

DESIGN AND DEVELOPMENT OF A MOBILE COURSEWARE FOR BASIC CHINESE LANGUAGE LEARNING AMONG UPSI STUDENTS

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ABSTRACT

This study focuses on the design and development of MasterHanyu, a mobile courseware developed to support Basic Chinese language learning among students at Universiti Pendidikan Sultan Idris (UPSI). Learning Chinese as a second language presents considerable challenges for beginner learners, particularly in vocabulary acquisition, pronunciation, and maintaining learner engagement. Traditional classroom-based instruction often provides limited opportunities for individualized practice and continuous reinforcement, creating a need for supplementary learning tools that are accessible, interactive, and self-paced. To address this need, MasterHanyu was designed and developed as a mobile learning application using the Flutter framework, with Supabase employed for user authentication, session management, and secure cloud-based data storage. The application offers structured learning modules, vocabulary exercises with native speaker audio, interactive quizzes, progress monitoring, and a gamified reward system based on experience points (XP) to enhance learner motivation. Personalized learning is supported through user authentication, enabling individual progress tracking and reward management. The development process was guided by the Incremental Evolutionary Prototyping Model and implemented in three phases: (1) development of learning modules and quizzes, (2) integration of progress tracking and performance statistics, and (3) implementation of the rewards system. User Acceptance Testing (UAT) was conducted with seven UPSI students to evaluate the application in terms of functionality, usability, learner engagement, and learning support effectiveness. Data were collected through functional testing and usability feedback questionnaires. The findings indicate that MasterHanyu operates according to its intended design specifications and provides an intuitive and user-friendly interface. Participants reported positive perceptions regarding the application's ease of use, motivational features, and effectiveness in supporting self-paced learning. The study demonstrates that mobile courseware can serve as an effective supplementary learning resource for university students studying Chinese as a foreign language. Although the current version does not include advanced features such as speech recognition and artificial intelligence-based feedback, MasterHanyu establishes a strong foundation for future enhancements in mobile-assisted language learning.

Keywords: Mobile courseware, Basic Chinese language learning, mobile learning, Flutter, Supabase, gamification, UPSI.

1.0 INTRODUCTION

Language functions as a fundamental instrument for communication, which determines social connections and academic achievements, especially within the multilingual environment of Malaysia. Chinese is the most widely spoken language in the world, spoken in some form by 1.3 billion people (Taleb-Agha, R., 2024). The worldwide rise of Chinese Mandarin as a leading spoken language stems from China's growing educational, commercial, and cultural activities worldwide. University students facing expanding Chinese global influence seek Mandarin Chinese education to unlock broader opportunities. The Malaysian educational institutions, together with their population, accept Mandarin as both an everyday language and an academic subject that students can study at institutions such as Sultan Idris Education University (UPSI). The acquisition of Mandarin Chinese proves difficult for second-language students, mainly those who do not speak it natively. Students face three key learning challenges, which include pronunciation difficulties alongside tone recognition issues and limited vocabulary expansion and grammar errors. Learning difficulties lead students to develop lower confidence levels while facing communication issues, which create a barrier to their continued learning. The project introduces MasterHanyu, which functions as a mobile educational tool for UPSI students learning basic Chinese. The application uses interactive design to offer students pronunciation training as well as vocabulary training, mini-quizzes, and contextual lessons, which help students learn independently. The chapter presents the research background along with the problem statement, research objectives, research questions, project scope, and study significance of the development of MasterHanyu.

People who learn Mandarin in Malaysia face major difficulties when learning its pronunciation. The tonal nature of Mandarin Chinese requires precise pitch control because each tone variation changes the meaning of words and phrases. A fifth neutral tone exists alongside the four fundamental tones of Mandarin Chinese. The tones serve as vital components that distinguish words through their pronunciation. Learning and understanding Mandarin requires students to master its tonal system. The complex nature of this language presents major obstacles to learners who speak non-tonal languages like Malay or English as their first language. Students who learn Chinese as a second language have difficulty producing correct tones with accuracy. Mispronouncing a word's tone can lead to misunderstandings or even completely change the meaning of a word (Pan et al., 2023). The difficulties in learning Mandarin pronunciation could extinguish learners' aspirations to learn Mandarin (Ting & Ooi, 2023). Although Chinese is widely taught in Malaysian institutions, effective teaching and learning remain hindered by several issues, including the shortage of trained instructors, ineffective materials, and a lack of language policy support (Ren et al., 2024). These shortcomings create significant barriers for second-language learners in some institutions.

Moreover, classroom-based teaching is often rigid, lacking flexibility and personalized learning. Not all students in the classroom can learn and pick up Chinese easily. The major setback in learning a language is the difficulty in remembering and constructing words using new sounds, rhythms, and intonations to smoothly convey thoughts and intentions (Nurul Ain et al., 2020). Research has shown that mobile-based learning tools improve learner autonomy, engagement, and motivation, offering solutions for these shortcomings (Jureynolds et al., 2021). Mobile learning applications provide an inspiring chance to deliver adaptable, self-directed, interactive learning opportunities for language education. MasterHanyu development seeks to address existing challenges by implementing interactive educational components that

provide beginner Chinese students with pronunciation tools alongside contextual vocabulary content and audio-visual materials.

2.0 LITERATURE REVIEW

Modern mobile devices and educational programs have significantly advanced second language acquisition, particularly for the challenging language Mandarin Chinese. Traditional methods of language acquisition face restrictions since they do not offer adaptable learning opportunities combined with individualized paces and interactive features essential for achieving mastery. Mobile-Assisted Language Learning (MALL) has emerged as a powerful alternative, offering learners autonomy, interactive content, and multimedia features that enhance vocabulary acquisition and pronunciation practice (Ally, 2004). This study examines present scholarly work about mobile applications for language learning and their learning approaches and Chinese pronunciation learning obstacles and gamification effects and AI and feedback systems. The study examines learning theories together with analysis of popular language learning applications to build a framework for MasterHanyu mobile courseware development for UPSI students.

2.1 Comparison Between Three Learning Theories

The three major learning theories Behaviorism, Cognitivism, and Constructivism offer distinct perspectives on how learners acquire knowledge and how instructional materials should be designed. As shown in Table 1, Behaviorism emphasizes observable changes in behavior through stimulus-response mechanisms, often implemented through repetitive drills and immediate reinforcement. Cognitivism focuses on internal mental processes such as information processing, memory, and understanding, and supports learning through structured guidance and scaffolding. In contrast, Constructivism views learning as an active process in which learners construct their own understanding through meaningful experiences, collaboration, and real-world problem-solving activities (Terry Anderson & Mohamed Ally, 2004; Peggy A. Ertmer & Timothy J. Newby, 2013).

Table 1: Comparison of Behaviorism, Cognitivism, Constructivism

Aspect	Behaviorism	Cognitivism	Constructivism
View of Learning	Passive response to external stimuli	Active mental processing and encoding	Constructing knowledge through experience
Instructional Design	Repetition, reinforcement, drill-based tasks	Scaffolding, chunking, use of memory aids	Real-world problem-solving, social interaction
Role of Feedback	Positive/negative reinforcement	Clarification and guidance	Peer or facilitator feedback
Example Application	Quizzes with immediate feedback	Guided practice with explanations	Discussion-based or exploratory learning

2.2 Comparison of Existing Mobile Applications

Apps designed to support the learning of Mandarin Chinese have emerged globally, offering diverse approaches in terms of interaction design, pedagogical methods, gamification elements, and learner engagement strategies. Each application reflects different instructional philosophies and levels of linguistic depth, particularly in areas such as pronunciation training, character acquisition, and skill progression. By comparing existing applications, it is possible to identify effective features, limitations, and design gaps that can inform the development of MasterHanyu. This study focuses on three widely used Mandarin learning applications: Duolingo, Busuu, and HelloChinese, which represent different instructional models ranging from highly gamified learning to structured curriculum-based systems. Duolingo is widely recognized for its gamified and accessibility-driven approach, which emphasizes short, repetitive exercises and motivational elements such as streaks and rewards. However, its Mandarin course is often described as limited in depth, particularly in areas such as tone mastery, grammar explanation, and productive language skills. Busuu, in contrast, provides a more structured learning pathway aligned with the CEFR framework. It integrates native speaker feedback and offers more formal grammar instruction, making it more suitable for learners seeking systematic progression and real-world language application.

HelloChinese is specifically designed for Mandarin learners and provides more comprehensive coverage of core language skills, including pronunciation training, tone recognition, character writing, and listening comprehension. Compared to Duolingo and Busuu, it places greater emphasis on Mandarin-specific pedagogy and structured progression, making it particularly effective for beginners aiming for functional proficiency. Overall, the comparison indicates that while Duolingo excels in engagement and accessibility, Busuu offers structured academic progression, and HelloChinese provides the most Mandarin-specialized learning experience. These findings highlight the importance of combining gamification, structured learning pathways, and Mandarin-specific instructional design in the development of MasterHanyu

Table 2: Comparison between Duolingo, Busuu and Hello Chinese.

No	Features	Duolingo	Busuu	HelloChinese	MasterHanyu
1	Learning Experiences	Gamified and interactive learning.	Structured lessons with real-world conversations.	Lessons that include Chinese culture and daily life situations.	Lesson prioritizes daily conversation in Malaysia.
2	Vocabulary & Pronunciation	Matching, speech tests, and listening tasks.	Word cards, audio clips, and pronunciation feedback.	Flashcards and tone correction.	Word cards feature local audio and pronunciation practice.
3	Grammar & Sentence Practice	Grammar through repetition, fill-in-the-blanks, tips	Sentence structure, grammar exercises, and writing tasks.	Fill-in-the-blanks, grammar notes, dialogue drills.	Dialogue exercises, grammar notes, and fill-in-the-blanks.
4	Achievement and Rewards System	XP points, daily streaks, crowns, and badges.	Points, badges, certificates (Premium).	Coins, stars, achievements, fluency bar.	Points and badges.
5	Content & Curriculum	Use a visual skill tree, where each skill is theme-based and designed to align with CEFR levels.	CEFR-aligned and use real-life dialogue themes.	Aligns with HSK (Chinese Proficiency Test) standards. * HSK: Hanyu Shuiping Kaoshi	Use the UPSI Basic Communication Chinese Language Module.
6	Target Audience	All ages	Adults and students	Beginners	Beginner-friendly
7	Language	Variety	Variety	Chinese (Mainland)	Chinese (Malaysian)

This part highlighted the distinctions of mobile-assisted learning methods and how they could address the difficulties non-native learners face when mastering Mandarin, bearing in mind that while mastering conceptual principles in the language, pronunciation of words with different tones may introduce difficulties in communicating correctly to other native speakers. Therefore, the literature reviewed highlights that pedagogical principles such as constructivism combined with behavioral and cognitive elements could be indigenously inserted into MasterHanyu. Hence, with the review and explanation of the educational theories and frameworks, a comparison of existing applications revealed that there are popular applications that support users in creating foundational learning in mandarin: duolingo, busuu and HelloChinese. Despite their success, there is an educational gap and not necessarily localization of content and contextual learning and developing a course relevant to Malaysian university students. MasterHanyu would try to bridge the educational gap by providing mLearning (Mobile Learning of Mandarin Language) through interactive, enjoyable, and meaningful experiences; using accessible mobile technology; and engaging language learners by integrating learning into language learners lived experiences, representing learners' daily basis for their education and learning language goals.

3.0 METHODOLOGY

The section presents the complete methodology developed to create MasterHanyu, which serves as a mobile learning application to help non-native Chinese speakers at Universiti Pendidikan Sultan Idris (UPSI) learn Chinese from the beginner level. The project development methodology matches the project development approach, which builds systems through incremental development and evolutionary change by allowing systematic development of learning modules and quizzes and progress tracking and authentication management and the rewards system. The application needed educational development because its main purpose required proper educational methods to be applied together with user-friendly design and ways to keep learners interested. The selected development model enables structured implementation through its capacity to enable ongoing improvement after each evaluation phase. The approach guarantees that both instructional content and technical functionality achieve the intended learning objectives. The chapter begins with an explanation of the chosen Software Development Life Cycle (SDLC) model, which leads to the detailed description of planning and requirements analysis and design and development and testing processes. The system implementation uses multiple technologies, which include Flutter for mobile development and Supabase for authentication and data management. It also includes details about the testing approach with UPSI students, and it also outlines the ethical standards followed during the development process.

3.1 Software Development Life Cycle (SDLC)

The MasterHanyu project needed a structured software engineering method that maintained system flexibility because it needed to develop both accurate teaching methods and mobile application user interface elements. The application required a development approach that would enable the researchers to validate content through system testing and implement multiple components while proceeding with system development until the final version.

The Software Development Life Cycle (SDLC) model selection process needs to identify the proper model because it will guide the development process for essential system features,

which include learning modules and quizzes, progress tracking, and rewards system functions. The educational application development process required continuous user feedback because subject-matter experts and actual users provided ongoing feedback, which required content structure, user interface design, and system functionality changes based on assessment results.

The Waterfall model and other traditional linear models proved unacceptable because they use a fixed sequence of development steps, which makes any changes to the project expensive after reaching advanced development stages. The testing process of educational applications requires modifications because user testing reveals issues with lesson comprehension and navigation systems and methods to attract user participation. The Agile methodologies provide flexible project management methods that use fewer documentation and validation methods, which research projects require under academic standards.

The Incremental Evolutionary Prototyping Model stood out as the best SDLC method for MasterHanyu according to our evaluation. The model enables system development, which advances through defined milestones, because developers create functional modules that undergo design, prototyping, assessment, improvement, and testing before moving to the next development stage. The model's evolutionary design enables developers to enhance existing features through ongoing user and expert feedback. Educational software applications benefit from this method because it enables them to test their teaching materials and user experience through multiple proofing processes, which establish both educational effectiveness and system dependability.

3.2 Incremental Evolutionary Prototyping Model

The development methodology adopted in this project is the Incremental Evolutionary Prototyping Model, which combines three complementary approaches: incremental development, evolutionary development, and prototyping. As illustrated in Figure 1, this model enables the system to be developed progressively through a series of structured increments, with each increment producing a functional prototype that is evaluated and refined before proceeding to the next stage. The incremental approach involves dividing the system into smaller and more manageable modules, with each increment representing a specific subset of the application's functionality. At the end of each increment, a working version of the system is produced and integrated into the overall application. This approach allows the development team to focus on one set of features at a time, thereby reducing complexity and improving project control.

The evolutionary approach emphasizes the continuous enhancement of the system through iterative development and user feedback. Rather than attempting to deliver a complete system in a single phase, an initial version is developed and then progressively improved based on testing results and user evaluations. This ensures that the final product evolves in response to identified issues and user needs. The prototyping approach involves creating an early working model of the system, which is tested and revised repeatedly until an acceptable solution is achieved. According to Lewis (2023), prototyping is a system development method in which a prototype is built, tested, and reworked as necessary before the complete system is finalized. This approach is particularly useful for validating design ideas and ensuring that system requirements are met effectively. By integrating these three approaches, each module of MasterHanyu was first developed as a standalone prototype. The prototype was then tested and

evaluated by end users, and the feedback obtained was used to refine the module before development proceeded to the next increment. This process ensured that every component was thoroughly assessed for both functional correctness and user satisfaction.

In this project, the methodology began with the requirements analysis phase, followed by a series of mini development cycles consisting of quick design, prototype construction, client evaluation, and prototype refinement. After completing each cycle, the system underwent testing and deployment. As shown in Figure 1, this sequence was repeated three times to develop the major functionalities of the application: (1) learning modules and quizzes, (2) progress tracking and statistics, and (3) the rewards system. Overall, the Incremental Evolutionary Prototyping Model was well suited to the development of MasterHanyu because it provided flexibility, encouraged continuous user involvement, and enabled the progressive enhancement of the application until a stable and effective mobile courseware was successfully produced.

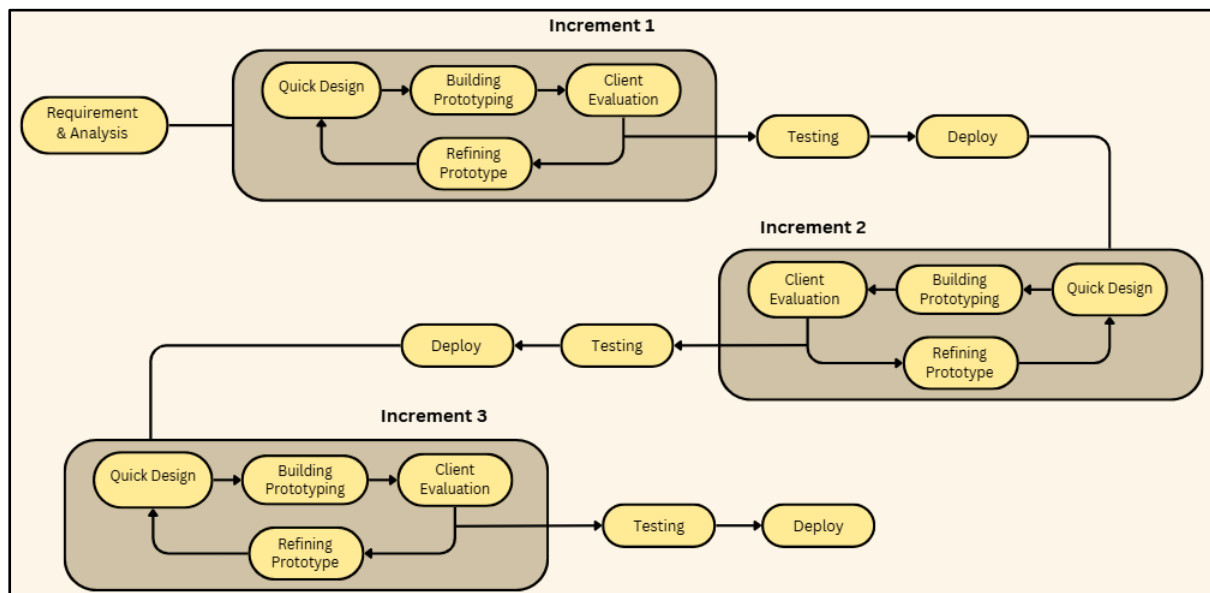


Fig 1: Incremental Evolutionary Prototyping Model

4.0 RESEARCH FINDINGS

The multimodal presentation significantly enhances word recognition and helps learners improve their pronunciation by integrating visual, auditory, and interactive elements. Immediate feedback is provided through the following interfaces:

- Correct Screen – Displays positive reinforcement messages along with reward animations to motivate learners and strengthen their confidence.
- Wrong Screen – Encourages learners to try again by providing supportive prompts without causing discouragement.
- Result Screen – Summarizes learners' performance, including score percentages and experience points (XP) earned.

Figure 2 illustrates the Profile Screen, which provides comprehensive progress tracking, including accumulated experience points (XP), completed lessons, and achievement badges. This feature supports self-regulated learning by enabling students to monitor their own progress and identify areas that require further improvement. Overall, the system's user interface (UI) is designed with clear and consistent visual elements, motivational feedback, structured learning progression, and intuitive navigation. These design features enhance learner engagement while minimizing cognitive load, thereby creating a more effective, efficient, and enjoyable learning experience for students.

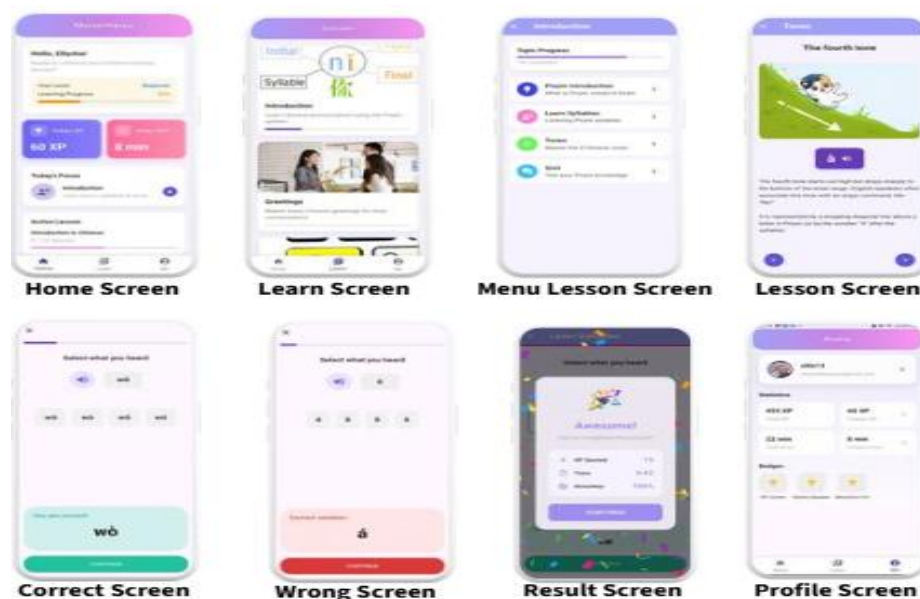


Fig 2: The Profile Screen

The development of MasterHanyu was carried out using the Incremental Evolutionary Prototyping Model, which facilitated the systematic refinement and enhancement of application features through a series of structured development increments. This approach enabled the research team to identify usability issues and functional limitations at an early stage and to address them progressively throughout the development process.

The development was organized into three main increments. The first increment focused on the implementation of the core instructional components, including structured vocabulary lessons, native speaker audio playback, and basic quiz modules designed to assess learners' understanding of lesson content. The second increment introduced learner progress tracking and statistical features, such as experience point (XP) calculation, study time monitoring, lesson completion tracking, and the development of a personalized profile dashboard to visualize learning progress. The third increment concentrated on enhancing the gamification elements, including the reward system, badge redemption, result feedback screens, user interface improvements, and overall performance optimization.

Each increment involved prototype construction, internal functional testing, feedback analysis, and iterative revisions. This evolutionary development process resulted in a stable and well-integrated mobile application with improved usability and a more engaging learning experience. The findings demonstrate that the Incremental Evolutionary Prototyping Model

was highly effective in supporting the structured development of educational mobile applications.

MasterHanyu was developed as a Mobile-Assisted Language Learning (MALL) application using a modern and scalable technology stack. The application was built with Flutter and the Dart programming language, enabling cross-platform deployment on both Android and iOS devices. Flutter's widget-based architecture supported the development of structured lesson interfaces, interactive quizzes, responsive user feedback screens, and smooth navigation transitions. Supabase was used to manage user authentication, session handling, and cloud-based database storage. The platform provided secure email-based authentication and ensured accurate storage and retrieval of users' XP records, lesson completion data, and quiz scores across multiple learning sessions. Development was conducted using Visual Studio Code, while testing and debugging were performed on a Samsung Galaxy Android device to evaluate real-world performance, including authentication reliability, touch responsiveness, screen rendering, and audio playback.

Several key features were incorporated into MasterHanyu to support beginner Chinese language learning. Vocabulary lessons were presented systematically with Chinese characters, pinyin, and English translations. Each vocabulary item was accompanied by native speaker audio recordings to improve pronunciation awareness. Interactive quizzes were provided at the end of each lesson to assess learner comprehension. Immediate feedback was delivered through dedicated Correct and Incorrect Result Screens, allowing learners to reinforce correct answers and review mistakes. XP points were awarded automatically based on quiz performance, and the system recorded study time upon completion of each lesson and quiz.

A personalized Profile and Progress Dashboard was also developed to display each learner's accumulated XP, total study time, lesson completion history, and achievement indicators. This feature enabled learners to monitor their own performance and encouraged self-regulated learning. The integration of gamification elements, such as XP accumulation and rewards, increased learner motivation and promoted consistent practice.

The final prototype successfully integrated structured lesson delivery, secure user authentication, individualized progress tracking, and gamified reward mechanisms into a single mobile learning environment. The modular architecture of the application provides a strong foundation for future enhancements, including speech recognition for pronunciation assessment, artificial intelligence-based adaptive quizzes, and expanded lesson categories. These findings indicate that mobile technology, when combined with systematic instructional design, can effectively support university students in acquiring basic Chinese language skills.

The testing phase confirmed that MasterHanyu functioned reliably and provided an effective and engaging learning experience for beginner Chinese learners. All testing activities were conducted according to a comprehensive test plan covering key components, including Authentication, Home Dashboard, Learning Modules, Quiz Interaction, Result Feedback, XP Calculation, and Profile Management. Iterative testing throughout the development cycle enabled the early detection and correction of technical issues. The testing process verified functional accuracy, system responsiveness, Android compatibility, and data integrity within authenticated user sessions. Overall, the results demonstrate that MasterHanyu met its design

objectives and is suitable for use as a supplementary mobile courseware for Basic Chinese language learning among students at Universiti Pendidikan Sultan Idris.

5.0 CONCLUSION

The development of MasterHanyu demonstrates how mobile technology, structured lesson design, and gamification elements can be effectively integrated to support beginner Chinese language acquisition among university students. Based on system implementation and User Acceptance Testing (UAT) results, the application successfully achieved its primary objective of providing a structured, user-friendly, and motivating mobile learning platform.

Strength of MasterHanyu that contributes greatly to learners' growth in Chinese is its modular lesson design. Each module builds on students' previously mastered words and skills so they can track their advance towards mastery/quiz-type knowledge. The use of characters, Pinyin (Phonetic System), English translations, and audio from native speakers creates multimodal learning, combining both visual and auditory stimuli. Therefore, the modules are presented in a manner consistent with Second Language Acquisition (SLA) principles: gradual scaffolding of Knowledge (for Beginning Students).

Gamification elements, such as XP (experience points) and user feedback to provide users with responses to their performance in the module and achievement indicators for completion, have established greater levels of learner engagement than if the same activities were conducted without the gamification elements. Additionally, UAT data from students confirmed that learners exhibited increased motivation to continue their study of Chinese as a result of the tracking and reward system established by the gamification components. This supports previous research that the use of gamified systems to provide performance comprehension and to assist with self-regulated learning functions promotes continued participation in digital educational environments.

Flutter and Supabase were a good match from a technology perspective to develop a mobile learning application that would be secure and reliable. The authentication and session management for users developed with Supabase provide unique and secure progress data for all users so that their individual performance is always tracked separately. Data stored in a cloud-based solution provides for a consistent performance from one session to the next, allowing for personalized learning to continue regardless of where the user was when the last session ended. The only minor limitation was having a reliable internet connection to synchronize the database and slow performance when users logged in for the first time during an unstable network connection. This information demonstrates the need for optimization and performance when designing and developing any cloud-based mobile learning application.

Overall, MasterHanyu shows how the principles of educational design can be implemented and incorporated into a successful application to meet the desired learning objectives.

REFERENCES

1. Ally, M. (2008). 1. Foundations of Educational Theory for Online Learning. In T. Anderson (Ed.), *The Theory and Practice of Online Learning* (pp. 15-44). Athabasca: Athabasca University Press. <https://doi.org/10.15215/aupress/9781897425084.003>

2. Busuu. (2011). Busuu: Learn Languages Online (Version 32.14.3) [Mobile App]. Google Play Store. <https://play.google.com/store/apps/details?id=com.busuu.android.enc>
3. Duolingo. (2013). Duolingo: Language Lessons. (Version 6.36.3) [Mobile App]. Google Play Store. <https://play.google.com/store/apps/details?id=com.duolingo>
4. Ertmer, P. A., & Newby, T. J. (2013). Behaviorism, Cognitivism, Constructivism: Comparing Critical Features from an Instructional Design Perspective. *Performance Improvement Quarterly*, 26(2), 43–71. <https://doi.org/10.1002/piq.21143>
5. Hadi Mogavi, R., Guo, B., Zhang, Y., Haq, E.-U., Hui, P., & Ma, X. (2022). When Gamification Spoils Your Learning: A Qualitative Case Study of Gamification Misuse in a Language-Learning App. *Proceedings of the Ninth ACM Conference on Learning @ Scale*. <https://doi.org/10.1145/3491140.3528274>
6. Hai, Y. N., & Norhaniza, W., (2023). Development of Mobile Learning Application for Chinese Pinyin with Virtual Assistant. *Applied Information Technology And Computer Science*, 4(1), 657-675. <https://publisher.uthm.edu.my/periodicals/index.php/aitcs/article/view/7415>
7. Henry, H., & Eryc Eryc. (2024). Speech Recognition to Aid Hanyu Pinyin Pronunciation as Part of Mandarin Language Education. In *CoMBInES-Conference on Management, Business, Innovation, Education, and Social Sciences*, 4(1), 102–117. <https://journal.uib.ac.id/index.php/combines/article/view/8705>
8. Hieu Le Ngoc & Khai, X. T. (2021). A NEW APPROACH IN ELEMENTARY CHINESE PRONUNCIATION TEST USING AI VOICE RECOGNITION AT HCMUE. *13th International Conference on Education and New Learning Technologies*, 5117–5127. <https://doi.org/10.21125/edulearn.2021.1056>
9. HelloChinese. (2015). HelloChinese: Learn Chinese. (Version 7.5.5) [Mobile App]. Google Play Store. <https://play.google.com/store/apps/details?id=com.hellochinese>
10. Gowtham, V., Manoj, Y., Pooventhiran, G., Praveen, A., Shivaram, R., & Kathiresan, A. (2017). Evolutionary models in software engineering. *International Journal of New Technology and Research*, 3(5), 263294. https://www.academia.edu/download/58728795/Evolutionary_Models_in_Software_Engineering_-_IJNTR.pdf
11. Jureynolds. (2024). Mandarin Learners' Use Perceptions of AI-Based Native Speaker Online Discussion Forums. *Engineering Proceedings*, 74(1), 11. <https://doi.org/10.3390/engproc2024074011>
12. Jureynolds, Theresia, & Ying, Y. (2021). Benefits of Using Mobile Apps as a Support for Mandarin Language Learning. *Journal of Physics: Conference Series*, 1764(1), 012088. <https://doi.org/10.1088/1742-6596/1764/1/012088>
13. Lewis, S. (2023). What is the Prototyping Model? *SearchCIO*. <https://www.techtarget.com/searchcio/definition/Prototyping-Model>
14. Lin, X., & Mariana. (2023). University Students Using Mobile Application as Self-Directed Learning Tool for Learning Chinese. *E3S Web of Conferences*, 426, 01029. <https://doi.org/10.1051/e3sconf/202342601029>
15. Ng, M. P., Norlidas, A., & Dewitt, D. (2022). Effectiveness of a gamification application in learning Mandarin as a second language *Malaysian Journal of Learning & Instruction*, 19(2), 183-211. <https://doi.org/10.32890/mjli2022.19.2.7>
16. Nurul Ain, C., Azza Jauhar, A., T., Goh, Y., S., & Che, M., Z. (2020). PERCEIVED DIFFICULTIES IN LEARNING OF MANDARIN AMONG FOREIGN-

- LANGUAGE LEARNERS AND STRATEGIES TO MITIGATE THEM. *Journal of Business and Social Development*, 8(2), 43–52.
<https://doi.org/10.46754/jbsd.2020.09.005>
17. Pan, L., Sun, D., Zou, Y. et al. RETRACTED ARTICLE: Psycho-linguistic and educational challenges in Teaching Chinese (Mandarin) Language: voices from None-Chinese teachers of Mandarin language. *BMC Psychol* 11, 390 (2023).
<https://doi.org/10.1186/s40359-023-01432-8>
 18. Rastogi, V. (2015). Software development life cycle models-comparison, consequences. *International Journal of Computer Science and Information Technologies*, 6(1), 168-172.
<https://www.academia.edu/download/92324675/ijcsit2015060137.pdf>
 19. Ren, Q., Norazrena, A. B., & Zhang, Y. (2024). Is Chinese Popular? Exploring the Learning Motivation of CSL Learners in a University in Malaysia. *International Journal of Academic Research in Business and Social Sciences*, 14(11).
<https://doi.org/10.6007/ijarbss/v14-i11/23171>
 20. Taleb-Agha, R. (2024). The 10 Best Languages to Learn in 2025 (and top places to learn them). *Go Overseas*. <https://www.gooverseas.com/blog/best-languages-learn#paragraph-item-68202-target>
 21. Ting, H. L., & Ooi, S. E. (2023). Mandarin pronunciation learning strategies of MFL learners in Malaysia. *International Journal of Academia Research in Business and Social Sciences*, 13(2), 1571-1585.
https://kwpublications.com/papers_submitted/10210/mandarin-pronunciation-learning-strategies-of-mfl-learners-in-malaysia.pdf
 22. Yang, J., Li, Y., Wang, L., Sun, B., He, J., Liang, Z., & Wang, D. (2024). Mobile application-based phonetic training facilitates Chinese-English learners' learning of L2. *Learning and Instruction*, 93, 101967.
<https://doi.org/10.1016/j.learninstruc.2024.101967>
 23. Yang, L., Karanyathikul, A., & Kotchasit, S. (2024). Effect of Gamification Combined with Mobile Learning on Chinese Language Speaking Skills of Second-Year Foreign Students at Guangdong University of Foreign Studies. *International Journal of Sociologies and Anthropologies Science Reviews*, 4(6), 563–578.
<https://doi.org/10.60027/ijrsasr.2024.5054>