for international students in Malaysia. International Journal of Education, Psychology and Counseling, 8(5), 180–189.

Adeoye, M. A., Wirawan, K. A. S. I., Pradnyani, M. S. S. M., & Septiarini, N. I. (2024). Revolutionizing education: Unleashing the power of the ADDIE model for effective teaching and learning. Jurnal Pendidikan Indonesia, 13(1), 202–209.

Bangor, A., Kortum, P. T., & Miller, J. T. (2008). An empirical evaluation of the System Usability Scale. International Journal of Human–Computer Interaction, 24(6), 574–594. https://doi.org/10.1080/10447310802205776

Basal, A. (2016). The use of mobile applications in vocabulary learning and retention. Journal of Educational Technology & Society, 19(2), 295–306. http://dx.doi.org/10.5539/ies.v5n6p99

Branch, R. M. (2009). Instructional design: The ADDIE approach. Springer. https://doi.org/10.1007/978-0-387-09506-6

Brooke, J. (1996). SUS: A 'quick and dirty' usability scale. In P. W. Jordan, B. Thomas, B. A. Weerdmeester, & I. L. McClelland (Eds.), Usability evaluation in industry (pp. 189–194). Taylor & Francis.

Csikszentmihalyi, M. (1990). Flow: The psychology of optimal experience. Harper & Row.

Dauchot, N. (2019, October 5). Formative vs. summative research. Medium. https://uxdesign.cc/formative-vs-summative-usability-research-3dd2317b8b75

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

Demir, K., & Akpinar, E. (2018). The effect of mobile learning applications on students' academic achievement and attitudes toward mobile learning. Malaysian Online Journal of Educational Technology, 6(2), 1–15.

Demmel, S., Groh, G., & Dillenberger, M. (2011). Learning success through serious games. In International Conference on Entertainment Computing (pp. 526–533). Springer.

Gee, J. P. (2003). What video games have to teach us about learning and literacy (Vol. 1). Macmillan. https://doi.org/10.1145/950566.950595

Godwin-Jones, R. (2011). Emerging technologies: Mobile apps for language learning. Language Learning & Technology, 15(2), 2–11.

Granic, I., Lobel, A., & Engels, R. C. M. E. (2014). The benefits of playing video games. American Psychologist, 69(1), 66–78. https://doi.org/10.1037/a0034857

Habbash, M. S. (2015). The effect of mobile assisted language learning on vocabulary retention. International Journal of Computer Science and Network Security, 15(8), 125–131.

Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J., & Edwards, T. (2016). Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning. Computers in Human Behavior, 54, 170–179. https://doi.org/10.1016/j.chb.2015.07.033

Hamzah, H. I., Chin, Y. J., Tuan Muda, T. Z., & Zaiyadi, M. F. (2025). Usability acceptance of MalayLearning: A game-based mobile application for second language vocabulary acquisition. International Journal of Education, Psychology and Counseling, 10(61), 1207–1217. https://doi.org/10.35631/IJEPC.1061083

Harley, A. (2018, February 25). UX expert reviews. Nielsen Norman Group. https://www.nngroup.com/articles/ux-expert-reviews/

Hashim, S. N., & Yahya, S. N. (2019). Difficulties in learning Malay language among international students: A case study. International Journal of Education, Psychology and Counseling, 4(27), 241–251.

Hsieh, Y. L., Lee, Y. M., & Chen, H. H. (2015). The impact of game-based learning on students' learning effectiveness: An exploration of the role of flow. Journal of Computer Assisted Learning, 31(3), 195–208.

Kramsch, C. (2014). Language and culture. AILA Review, 27(1), 30–40. https://doi.org/10.1075/aila.27.02kra

Kurasinska, L. (2024, October 18). Formative vs summative evaluations in user research: What's the difference? Survicate. https://survicate.com/blog/formative-vs-summative-user-research/

Lai, C. H., & Lai, K. C. (2021). Investigating the use of mobile applications for learning English vocabulary: Effects on learning performance and satisfaction. Interactive Learning Environments, 29(7), 1184–1199.

Latha, S. S., Devi, G. R., & Sankar, A. (2015). Effectiveness of word puzzle games in teaching vocabulary in English language classrooms. International Journal of English Language Teaching, 3(2), 1–10.

Liaw, S. S., & Huang, H. M. (2013). The effect of perceived usefulness and perceived ease of use on the intention to use mobile learning applications. International Journal of Mobile Learning and Organisation, 7(3), 226–241. doi:10.17718/tojde.471649

Lut, K., & Starenkova, H. (2022). The relationship between language, culture, and development of society. Studies in Modern English, 63–72.

Mayer, R. E. (2001). A cognitive theory of multimedia learning: Implications for design. Computers in Human Behavior, 17(4), 305–316.

Mertasari, N. M. S. (2022). Summative evaluation of ICT-based learning media. Journal of Education Research and Evaluation, 6(4), 688–695. https://doi.org/10.23887/jere.v6i4.54695

Morrison, G. R., Ross, S. M., Kalman, H. K., & Kemp, J. E. (2019). Designing effective instruction (9th ed.). John Wiley & Sons.

Mutalib, A. A., & Jaafar, Y. (2018). Segmenting principle engages pre-school children with multimedia learning material. Journal of Social Sciences Research, 2018(Special Issue 6), 791–800. https://doi.org/10.32861/jssr.spi6.791.800

Nielsen, J. (2012). How many test users in a usability study? Nielsen Norman Group. https://www.nngroup.com/articles/how-many-test-users/

Phuc, T. H., & Nghi, T. T. (2023). Examining the impact of mobile apps on language teaching and learning in a public university: An experimental study. International Journal of Linguistics Literature & Translation, 6(6), 113–121.

Polakova, P. (2022). Use of a mobile learning application in the process of foreign vocabulary learning. Procedia Computer Science, 207, 64–70. https://doi.org/10.1016/j.procs.2022.10.115

Razak, A. H. A., Hamzah, H. I., & Hamzah, M. H. I. (2024). Qualitative evaluation questions for formative and summative assessment of multimedia projects. International Journal of Business and Technology Management, 6(S3), 253–264. https://doi.org/10.55057/ijbtm.2024.6.S3.25

Salam, S. N. A., Mutalib, N. A. A., & Aziz, N. (2025). Designing interactive mobile learning applications for visually impaired children: A user experience evaluation based on affective design principles. International Journal of Interactive Mobile Technologies, 19(3), 114–131. https://doi.org/10.3991/ijim.v19i03.52091

Salam, S. N. A., Saidin, A. Z., Razif, F. M., Zainal, R. N., & Ramli, P. (2019). User requirements analysis and persona for mobile application guide for infrequent flyers (Magif). International Journal of Recent Technology and Engineering, 8(3), 293–308.

Sarif, S. M., Hanafi, Z., Packeer Mohamed, S. F., Zaibon, S. B., & Mohamad Mohsin, M. F. (2020). Makan@Local chatok: Mobile eatery recommendation system based on local knowledge. International Journal of Interactive Mobile Technologies, 14(5), 112–126. https://doi.org/10.3991/ijim.v14i05.13357

Smidt, E., Li, R., Broido, E., & Muirhead, B. (2017). The interplay of language, culture, and technology in international higher education. International Journal of Educational Technology in Higher Education, 14(1), 1–16. https://doi.org/10.1186/s41239-017-0056-1

Tractinsky, N., Shoval-Katz, A., & Ikar, D. (2000). Bridging the gap: Between the theory and practice of aesthetics in human-computer interaction. ACM SIGCHI Bulletin, 32(4), 169–183.

UNESCO. (2021). Basic texts of the 2003 Convention for the Safeguarding of the Intangible Cultural Heritage. UNESCO Publishing. https://ich.unesco.org/en/basic-texts-00503

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.1540-5915.2008.00192.x

Wiwat, T. (2013). The effectiveness of word puzzle games in promoting English vocabulary learning. Journal of Language Teaching and Research, 4(2), 246–252.

Wong, M. S., & Lim, C. P. (2022). Enhancing language learning effectiveness through the application of Mayer's multimedia principles in mobile learning environments: A review. Educational Technology Research and Development, 70(3), 875–896.

Zaini, M., & Yaacob, R. (2023). Developing a mobile application using gamification elements for learning Malay vocabulary among non-native speakers. International Journal of Modern Languages and Applied Linguistics, 7(1), 1–15.