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Evaluating Skritter's Impact on Vocabulary Mastery and Academic Self-Efficacy among Chinese as a Foreign Language Learners

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Abstract

This study investigates the relationship between academic self-efficacy, mobile learning acceptance, and their influence on students learning Chinese at an international school in Johor Bahru. Using Skritter in a quasi-experimental design with 49 participants, the results showed that the experimental group achieved significantly greater improvements in academic performance, self-efficacy, and technology acceptance compared with the control group. The experimental group's self-efficacy improved from M = 2.03 (SD = 0.54) to M = 4.05 (SD = 0.56), and technology acceptance increased from M = 1.96 (SD = 0.29) to M = 3.36 (SD = 0.39), $p < .001$, confirming Skritter's significant positive effect. Guided by the Technology Acceptance Model (TAM) and Cognitive Load Theory, the findings demonstrated a reciprocal relationship between students' academic self-efficacy and their acceptance of mobile learning technologies. This relationship suggests that self-efficacy mediates students' engagement and motivation. In conclusion, the integration of Skritter shows that mobile learning applications can enhance learners' confidence and vocabulary mastery through positive attitudes toward technology use. The study underscores the need for engaging, user-friendly digital learning environments and provides practical insights for educators and curriculum developers seeking to improve Chinese language learning experiences and outcomes.

Keywords: Skritter, Technology Acceptance Model (TAM), Academic Self-Efficacy, Academic performance, Technology Acceptance, Chinese as a Foreign Language (CFL), Mobile Learning

Introduction

The teaching pattern has shifted from physical pedagogy to online teaching-learning after post-pandemic (Dhawan, 2020; Ali, 2020). The usage of mobile device becomes common while it allows students to adapt knowledge anywhere and anytime, changes the ways students learn. It is flexible and practical with the usage of mobile apps and games (Amalia, 2023).

On the other hand, language is an important tool for communication. In Malaysia, the demand for multilingual proficiency is increasing, particularly in the use of Chinese for commercial and

business purposes (LingLing & HongHeng, 2016). Chinese can be taught as a first, second, or foreign language. Chinese as a Foreign Language (CFL) refers to the study of Chinese by individuals who do not speak it as their mother tongue or did not grow up using it in daily life (Vollmann & Soon, 2019). Malaysia's multicultural learning environment further enriches opportunities for learners to study CFL (Thock, 2013).

Although the complexity of learning Chinese lies in its distinct features, such as tonal pronunciation, complex characters, and unique grammatical structures (Chua, et al., 2015), the learning of CFL getting popular recent years in Malaysia. Liu (2006) highlighted that the challenge of learning Chinese intensifies because each character is not simply a letter, but a symbolic representation that combines form, sound, and meaning. Each symbol is formed by shapes and sounds that come with certain semantics.

While the vocabulary becomes the fundamental component of language acquisition, it helps to transmit information and establishes significance (Zhao & Huang, 2023). Misuse of vocabulary often cause disruptions of communicative endeavours (Gass, 2001). Therefore, in the beginning of language learning, it is important to put attention on vocabulary acquisition while it conveys communicative intentions, and it is important for semantic expression.

However, in reviewing the literature review of Chinese language learning especially in vocabulary mastery, Chua, et al. (2022) stated that the learning of Chinese would require high demands on memory, time, and study capabilities due to the massive number of Chinese characters; learners need to memorise and differentiate the shapes of different characters. It is very challenging for early learners to acquire the massive number of Chinese characters in order to be fully literate in (Sung & Wu, 2011), as some of the Chinese characters seem to appear to be the same, making it hard for students to memorise and differentiate them in a short time.

Therefore, to enhance this teaching and learning process of Chinese, lots of research had been conducted, showcased the effectiveness of technology in the process of language teaching and learning (Zeng& Jiang, 2021; Lin, et al., 2022; Wang, et al., 2021; Xie & Yao, 2020; Panagiotidis, 2021), especially the utilisation of mobile applications for foreign language skills training (Chang, et al., 2011; Lee, 2009; Sandberg, et al., 2011). According to Attewell (2005), the usage of mobile device in language instruction and acquisition can encourage students to improve their spelling and engage students to learn. Students had better access to learn via mobile learning's contextual, portable, ubiquitous, and personal qualities (O'Malley et al., 2003).

As Chinese language learning challenges still include difficulties with memory and recall, the need for contextual understanding, individual learning differences, declining motivation over time, and the inherent complexity of the language itself (TzuChing et al., 2007), understanding the impact of mobile learning tools on language learning outcomes is crucial for improving teaching strategies, designing digital materials, and promoting motivation and autonomy. While prior studies have shown that digital flashcard tools enhance retention and learning attitudes compared to traditional methods (Basoglu & Akdemir, 2010), mobile apps such as Skritter have been developed. Skritter is one type of the Mandarin mobile learning

application, it enhances character writing skills and vocabulary acquisition in Chinese learning through interactive writing and review practices.

Despite its educational potential, there is a lack of empirical research investigating the impact of mobile learning tools such as Skritter on students' academic self-efficacy and technology acceptance within the context of Chinese as a foreign language (CFL). Given that academic self-efficacy significantly influences learners' motivation and engagement in mobile learning environments (Zheng & Xiao, 2024), it is crucial to examine the acceptance and effects of these applications on CFL learners' vocabulary development and overall learning experiences. Therefore, this study is significant in three ways:

(i) Pedagogical significance: It provides teachers with evidence-based insights on integrating mobile tools effectively into Chinese language classrooms.
(ii) Theoretical contribution: It extends understanding of how self-efficacy and technology acceptance interact within mobile-assisted language learning frameworks.
(iii) Practical implications: It offers developers and curriculum designers data-driven recommendations to optimize mobile applications for character and vocabulary learning.

In sum, this study addresses a timely educational need by examining how mobile learning applications like Skritter can enhance learners' vocabulary mastery, confidence, and acceptance of technology, ultimately contributing to more effective and engaging CFL instruction in Malaysia and beyond.

Research Objectives

(i) To analyse students' acceptance and academic self-efficacy towards learning using Skritter on Chinese Foreign language Studies.
(ii) To identify the impact Skritter towards Chinese Foreign Language Studies in an international school in Johor Bahru.
(iii) To study the relationship between students' acceptance and academic self-efficacy with the mastery of vocabulary Skritter.

Research Questions

(i) What is the level of students' acceptance and academic self-efficacy among Chinese Foreign Language students towards Skritter?
(ii) What is the average proficiency and the accuracy level in Chinese Foreign Language vocabulary among students who use Skritter compared to those who do not?
(iii) Is there a statistically significant correlation between the level of acceptance of Skritter, the academic self-efficacy scores of Chinese Foreign Language students and mastery of the vocabulary memorization?

Research Hypothesis

Ho1: There is no significant difference in the level of acceptance and academic self-efficacy among Chinese Foreign Language students towards Skritter between the experimental group and the control group.
Ho2: There is no significant difference in the average proficiency and accuracy level in Chinese Foreign Language vocabulary between students who use Skritter and those who do not.

Ho3: There is no statistically significant correlation in experiment group between the level of acceptance of Skritter, the academic self-efficacy scores of Chinese Foreign Language students, and mastery of vocabulary memorization.

Importance of Study

The incorporation of mobile technologies has the capacity to enhance the distribution of content, accommodate various learning preferences, and enable effective evaluation and feedback systems (Koehler & Mishra, 2009; Siddiquei & Khalid, 2018; Martin & Bolliger, 2018). As vocabulary acquisition to learning Chinese is crucial, to study the usage and incorporating mobile applications like Skritter in the field of Chinese language education, it not only tackles the enduring difficulties of learning Chinese vocabulary but also offers insights into how mobile learning can improve the teaching and learning of CFL.

Simultaneously, addressing the lack of literature in CFL teaching in Malaysia is of utmost significance for multiple reasons. Given the broad and unique educational landscape in Malaysia, the prevalence of Chinese language usage is steadily increasing in this multicultural and multilingual society. By addressing the literature gap in CFL education, it gains a deeper understanding of the CFL education, allow the educator to develop teaching strategies, identify the most effective methods and allow more CFL students to learn Chinese effectively. In sum, this study aims to inform students about how Skritter mobile application, enhance their educational experiences, and improve learning outcomes by understanding vocabulary mastery. Curriculum developers and educators can customize teaching materials, while language learning researchers can contribute to existing knowledge. Researchers can also develop strategies for curriculum development to improve the learning environment.

Literature Review

From previous studies, mobile learning facilitates student engagement; foster students in doing some practise at any time and in any location (Kukulska-Hulme & Bull, 2009; Panagiotidis, 2021). While Lin, et al., (2022) stated out the usage of mobile device increased their frequency of using the Chinese character and indirectly strengthen their ability to remember, understand and using the language, This study aims to examine how mobile learning applications support Chinese language learning, with a focus on vocabulary development. Furthermore, there is still few more term and concept had been discussed in this study. While discussing about the usage of technology in teaching learning process, not to deny the generality of Technology Acceptance Model (TAM). This theory determines the elements that affect consumers' intention to use technology and the level of the acceptance (Munir et al., 2021). Figure 1 shows the adapted theoretical framework of TAM from Navarro et al. (2023) and Cigdem & Ozturk (2016).

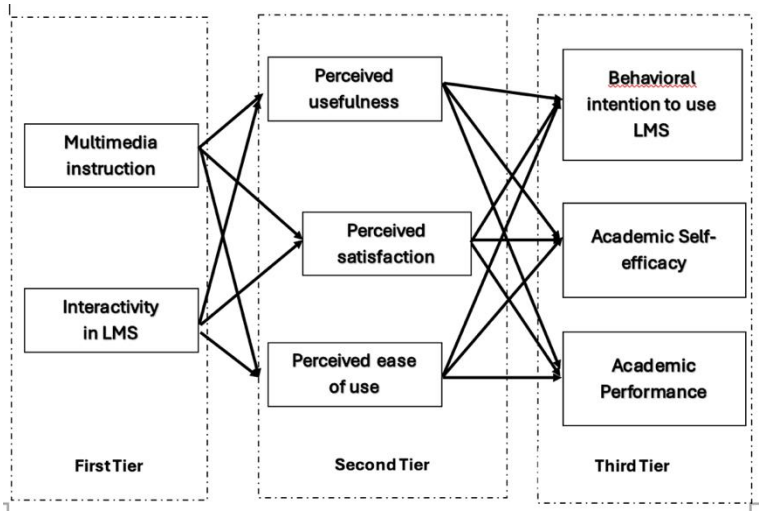


Figure 1 Adapted TAM model (Cigdem & Ozturk, 2016; Navarro et al., 2023)

From Figure 1, there is the assumption that academic performance, intention to use and academic self-efficacy can be impacted by the perceived usefulness, perceived satisfaction and perceived ease of use. The perceived usefulness, perceived satisfaction and perceived ease of use will be representing technology acceptance among students. Teo (2011) defines technology acceptance as the tendency of a user to utilise technology for its intended objectives. In other words, a person's academic self-efficacy, behavioural intention or academic performance can be formed by the effectiveness of different learning applications. As stated by Alexander et al. (2020), academic self-efficacy refers to learners' reflection regarding their own abilities and limitations. It also involves the practice of self-regulated learning, which enables learners to autonomously oversee their teaching and learning process, ensuring the completion of tasks using their own abilities and resources (Alexander et al., 2020).

While second component, academic performance refers to students' academic gaining and learning progress with outcome; there is numerous factors, such as gender, age, the teaching staff, the students' education, the socioeconomic status of the parents or guardians, the students' residential area, the medium of instruction in schools, the trend in tuition, the number of hours that students study each day, and their accommodations as hostels that affected to the students' performance (Ali et. al., 2013).

Also, the behavioural intention refers to the degree to which a person has intentionally planned to participate in or abstain from participating in a technology tool (Cigdem & Ozturk, 2016) and this will become one of the dependent variables in this paper.
Inside the theory, multimedia instruction had been discussed. According to Cigdem & Ozturk (2016), multimedia instruction, will include course materials that students can refer to at any time and from any location, it will provide students with an extensive learning experience. Using multimedia to present the course information is likely to encourage students to participate in the learning process (Liaw, 2008).

Furthermore, interactivity is also a crucial component of e-learning practices. It encompasses the communication between interaction between the students and the system's sources, and

it will discuss about the technologies or teaching strategies employed (Cigdem & Ozturk, 2016).

Also, the perceived usefulness is referring to the degree to students believes that Skritter is easy to use and operate (Davis, 1989), while perceived satisfaction is is a crucial indicator of a system's success or failure, especially in an e-learning environment. It can be a barrier to successful implementation, as perceived usefulness positively predicts learners' satisfaction with the learning system (Cigdem & Ozturk, 2016). Both satisfaction and usefulness directly affect learners' behavioral intention to use the e-learning systems (Liaw, 2008).

Adds on, Cognitive Load Theory places a strong emphasis on the function of cognitive ability in working memory for effective learning outcomes (VanMerrienboer & Sweller, 2005). This theory mentions the limitation of memory capacity; therefore, students must manage limited working memory to comprehend content while maximizing their learning outcomes within that capacity (Asma & Dallel, 2020). Hence, this theory could explain the effectiveness of a simple online learning environment like Skritter.

With Skritter, students can study anytime and anywhere, freely choosing the vocabulary they wish to practise. The Skritter mobile interface illustrate its main learning functions, including progress tracking, mock-test practice, flashcard and note-taking tools, and multimedia features such as video demonstrations and word-tracing exercises. To conclude, Skritter offers self-paced learning supported and accommodate diverse learning styles.

Methodology

This study adopted an experimental, deductive quantitative design within a cross-sectional framework, involving all Chinese as a Foreign Language (CFL) students (M1–M4) at an international school in Johor Bahru, Malaysia. Data were collected through both online and offline modes using a pre-test–post-test approach to evaluate the impact of the Skritter mobile application (Bryman, 2012). The analytical framework integrated descriptive and inferential analyses: descriptive statistics summarized students' acceptance, academic self-efficacy, and academic performance, while Wilcoxon Signed-Rank and Mann–Whitney U tests were employed to test the hypotheses.

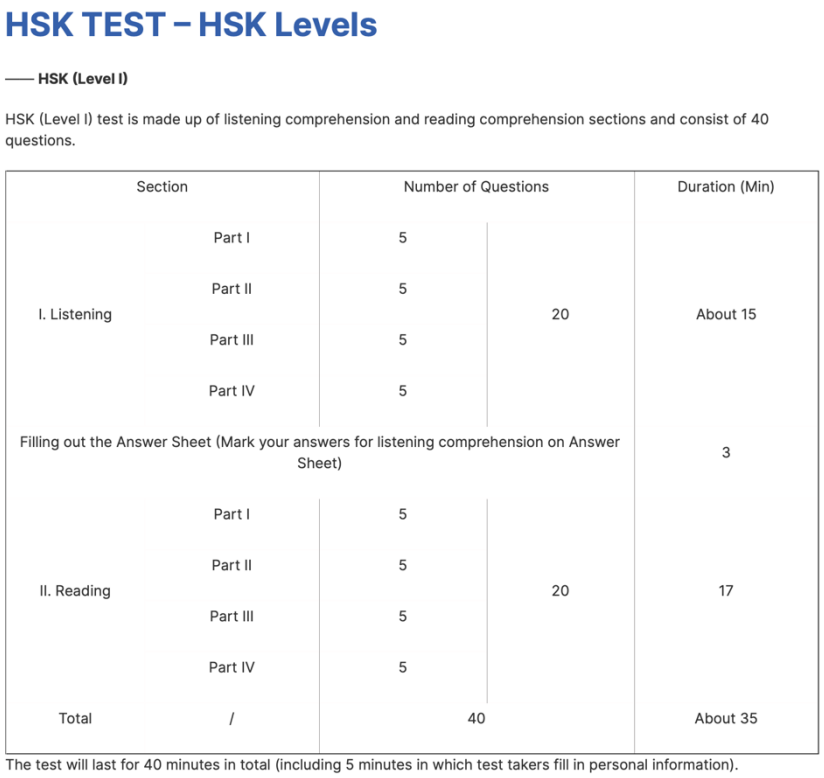
Due to the limited CFL cohort population, all students were included. To minimize selection bias, classes were randomly assigned into control and experimental groups. Non-parametric analyses were selected due to the small sample size (N = 49) and the non-normal distribution of the data. Two groups were compared over two weeks—the experimental group (n = 25), which used Skritter independently to achieve HSK Level 1 mastery (150 words), and the control group (n = 24), which used slides and YouTube materials. Vocabulary test scores were converted into a five-point Likert scale (1 = 1–20 to 5 = 81–100). A validated questionnaire measured technology acceptance and academic self-efficacy using a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). The content validity of the instrument was reviewed by one Mandarin language educator and one educational technology expert to ensure item clarity and relevance. Statistical significance was determined at $p < .05$.

This study complied with ethical standards for research involving human participants. Approval was obtained from the school administration, and informed consent was provided

by all participants and their guardians. Participation was voluntary, and confidentiality was assured.

Research Instrument: Academic Performance Test

For the academic performance test, the HSK Level 1 sample assessment paper (HSK Level 1 | HSK Crestar Singapore, 2023) will be used. This assessment paper requires learners to master 150 vocabulary words. HSK Level 1 represents the beginner level for Chinese learners, and the assessment includes listening and reading sections (What Is HSK Test – Malaysia HSK Test Official Website, n.d.).



HSK TEST – HSK Levels

—— **HSK (Level I)**

HSK (Level I) test is made up of listening comprehension and reading comprehension sections and consist of 40 questions.

Section		Number of Questions		Duration (Min)
I. Listening	Part I	5	20	About 15
	Part II	5		
	Part III	5		
	Part IV	5		
Filling out the Answer Sheet (Mark your answers for listening comprehension on Answer Sheet)				3
II. Reading	Part I	5	20	17
	Part II	5		
	Part III	5		
	Part IV	5		
Total	/	40		About 35

The test will last for 40 minutes in total (including 5 minutes in which test takers fill in personal information).

Figure 2 Detail of HSK level 1 test (HSK Level 1 | HSK Crestar Singapore, 2023)

Research Instruments: Questionnaire

In order to gather data for the aim of determining the participants' academic self-efficacy, behavioural intention, multimedia instruction, interactivity, perceived usefulness, perceived satisfaction and perceived ease of use, a questionnaire will be given to the learner before and after the implementation of mobile apps. With using all the related concepts, the basis of the questionnaire had been created as it is was modified from the scale of Cigdem & Ozturk (2016). There is a total of 28 items that are evaluated on a scale of 1 to 5, ranging from "Very Disagree" to "Very Agree".

Table 1
The questionnaire adapted from Cigdem & Ozturk (2016)

Academic Self-Efficacy	1. I feel confident in complete most of the questions in Mandarin HSK level 1. 2. I think I can answer most of the questions correctly. 3. I can do quite well even when I don't fully understand the questions. 4. I can acquire the needed vocabularies in my respective level. 5. I don't have to depend too much on the teachers
Bahavioral Intention	6. I intend to use Skritter to assist my Mandarin learning 7. I intend to use functions of Skritter in learning new vocabulary 8. I intend to use Skritter as an autonomous learning tool 9. I will increase the occurrences of using Skritter. 10. I find learning Chinese language interesting and absorbing
Perceived Usefulness	11. Using Skritter help me to understand more about the vocabulary 12. Using Skritter improves my learning outcome 13. Using Skritter makes it easier to memorize the vocabulary 14. I believe Skritter contents are useful
Perceived Satisfaction	15. I am satisfied with using Skritter as a learning assisted tool 16. I am satisfied with using functions of Skritter 17. I am satisfied with multimedia instruction in Skritter 18. I am satisfied with interactivity in Skritter
Perceived ease of use	19. Learning to operate Skritter would be easy for me 20. I would find it easy to get Skritter to learn the new vocabulary 21. I would find the Skritter is flexible to use 22. I would find it is easy to understand the instruction of Skritter
Multimedia Instruction	23. I like to use the contents and resources in Skritter 24. I like to use the vocabulary test in Skritter 25. I like to use the vocabulary of different topic in Skritter
Interactivity	26. I like to listen the correct pronunciation of new vocabulary and mimicking it using Skritter. 27. I like to trace the vocabulary with using Skritter. 28. I like to track my daily progress about my words learned using Skritter

Pilot Study

Pilot study had been conducted for M4 students at another international school at Kuala Lumpur, Malaysia in this study. As this is the preliminary investigation, the time consuming will be reducing into two weeks. The primary purpose of this pilot study is to identify the significant level between each variable for the study and check the application of the instrument in the study. All the M4 students will be included as their aging and level would be similar to the target respondents for the main study. Purposive sampling will be using which is three from good grade, three from average and three from poor grade. So, in total there is only 9 students in this pilot test. Also, the questionnaire that adapted from Cigdem & Ozturk (2016) and HSK Level 1 samples assessment paper (*HSK Level 1 | HSK Crestar Singapore*, 2023) will be using. Wilcoxon Signed-Rank Test, regression analysis and Spearman Correlation will be tested.

Reliability of Variables for Pilot Study's Questionnaire

Reliability was tested using Cronbach's Alpha. The internal consistency of the majority of the structures was good to exceptional, values ranging between .814 and.937.Due to their limited

relevance and lower post-test scores, two constructs (Interactivity and Multimedia Instruction) were eliminated in order to increase reliability. Additionally, the Academic Self-Efficacy scale's dependability was increased by eliminating one item. All remaining constructs attained acceptable levels following these modifications, guaranteeing a reliable examination of academic achievement, academic self-efficacy, and student acceptance in Skritter.

Table 2
The Analysis of the all Reliability after the adjustment made

Variable	Test Type	Cronbach's Alpha	Reliability Level
Academic Performance (Pre & Post)	Pre-Test/ Post-Test	0.852	Good
Academic Self-Efficacy (Pre-Test)	Pre-Test	0.87	Good
Academic Self-Efficacy (Post-Test)	Post-Test	0.814	Good
Behavioral Intention (Pre-Test)	Pre-Test	0.888	Good
Behavioral Intention (Post-Test)	Post-Test	0.929	Excellent
Perceived Usefulness (Pre-Test)	Pre-Test	0.871	Good
Perceived Usefulness (Post-Test)	Post-Test	0.878	Good
Perceived Satisfaction (Pre-Test)	Pre-Test	0.984	Excellent
Perceived Satisfaction (Post-Test)	Post-Test	0.889	Good
Perceived Ease of Use (Pre-Test)	Pre-Test	0.937	Excellent
Perceived Ease of Use (Post-Test)	Post-Test	0.892	Good

Results

Demographic Information

A total of 49 students were involved in the study, comprising 25 individuals in the experimental group and 24 individuals in the control group. The participants were aged between 13 and 16 years and exhibited a variety of linguistic backgrounds, predominantly consisting of English and Mandarin speakers. The majority had engaged in the study of Mandarin for a duration of one to two years, whereas approximately fifty percent were novice users of Mandarin learning applications. The learning preferences exhibited a relatively equitable distribution between digital and traditional methodologies in both groups. The two groups exhibited comparable age and experience, indicating that any differences in outcomes observed can be attributed to the intervention rather than demographic variation.

Table 3
Demographic and Learning Preferences Analysis of Control and Experimental Groups

Category	Control (24 students)	Experiment (25 students)
Age		
13 years	15 (62.5%)	0 (0%)
14 years	7 (29.2%)	10 (40%)
15 years	11 (45.8%)	14 (56%)
16 years	2 (8.3%)	1 (4%)
Native Language		
Mandarin	7 (29.2%)	4 (16%)
English	12 (50%)	15 (60%)
Malay	2 (8.3%)	0 (0%)
Other	3 (12.5%)	6 (24%)
Mandarin Language Study Duration		
Less than 1 year	12 (50%)	4 (16%)
1-2 years	7 (29.2%)	14 (56%)
More than 2 years	5 (20.8%)	7 (28%)
Previous Experience with Other Mandarin Learning Applications		
Yes	12 (50%)	10 (40%)
No	12 (50%)	15 (60%)
Learning Preferences		
Digital Tools	16 (66.7%)	14 (56%)
Traditional Methods	8 (33.3%)	11 44%)

The Analysis of Academic Self-Efficacy and Technology Acceptance
The descriptive results showed that both academic self-efficacy and the experimental group's acceptance of Skritter usually improved. Specifically, mean academic self-efficacy increased from 2.03 (SD = 0.54) to 4.05 (SD = 0.56), and acceptability ratings climbed from 1.96 (SD = 0.29) to 3.36 (SD = 0.39). Following the intervention, these descriptive results show a definite rising trend.

The Wilcoxon test was used to determine whether these improvements were statistically significant. In terms of acceptability ($Z = -4.378$, $p < .001$) and academic self-efficacy ($Z = -4.393$, $p < .001$), all 25 students in the experimental group scored highly. In contrast, the control group only marginally improved: acceptance improved, but not as much as the experimental group ($Z = -4.083$, $p < .001$), and self-efficacy increased for 8 students while remaining same for 15 ($Z = -2.356$, $p = .018$). These results also show the strong positive impact of Skritter intervention when compared to the control condition.

The Mann-Whitney U Test also revealed notable differences between the groups. In comparison to the control group, the experimental group reported higher mean ranks for acceptance (U = 10.00, Z = -5.810, p <.001) and academic self-efficacy (U = 1.00, Z = -5.998, p <.001).

In conclusion, the combined evidence strongly supports the rejection of the null hypothesis (Ho1). Students' academic self-efficacy and acceptance were considerably enhanced in the experimental group as compared to the control group by Skritter. Students who utilised the Skritter experienced higher increases in academic self-efficacy and acceptance, as evidenced by both within-group and between-group comparisons.

Table 4
Descriptive Statistics for Students Acceptance and Academic Self-Efficacy (experiment group).

	N	Minimum	Maximum	Mean	Std. Deviation
MeanASE_Before	25	1.0	3.25	2.03	0.53677
MeanASE_After	25	3.25	4.75	4.05	0.55902
MeanAcceptance_Before	25	1.58	2.5	1.96	0.28674
MeanAcceptance_After	25	2.67	3.92	3.36	0.38781

Table 5
Wilcoxon Signed Rank Test for Students Acceptance and Academic Self-Efficacy (Experiment group & Control group).

Group	**Experiment**	**Experiment**	**Control**	**Control**
Variable	Mean ASE After - Mean ASE Before	Mean Acceptance After - Mean Acceptance Before	Mean ASE After - Mean ASE Before	Mean Acceptance After - Mean Acceptance Before
Number of Variable	25	25	24	24
Negative Ranks	0	0	1	1
Positive Ranks	25	25	8	21
Ties	0	0	15	2
Mean Rank	13	13	5.25	12
Sum of Ranks	325	325	42	252
Z-Value	-4.393	-4.378	-2.356	-4.083
P-Value	< 0.001	< 0.001	0.018	< 0.001

Table 6
Mann-Whitney Test for Students Acceptance and Academic Self-Efficacy (ACE)

Rank	Group	N	Mean Rank	Sum of Ranks
Change_Acceptance	Experiment	25	35.86	896.5
	Control	24	13.69	328.5
	Total	49	0.0	0.0
Change_ACE	Experiment	25	35.86	896.5
	Control	24	13.69	328.5
	Total	49	0.0	0.0

Test statistics	Change_Acceptance	Change_ACE
Mann-Whitney U	28.5	28.5
Wilcoxon W	328.5	328.5
Z	-5.44	-5.44
Asymp. Sig. (2-tailed)	<.001	<.001

The Analysis of Academic Performance

The descriptive statistics for academic performance prior to and following the intervention indicate a substantial enhancement. With a sample size of 25 students, the mean academic performance score was 11.32 (5.367) to 22.44 (6.172). The scores of pre-test varied from a minimum of 4 to a maximum of 20 while it was adjusted to a minimum of 14 and a maximum of 32. Subsequent to the intervention, these findings suggest a substantial improvement in academic performance level.

In terms of academic performance ($Z = -4.81$, $p < .001$), all 25 students in the experimental group scored highly; same to the control group ($Z = -4.239$, $p < .001$), only 1 student remain unchanged in Wilcoxon Signed Rank Test. These results show while both groups benefited, the experimental group demonstrated a more uniform and consistent improvement in academic performance compared to the control group.

The Mann-Whitney U Test also revealed notable differences between the groups. In comparison to the control group, the experimental group reported higher mean ranks for acceptance ($U = 115.00$, $Z = -3.727$, $p < .001$).

In conclusion, the experimental group, which implemented Skritter, exhibited a significantly greater improvement compared to the control group, as reflected in the total sum of ranks (810 vs. 415). The result was statistically significant, indicating that the differences in academic performance gains between the two groups were not due to chance. Therefore, the null hypothesis (Ho2) was rejected, confirming that the academic performance of students in CFL vocabulary was positively influenced by Skritter. These findings further corroborate the effectiveness of mobile learning applications in enhancing both the accuracy and proficiency of Chinese vocabulary.

Table 7
Descriptive Statistics for Pre-Academic Performance and Post Academic Performance (experiment group).

	N	Minimum	Maximum	Mean	Std. Deviation
Academic_Performance_Pre	25	4	20	11.32	5.367
Academic_Performance_Post	25	14	32	22.44	6.172

Table 8
Wilcoxon Signed Rank Test for Academic Performance (Experiment Group & Control Group).

Group	Experiment	Control
Variable	**Academic_Performance_Post-Academic_Performance_Pre**	**Academic_Performance_Post-Academic_Performance_Pre**
Number of Variable	25	24
Negative Ranks	0	0
Positive Ranks	25	23
Ties	0	1
Mean Rank	13	12
Sum of Ranks	325	276
Z-Value	-4.381	-4.239
P-Value	< 0.001	<0.001

Table 9
Mann-Whitney U Test Between-Group Comparisons for Academic Performance.

Rank	**Group**	**N**	**Mean Rank**	**Sum of Ranks**
Change_AcademicPerformance	**Experiment**	25	32.40	810.00
	Control	24	17.29	415.00
	Total	49	0.0	0.0

Test statistics	**Change_Acceptance**
Mann-Whitney U	115.000
Wilcoxon W	415.000
Z	-3.727
Asymp. Sig. (2-tailed)	<.001

Correlations between students' acceptance and academic self-efficacy with mastery of vocabulary using Skritter

In this part, the results provide partial support for this hypothesis. There appears to be a general pattern that acceptance, academic self-efficacy (ACE) and academic performance are all positively related. As the correlations between acceptance with ACE and academic performance indicated a strong positive correlation which $r = .796$, $p < .001$ and $r = .628$, $p < .001$. Meanwhile, there is moderate positive correlation between ACE to academic performance ($r = .448$, $p = .001$) which mean somehow higher academic self-efficacy

improvements are related to better performance. This showed the technology acceptance and academic self-efficacy improved the academic performance.

However, when the data splits into experimental (N=25) and control (N=24) groups, showing correlations differ across groups. In experiment group, only the correlation between technology acceptance and academic performance is showing the strong significant correlation ($r = .675$, $p < .001$) but only weak significant correlation ($r = .123$, $p = .567$) in control group. Also, no significant link for the academic self-efficacy and academic performance in both experiment group ($r = .032$, $p = .878$) and control group ($r = –.092$, $p = .669$), this suggests that academic self-efficacy alone was not sufficient to predict academic performance within either group. While there is only weak significant correlation between technology acceptance and academic self-efficacy in experiment group($r = .190$, $p = .363$), and no significant link in control group ($r = .334$, $p = .110$), it also deny the null hypothesis.
Conclusion, the hypothesis(Ho3) is therefore accepted in the combined analysis, but rejected when groups are analyzed separately. The split data showed the technology acceptance and academic self-efficacy did not influence performance without the intervention. Overall, academic self-efficacy appears to play a supportive rather than direct role in influencing performance, with technology acceptance emerging as the stronger predictor in the experimental group.

Table 10
Results for the combined group showing the nonparametric correlations among students' acceptance, academic self-efficacy, and vocabulary mastery using technology.

Spearman's rho		Change_Acceptance	Change_ACE	Change_Academic Performance
Change_Acceptance	Correlation Coefficient	1.0	.796**	0.628**
	Sig. (2-tailed)	-	<.001	<.001
	N	49	49	49
Change_ACE	Correlation Coefficient	.796**	1.000	0.448**
	Sig. (2-tailed)	<.001	-	<.001
	N	49	49	49
Change_Academic Performance	Correlation Coefficient	.628**	.448**	1.000
	Sig. (2-tailed)	<.001	.001	-
	N	49	49	49

Table 11
Results for the separate experiment and control groups showing the nonparametric correlations among students' acceptance, academic self-efficacy, and vocabulary mastery using technology.

Spearman's rho		Change_Acceptance	Change_ACE	Change_Academic Performance
Change_Acceptance Experiment	Correlation Coefficient	1.0	.190	0.675**
	Sig. (2-tailed)	0	.363	<.001
	N	25	25	25
Change_Acceptance Control	Correlation Coefficient	1.0	.334	.123
	Sig. (2-tailed)	-	.110	.567
	N	24	24	24
Change_ACE Experiment	Correlation Coefficient	.190	1.000	.032
	Sig. (2-tailed)	.363	0	.878
	N	25	25	25
Change_ACE Control	Correlation Coefficient	.334	1.000	-.092
	Sig. (2-tailed)	.110	0	.669
	N	24	24	24
Change_Academic Performance Experiment	Correlation Coefficient	.675**	.032	1.000
	Sig. (2-tailed)	<.001	.878	0
	N	25	25	25
Change_Academic Performance Control	Correlation Coefficient	.123	-.092	1.000
	Sig. (2-tailed)	.567	.669	0
	N	24	24	24

Discussion of Findings

Relationship among students' Acceptance and Academic Self-Efficacy with Mastery of Vocabulary using Skritter

The findings indicate that Skritter positively influenced students' academic performance, which consequently enhanced their academic self-efficacy. This aligns with the studies of Cho et al. (2018) and Sung, et al. (2016), who found that mobile learning applications significantly improve language acquisition, vocabulary mastery, and overall academic outcomes. Furthermore, mobile technology can effectively foster self-confidence and long-term retention, encouraging students to engage in more innovative and autonomous learning (Guspatni, 2018). When students feel confident in a particular domain, they are more likely to participate actively and approach learning with enthusiasm and creativity.

In addition, the results highlight the importance of metacognitive development in sustaining improved performance. As Khan et al. (2017) and Ozer & Kılıç (2018) noted, sharpening metacognitive abilities enhances students' ability to plan, monitor, and evaluate their learning and their self-regulated learning behaviours leads to higher academic achievement. Therefore, when students find Skritter beneficial, they are more motivated to continue using it, resulting in sustained engagement and better academic outcomes.

Meanwhile, there seems to be a reciprocal relationship between technological acceptance and academic self-efficacy (ASE). While the quantitative analysis revealed that academic self-efficacy alone did not directly predict academic performance, the intervention group demonstrated significant improvements in both technological acceptance and learning outcomes. This finding suggests that self-efficacy plays a supportive and mediating role, rather than a direct predictive one.

There is a positive feedback loop: greater technology acceptance leads to better performance, which strengthens self-efficacy and encourages sustained use for even greater better vocabulary results. This similar to the demographic data previously stated, the majority of students preferred digital tools; 56% of the experimental group and 66.7% of the control group indicated a preference for mobile learning.

The reciprocal relationship between academic self-efficacy and technological acceptability is consistent with the fundamental ideas of the Technology acceptability Model (TAM). As Shuja et al. (2019) claimed that, technology-enhanced learning environments can significantly boost students' positive attitudes towards learning, this is further supported by the research of Jeno et al. (2019) and Talan (2020), which shows that mobile learning positively affects learning performance and academic self-efficacy.

Effects of Skritter on CFL Learning Process

Addressing the second research question, the between-group comparisons showed that the experimental group, which utilized Skritter, achieved significantly greater gains in vocabulary mastery compared to the control group. This suggests that Skritter can serve as effective tools for improving Chinese vocabulary learning. It is believed that the Skritter could improve their academic performance as it has the following features:

Simple Online Learning Environment

According to Ozer and Kılıç (2018), if students in the generally perceived a low level of mental effort when completing learning activities, it could increase their academic performance; when students reported cognitive overload, this will affect their academic performance. This was parallel with the Cognitive Load Theory. As the students have the limitation of memory capacity, they must manage limited working memory capacity to comprehend content (Asma & Dallel, 2020).

While Skritter creates a simple online learning environment, it can definitely minimise unnecessary cognitive demands, optimise information displays, and customise learning experiences according to users' cognitive capacities. Reducing cognitive load by utilising multimedia tools and deconstructing intricate information into manageable portions (Sweller, 2010; Fan et al., 2024) enhanced learning outcomes by allowing students to comprehend information more efficiently. Reducing extraneous cognitive burden frees up mental resources for problem-solving and learning, thereby increasing academic self-efficacy. For example, Skritter's use of flashcards for the purpose of learning single vocabulary words enables students to concentrate on one element at a time, thereby reducing the learning process to a more manageable and efficient level. Also, since Skritter allows students to learn Chinese vocabulary by doing some multiple-choice or fill-in-the-blank questions in single word learning, the simple and organised interface means students will not experience cognitive overload (Sweller, 2010).

Character Recognition and Writing

Skritter's feature also facilitates the process of character recognition and writing by instructing students on the order of strokes and offering opportunities to practice writing Chinese characters. This enhances students' learning processes in the area of written language mastery. While the significance of stroke order learning remains a topic of discussion, Sun et al. (2024) provided evidence that learners who engaged in stroke order practice exhibited superior performance compared to those who did not, as indicated by quicker response times and enhanced accuracy in orthographic discrimination and form-meaning matching. The results show that the order of the strokes is very important for CSL students to remember the link between orthography and semantics and to make and keep more accurate representations of orthography.

Furthermore, a student who is experiencing difficulty with the intricacy of Chinese characters also can utilise Skritter's stroke order animations to acquire and refine the ability to write characters accurately. When students repeat the practise of Chinese character that maximise retention while minimising cognitive strain, this is one kind of spaced repetition algorithms (Sweller, 1994). The animated character by Skritter could enhance the learning experience of students (Fan et al., 2024); while the consistent practice results in enhanced writing abilities. This had been supported by Eyenaka et al. (2023) which is their study bring out that ICT-based teaching strategies like visualizing the concept of knowledges could enhance the academic performance and information retention.

Audio Visual Tool

Also, as per mentioned by Shuja et al. (2019), the improvement of academic performance can be expressed in terms of higher retention of knowledge and enhanced note-taking ability.

Allowing students to customize their learning methods through text, video, or audio using mobile devices and internet technology can enhance their learning experience. With using Skritter, student can learn with variety of learning styles as Skritter offers different multimedia content, including animations, interactive graphics, and videos, which simplify intricate concepts. Consequently, the content of variety multimedia is rendered more engaging and accessible to students by allowing them to view explanatory videos on Skritter (Fan et al., 2024).

Skritter's audio-visual tool aids students in improving their speaking and listening skills, essential for acquiring tonal languages like Mandarin. Mastering the tonal aspects of Mandarin is significantly enhanced by the inclusion of features that enable students to practise speaking and receive feedback on their pronunciation, thereby dramatically boosting their confidence in the language. For instance, a students can enhance their pronunciation accuracy by practicing Mandarin tones with Skritter's speech recognition feature, which provides immediate feedback.

Personalised Learning

Furthermore, Skritter provides personalised learning through adaptive learning pathways, which customise content to the Mandarin proficiency levels of individual students. This guarantees that each student is provided with instruction that is appropriately challenging, thereby enhancing their self-efficacy and enabling them to achieve success (Makhambetova et al., 2021). For example, students who are preparing for the HSK (Hanyu Shuiping Kaoshi) examinations can utilise Skritter to acquire a comprehensive understanding of vocabulary at different HSK levels. They can perform specific searches and engage in relevant exercises, without follow the other students' pace. Skritter enables students to concentrate on the precise vocabulary necessary for the exam, practise consistently, and, as a result, enhance their test scores, thereby substantially increasing their self-efficacy in their ability to master Mandarin.

Moreover, Skritter offers immediate feedback on exercises and assessments, enabling students to quickly comprehend their strengths and areas for improvement. Personalised learning, as discussed by Makhambetova et al. (2021), enhances students' management of their learning experiences through differentiated instruction and real-time feedback. Similarly, Skritter's immediate feedback allows students to adapt their learning strategies independently, thus enhancing their learning efficacy. For instance, a student who is practicing writing Chinese characters can instantaneously observe corrections in their stroke order and adjust accordingly, resulting in a more rapid acquisition of the correct writing techniques. Another word, incorporating self-paced mobile activities in Skritter transformed Mandarin language learning into a more interactive and engaging process, thereby promoting autonomous learning.

Flexibility and Accessibility

Meanwhile, research by Jeno et al. (2019) and Talan (2020) supports the idea that flexible learning experiences enhance students' self-efficacy. As Skritter provides flexibility and accessibility by enabling students to learn at their own tempo and schedule, thereby reducing anxiety and pressure. This adaptability can result in more consistent study habits and a more resolute belief in their academic success. For instance, a high school student who is occupied

can utilise Skritter during their commutes or brief pauses to ensure consistent practice without the necessity of locating large blocks of dedicated study time.

With using Skritter, students can access to all the learning materials ubiquitously. It is believed this also one of the reason that the students' academic performance can be increasing. Nowadays, students met a lot of challenging in the process of learning, including they easily distract and cannot dealing with multitask. With the generalise of technology in learning process, if the mobile application that could not provide sufficient learning resources, this might lead to students crying and disengagement students (Rotas & Cahapay, 2021). Skritter's extensive collection of resources, including dictionaries, pronunciation guides, and practice exercises; equips students with essential tools to independently enhance their speaking skills and pronunciation, thereby boosting their confidence and readiness without the constraints of time.

Implications of Technology Acceptance for Mobile Learning

The findings indicate that technology acceptance is essential for enhancing learning outcomes. Educators should emphasise the practical advantages of technology in language acquisition by illustrating its perceived usefulness and its role in enhancing the achievement of learning objectives.

Furthermore, ensuring that mobile technologies are user-friendly and intuitive can improve their perceived ease of use. Offering tutorials and technical support assists students in addressing initial challenges, while the consistent collection of feedback and implementation of learner-centred adjustments can enhance perceived satisfaction. When students perceive a learning tool as user-friendly and advantageous, their satisfaction and engagement increase, resulting in prolonged usage.

Empirical research provides additional evidence for this relationship. Gao et al. (2015) established that user satisfaction and engagement are directly affected by perceived usefulness and ease of use. In addition, Hong et al. (2021) showed that these perceptions increase motivation and encourage the consistent use of educational technologies. Huang (2017) and Prasetyo et al. (2021) identified perceived usefulness and ease of use as key determinants of technology acceptance, demonstrating that these factors significantly affect students' willingness to adopt mobile learning tools.

It is essential for developers to prioritise intuitive design and user-centred interfaces to enhance the acceptance and effectiveness of mobile learning applications (Lu et al., 2022). When learners perceive technology as straightforward and dependable, they are able to concentrate more on content instead of technical difficulties. This personalised, low-friction experience enhances self-efficacy and academic performance (Huang, 2017; Lu et al., 2022). Understanding and optimising the relationships among usefulness, ease of use, and satisfaction can enhance the effectiveness of technology-enhanced learning experiences.

Conclusion

This research indicated that the implementation of Skritter markedly improved students' academic performance, academic self-efficacy, and technology acceptance within Chinese as a Foreign Language (CFL) courses. Students utilising the application demonstrated superior

proficiency and accuracy in Chinese vocabulary compared to those employing slide and Youtube. The personalised pathways, flexibility, and immediate feedback provided by Skritter have been shown to enhance confidence, diminish learning anxiety, and promote more consistent study habits. These outcomes are consistent with Cognitive Load Theory and facilitate effective, self-regulated learning.

However, it is important to recognise several limitations. The limited sample size (n = 49) constrains the generalisability of the findings, which was restricted to a single international school cohort owing to scheduling constraints. The findings may not comprehensively reflect other contexts of CFL learning. As demographic variables, such as age, gender, and prior experience with Mandarin may have impacted the outcomes related to academic self-efficacy and technology acceptance. Subsequent investigations may seek to replicate this study across various institutions, utilising larger cohorts, more heterogeneous samples and diverse proficiency levels to enhance validity and consistency of the observed relationships.

To enhance comprehension of mobile learning adoption, future research may utilise mixed-method designs that integrate quantitative surveys with qualitative interviews or focus groups. Longitudinal studies would be beneficial for assessing the enduring impacts of these variables. Furthermore, given that this study omitted interactivity and multimedia variables to ensure measurement reliability, subsequent research should investigate the impact of different levels of interactivity and multimedia richness on perceived usefulness, satisfaction, and self-efficacy within the framework of the Technology Acceptance Model (TAM).

The findings indicate that carefully designed mobile learning tools, such as Skritter, can offer engaging, flexible, and effective environments for language acquisition. Ongoing evaluation of these technologies will assist educators and developers in creating more inclusive and engaging digital learning experiences that promote sustained language proficiency.

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Appendix A: Skritter Interface Screenshots (Figures 2–5)

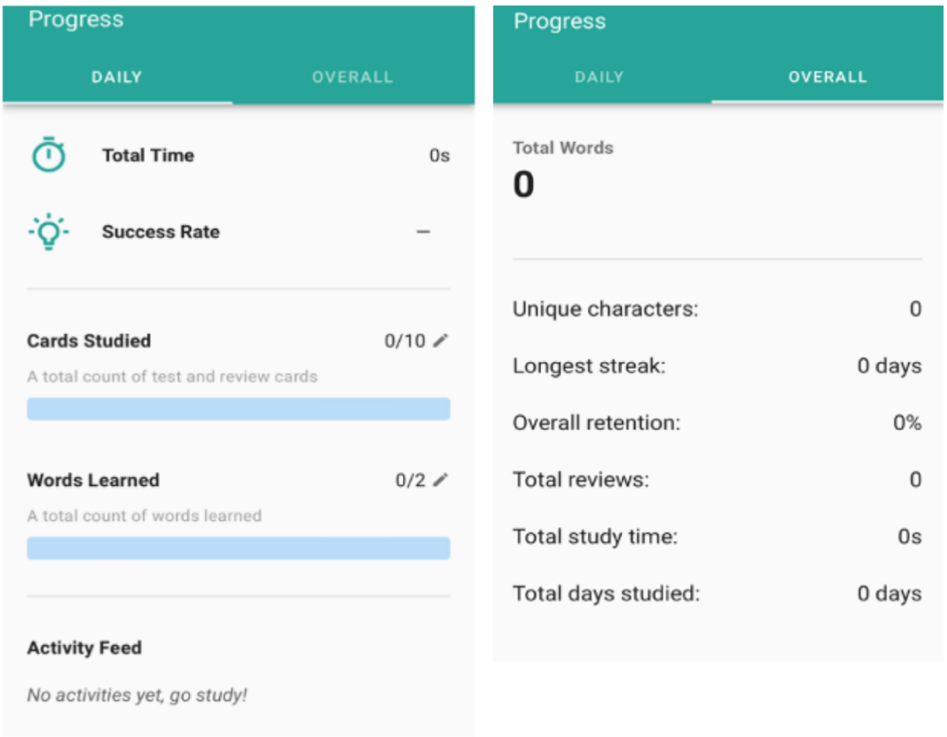

Figure 3 Interface shows the daily and overall progress report in Skritter.

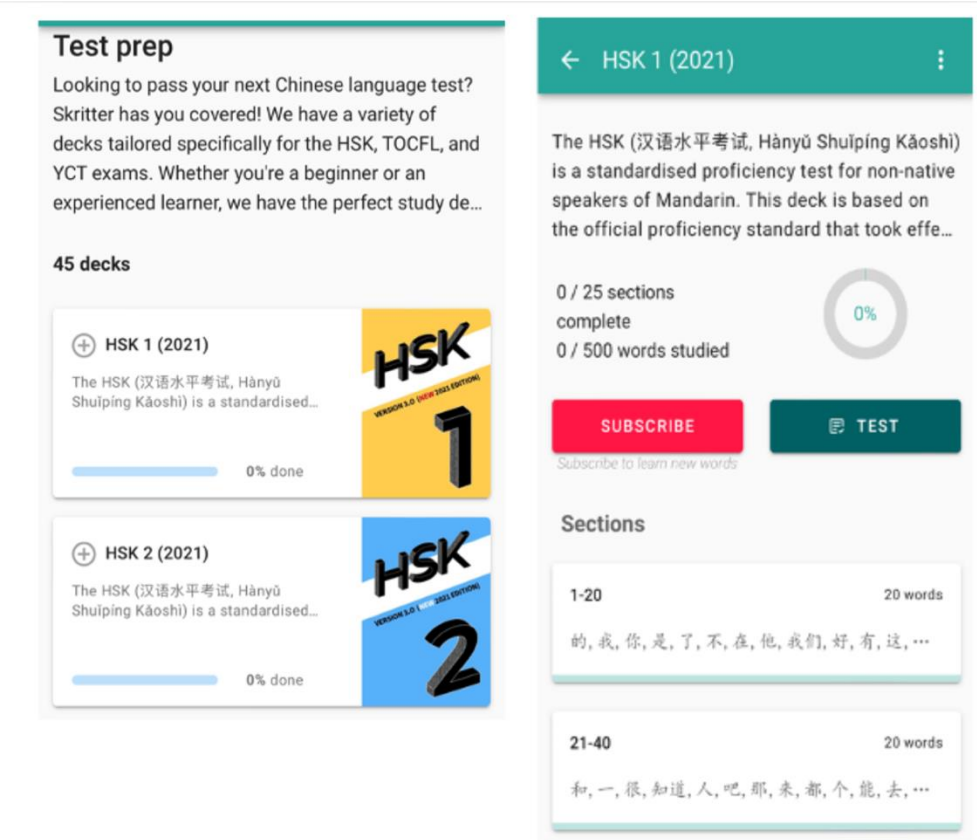

Figure 4 Screenshot from the Skritter mobile application showing the mock-test section.

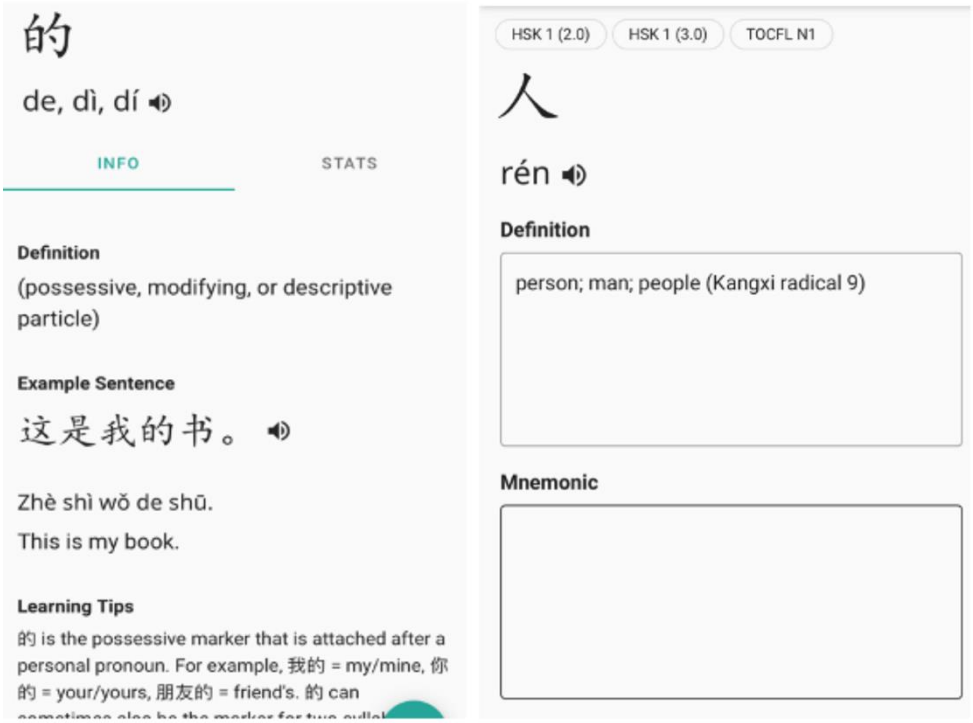

Figure 5 Screenshot from the Skritter mobile application showing the flashcard and note-taking interface.

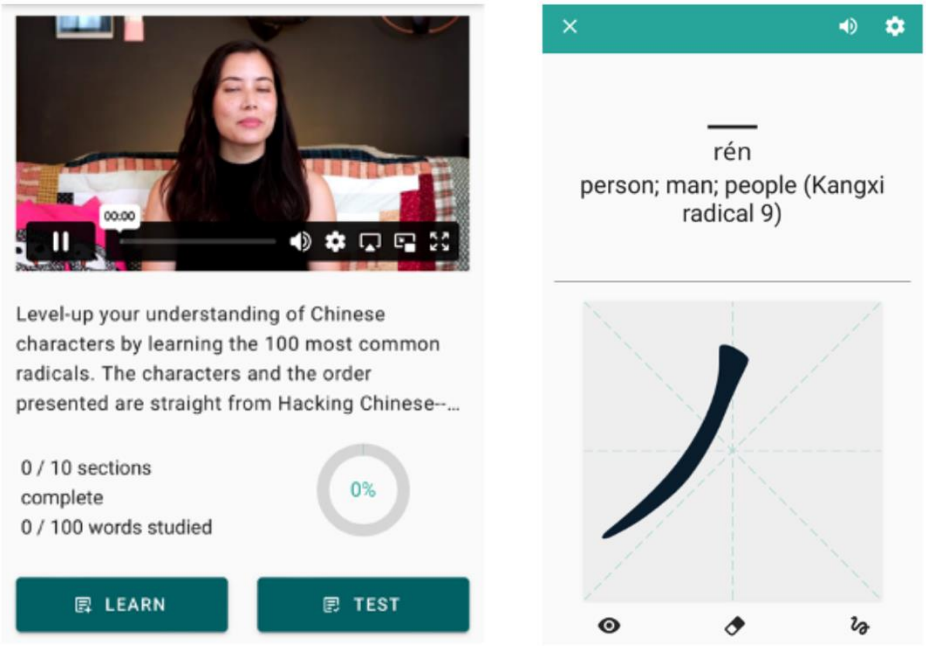

Figure 6 Screenshot from the Skritter mobile application showing video resources and the word-tracing session.

Appendix B: Summary of Expert Validation Form

This study's instrument was validated by one Mandarin language educator and one educational technology specialist. The validation form included 10 items rated on a five-point scale (1 = Strongly Disagree to 5 = Strongly Agree). Experts reviewed the clarity, content relevance, and item alignment with the study's constructs.

EXPERT VALIDATION FORM:

Questionnaire on Investigating the Correlation among Mobile Learning Acceptance, Academic Self Efficacy and Impact on Chinese Foreign Language Studies at Fairview International School, Johor Bahru.

I hereby certify and validate that the content in "Questionnaire on Investigating the Correlation among Mobile Learning Acceptance, Academic Self Efficacy and Impact on Chinese Foreign Language Studies at Fairview International School, Johor Bahru" from CHONG POOI YEE (MPP221006) is suitable / not suitable to be used as an assessment to measure Mobile Learning Acceptance, Academic Self Efficacy and Students Performance after taking into account improvement measure as suggested.

Dengan ini saya mengesahkan bahawa kandungan dalam "Soal Selidik mengenai Questionnaire on Investigating the Correlation among Mobile Learning Acceptance, Academic Self Efficacy and Impact on Chinese Foreign Language Studies at Fairview International School, Johor*" dari* CHONG POOI YEE (MPP221006) *sesuai / tidak sesuai digunakan sebagai penilaian untuk* Mobile Learning Acceptance, Academic Self Efficacy and Students Performance *setelah mengambil kira langkah penambahbaikan seperti yang disarankan.*

No	Detail perincian	Evaluation Penilaian	
		Suitable Sesuai	Not suitable Tidak sesuai
1.	The objectives of the instrument are constructed and clearly stated. *Objektif instrumen dibina dan dinyatakan dengan jelas.*		√
2.	The format of the instrument is appropriate and attractive. *Format instrumen adalah bersesuaian dan menarik.*	√	
3.	The font size used is appropriate and clear. *Saiz huruf yang digunakan adalah bersesuaian dan jelas.*		√
4.	The meaning of each question item is clear. *Maksud setiap item soalan adalah jelas.*	√	
5.	The instructions for answering the questions are clear and easy to understand. *Arahan untuk menjawab soalan adalah jelas dan mudah difahami.*	√	
6.	The scale size used is appropriate. *Ukuran skala yang digunakan adalah bersesuaian.*	√	

Comments / *Komen*:

The objectives of the instrument need to be constructed and clearly stated as your objective is on Investigating the Correlation among Mobile Learning Acceptance, Academic Self Efficacy and Impact on Chinese Foreign Language Studies at Fairview International School, Johor. What variable classifies behavioural intention, multimedia instruction, interactivity, perceived usefulness, perceived satisfaction, and perceived ease of use? Just include the necessary variable for mobile learning acceptance, academic self-efficacy and students performance and remove unnecessary variables. List out clearly each questions with the variable you want to test.

List out your questionnaire's title. Change your format of 5 Likert scale. State out strongly disagree until strongly agree. Do not use the word "don't." Be consistent with your sentences in the questionnaire; if you prefer to use the pronoun "I," use it in whole items. The font size should be Times New Roman 12. This questionnaire is appropriate for use after the amendments made. Thank you.

Appendix C: Sample Items from the Academic Performance Exam (HSK Level 1)

Sample Listening Item

听录音，选出你听到的句子。

A. 她喜欢吃苹果。

B. 她喜欢喝茶。

C. 她喜欢看书。

Sample Reading Item

选择正确的答案：

他每天早上（ ）去学校。

A. 吃饭 B. 走路 C. 睡觉

Note. Sample items adapted from HSK Level 1 Sample Paper, HSK Crestar Singapore (2023).