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Mobile learning for less-commonly taught languages: design and application

<https://doi.org/10.1515/jccall-2024-0006>

Received April 11, 2024; accepted August 29, 2024; published online November 1, 2024

Abstract: The increasing development of emerging technologies contributes to ubiquitous and personalized language learning. Hence this study reported a project of designing and applying mobile learning for a less-commonly taught language, Fijian language, at a university in China. Guided by the natural approach and the immersion method of foreign language learning, and principles of multimedia learning, a Fijian language learning application was designed and applied, involving creating a Fijian language environment via situational simulation and offering sufficient language practice and immediate feedback based on speech evaluation and adaptive learning. The rationale, course design, technology support, along with students' Fijian learning experiences gauged from a questionnaire and an online group interview are documented and discussed. Learners reported increased interest, improvements in spoken communication and learner autonomy. The study will yield implications to future mobile language learning resources design and the pedagogy of integrating the application into teaching and learning of foreign languages.

Keywords: mobile language learning; less-commonly taught languages; technology-enhanced language learning; AI-supported language learning

1 Introduction

With the increasing development of cross-cultural communication and global exchanges, the importance of learning and teaching foreign languages beyond English is growing (Graddol 2006). In this context, this study focuses on less-commonly taught languages, which primarily include those not usually used in

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international communication and not commonly taught in educational institutions (Yang and Tong 2008).

However, challenges exist in the instruction of less-commonly taught languages, particularly the scarcity of teaching and learning resources, the lack of teachers and real-life situations for language use. In the meanwhile, the rapid development of emerging technologies brought about affordances for foreign language learning such as creating real-life communication environments, providing authentic language learning resources, offering automated assessment of spoken and written outputs (Tang and Rich 2017; Tang and Wu 2017), and enabling ubiquitous and personalized language learning (Kukulska-Hulme 2019). In this regard, using technology in teaching less-commonly taught languages might be a viable solution, which can be verified by the emergences of various online and mobile language learning platforms such as Duolingo, Rosetta Stone, Mondly, Busuu, etc., though for most of which, commonly-taught languages are their major concerns.

With the purpose of tackling the existing challenges, this study reported a project of designing and applying mobile learning for a less-commonly taught language Fijian in a university in China. Fijian was not available in any of the existing online or mobile language learning platforms, nevertheless required for study in the university under research. Guided by the following language learning theories such as the natural approach (Krashen and Terrell 1983; Richards and Rodgers 2001), the immersion method (e.g., Cummins 2009; Kinginger 2011; Wilkinson 1998), the multimedia learning theory (Mayer 2022), which will be elaborated in detail in Section 2 on the literature review, a Fijian language learning application was devised involving creating a target language environment via situational simulation and offering sufficient language practice and immediate feedback based on speech evaluation and adaptive learning. The rationale, course design, technology support, along with students' learning experiences gauged from a questionnaire will be reported and discussed. The study will yield implications to future mobile language learning resources design and the pedagogy of integrating the application into teaching and learning of foreign languages.

2 Literature review

In this part, language learning theories pertinent to mobile language learning design, pedagogical design in mobile language learning environments and relevant language learning platforms are reviewed and discussed.

2.1 The natural approach and the immersion method

Foreign language teaching approaches informing the design of mobile language learning applications include the natural approach, the immersion method and multimedia learning theory.

The natural approach, developed by Stephen Krashen and Tracy Terrell in the late 1970s and early 1980s, perceives language as a vehicle for communicating meanings and messages (Krashen and Terrell 1983), hence advocates the language teaching method which is “based on observation and interpretation of how learners acquire both first and second languages in non-formal settings.” (Richards and Rodgers 2001, p. 190). It emphasizes input, comprehension, and meaningful communication, advocating the use of real-life instructional materials such as pictures and other visual aids to provide an extralinguistic context that helps learners understand and acquire language.

Complementing the natural approach, the immersion method involves creating an environment where learners are surrounded by the target language, promoting naturalistic acquisition. Studies have shown that students exposed to immersive environments, such as bilingual programs or study-abroad experiences, exhibit higher levels of fluency (Cummins 2009; Kinginger 2011; Wilkinson 1998). Brain studies from Georgetown University Medical Center indicate that immersion can lead to native-like brain processing more effectively than traditional classroom training (Morgan-Short et al. 2012).

Recent studies continue to support Krashen’s hypothesis that comprehensible input is crucial for language acquisition (Ellis 2015; Lightbown and Spada 2013). The natural approach’s focus on meaningful communication rather than explicit grammar instruction aligns with findings in communicative language teaching (CLT). Studies by Long (2015) and VanPatten (2017) highlight the effectiveness of communication-focused instruction in promoting fluency and natural language use.

Nevertheless, critics argue that the lack of explicit grammar instruction may hinder learners’ ability to produce accurate language (Norris and Ortega 2000). More importantly, the natural approach may not be as effective in environments where exposure to the target language is limited (Butler 2011). Similarly, while immersion has demonstrated effectiveness in leading to higher fluency and more efficient language processing (Georgetown University Medical Center 2012), not all learners have the opportunity to participate in immersive environments due to logistical and financial constraints. Furthermore, immersion may not address specific linguistic challenges that some learners face (Butler 2011).

In the current study, authentic visual materials and technologies are used to create a real-life communication environment and offering comprehensible input,

reflecting the principles of both the natural approach and the immersion method. These methods aim to replicate the benefits of immersion in a more accessible format. Additionally, the study integrates explicit grammar instruction to address potential shortcomings of the natural approach, ensuring a comprehensive language learning experience.

2.2 Multimedia language learning

As mentioned in the preceding section, in immersive foreign language learning, contextual clues such as pictures and photos are manipulated along with the medium of foreign language to help learners acquire the target language. This practice is supported by the multimedia learning theory, which argues that learners can comprehend content better when it is presented in words and pictures than when it is presented in words alone (Mayer 2022).

Multimedia content can be based on the delivery media (e.g., amplified speaker and computer screen), presentation mode (e.g., words and pictures), or sensory modalities (e.g., auditory and visual). In multimedia learning, learners process auditory/verbal and visual/pictorial information through separate channels, enhancing understanding when these elements are integrated with prior knowledge, the process of which is demonstrated in Figure 1 (Mayer 2018).

Learners typically engage in three types of processing during multimedia learning, namely extraneous processing (which is not relevant to the learning goals and is caused by way the material is presented), essential processing (which is needed to achieve the learning goal and depends on the inherent complexity of the material for the learner), and generative processing (which is caused by the learner's efforts including schema construction and automatization) respectively (Mayer 2001; Sweller 2005).

As extraneous processing does not serve the instructional goal, five principles to reduce it are suggested as coherence principle (i.e. eliminate unneeded material),

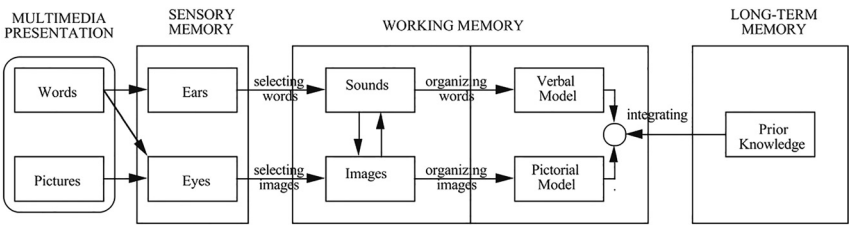


Figure 1: Flow chart representing the cognitive theory of multimedia learning (Mayer 2018, p. 154).

signaling principle (i.e. highlight essential material), redundancy principle (i.e. do not add onscreen text to narrated graphics), spatial contiguity principle (i.e. place onscreen text near corresponding graphics), and temporal contiguity principle (i.e. present corresponding speech and graphics at the same time). Three principles are proposed to enhance essential processing as segmenting principle (i.e. break lessons into user-paced parts), pre-training principle (i.e. provide names and definitions of key components before the lesson), and modality principle (i.e. present words in spoken form). Personalization principle (i.e. use conversational language), embodiment principle (i.e. use human-like gesture for on-screen instructor), and voice principle (i.e. speak with friendly human voice) are outlined to facilitate generative processing (Mayer 2018).

The effectiveness of multimedia learning can be hindered by extraneous cognitive load if materials are not well-designed (Sweller 2005). Overloading learners with too much information can impede learning. The study applies Mayer's principles to reduce extraneous cognitive load, such as eliminating unneeded material and highlighting essential content. It also incorporates the segmenting principle and modality principle, ensuring that learners receive information in manageable chunks and through multiple modalities. This approach aims to optimize the design of the mobile language learning application for better learning outcomes.

2.3 Pedagogical design in mobile language learning resources

With technology pervading almost all aspects of our lives, contemporary language learning is featured by being ubiquitous and incidental, with informal mobile language learning increasingly augmenting or replacing formal learning, especially when formal learning is scarce (inaccessible, unaffordable) (Kukulska-Hulme 2021). Mobile-Assisted Language Learning (MALL) resources are increasingly used by teachers and learners. The “resources” refer to both the digital material(s) and learning activities designed by teachers. Key features of effective MALL resources design have been identified such as authentic listening tasks in the dynamic real-world communicative situations, task-based linguistic resources, e.g. relevant vocabulary, dictionaries, pronunciation, etc (e.g. Palalas 2012; Palalas and Hoven 2013). Based on their experiences as language teacher and instructional designer, and drawing upon prominent literature in second language learning and MALL, Yates and Palalas (2018) proposed four key pedagogical principles for mobile-assisted language learning resource development as: make learning authentic, connect resources to theory, learn by doing, balance individual and social learning.

The resources enabling authentic learning will use real-life or scaffolded input and output, mediated by, captured and documented on students' mobile devices. The

importance of using theories of language learning and second language acquisition to guide MALL resources design has been emphasized by Stockwell and Hubbard (2013, p. 7) who argued that “if the fundamental goal is language learning, then these (mobile learning) affordances and limitations should be directly connected in a principled way to second language learning research and theory”. Language teaching approaches and their Computer-Assisted Language Learning (CALL) and Mobile-Assisted Language Learning (MALL) manifestations have evolved from the older behaviorist approach, which focused on repetitive drills and memorization (Lado 1964; Skinner 1957), towards communicative methodologies that emphasize meaningful interaction and communication (Canale and Swain 1980; Hymes 1972). This shift is supported by socio-cultural theories that highlight the importance of social interaction and context in language learning (Lantolf et al. 2018), and has further progressed to postmodern approaches that incorporate diverse, learner-centered strategies, recognizing the limitations of one-size-fits-all methods and the need for adaptability in addressing individual learner differences (Kramsch 2021; Pennycook 2018). Resources designed following “learning by doing” principle put students at the center of learning process, and increase learners’ engagement and genuine participation in the MALL process through hands-on tasks and involvement. The pedagogical and technological affordances of MALL lend itself to both individual and collaborative learning activities via synchronous and asynchronous communication technologies, resulting in more dynamic and active learning.

In their review of language-learning mobile apps, Kim and Kwon (2012) discovered that most of activity designs concentrated on cognitive processes, including recognition, recall, and comprehension, as well as receptive language skills. They pointed out that socio-cognitive activities or opportunities for collaborative learning, which were more consistent with modern approaches to CALL and MALL were lacking. However, what is deemed good practice by a CALL/MALL practitioner may not align with users’ preferences. As classroom practices have shifted to modern approaches, some learners may feel the need for more grammatical reinforcement in the form of drilling, given that many learners equate language learning with grammar learning.

Learners rarely receive personalized feedback on their performance outside of formal instruction (Kan and Tang 2018). Therefore, activities such as answering quiz questions and using language-learning apps to memorize vocabulary and verb forms can be rewarding. Users feel a sense of satisfaction when they get things right. Although some apps offer only repetitive drilling without meaningful feedback or support, there are now examples of good practices available. Some language-learning apps, such as Duolingo and Busuu, provide a comprehensive language-learning experience.

2.4 Mobile language learning platforms

To better inform the design of our mobile learning application, we have conducted a survey on six widely used language learning platforms, namely Rosetta Stone, Busuu, Duolingo, Babbel, Memrise, and Mondly. The courses in Rosetta Stone, Busuu, Memrise and Mondly cater for a wide range of learners, from beginners to advanced users. Duolingo and Babbel are designed for beginners to intermediate learners (Chen 2016; Mendes de Oliveira et al. 2021).

Rosetta Stone is a language learning platform that uses a natural approach and an immersion method with visual and auditory cues, aligning with behaviorist theories through repetitive drills and immediate feedback (Skinner 1957). Busuu combines self-paced lessons with social interaction, incorporating social constructivist theory by facilitating learning through collaboration (Vygotsky 1978).

Duolingo offers gamified lessons that emphasize vocabulary, grammar, and sentence structure, utilizing behaviorist principles and cognitive theories to enhance memory retention (Atkinson and Shiffrin 1968; Skinner 1957). Babbel focuses on real-life conversation skills, rooted in communicative language teaching (CLT) and socio-cultural theories that highlight the importance of context and social interaction (Hymes 1972; Lantolf et al. 2018).

Memrise uses spaced repetition and mnemonic techniques to help users memorize vocabulary, aligning with Ebbinghaus's forgetting curve (Ebbinghaus 1964). Mondly offers interactive lessons and augmented reality experiences, incorporating both behaviorist and communicative approaches to provide immediate feedback and context-rich learning environments (Hymes 1972; Skinner 1957).

The detailed characteristics of these platforms are summarized from the aspects of *language learning theories, authentic learning, learning communities, technologies used and language skill focus* (Table 1), echoing the key pedagogical principles proposed by Yates and Palalas (2018) for mobile-assisted language learning resource development.

As can be seen from Table 1, most language learning theories involve multimedia learning, communicative language teaching, behaviorism, and social constructivism. To ensure authentic learning, natural and realistic learning materials, primarily authored by native speakers, are extensively utilized. Diverse formats of learning communities exist to foster social learning. Common technologies used include spaced repetition, speech recognition or processing, AI technologies for reviewing and providing appropriate content (Karasimos 2022). Among the four language skills, greater emphasis is placed on speaking skills (except Memrise).

Each platform offers a variety of activities to enhance users' language proficiency. Commonly used activities encompass listening and repeating, translation-

Table 1: Comparison of six widely used language learning platforms.

Platforms	Language learning theories	Authentic learning	Learning communities	Technologies used	Language skill focus
Rosetta stone	The natural approach, behaviorism, multimedia learning, immersion and contextual learning	Real-life images, native speakers' voices	Live virtual classes, engaging in activities and games with other learners	Spaced repetition, speech recognition	Speaking skills
Busuu	Communicative language teaching, behaviorism, multimedia learning, social constructivism	Practical language use, interaction with native speakers	Subscribed learners can receive feedback from native speakers	Adaptive proficiency test, reviewing helped by AI technologies	All four language skills and grammar
Duolingo	Communicative language teaching, behaviorism, multimedia learning, social constructivism	Vocabulary relevant to everyday communication	Discussion forums, leaderboard competition, connection with friends and followers	Adaptive proficiency test, spaced repetition, AI technologies for suggesting content	Speaking skills and vocabulary acquisition
Babbel	Communicative language teaching, behaviorism, multimedia learning	Natural and authentic language, conversation in real life scenarios	Live virtual classes	Spaced repetition, speech recognition	Speaking skills and grammar
Memrise	Behaviorism, multimedia learning, social constructivism	Video clips of real locals	Crowd-sourcing approach to build courses	Mnemonic devices, spaced repetition, text-based chatbots	Vocabulary learning
Mondly	Communicative language teaching, behaviorism, multimedia learning	Realistic situations, AR immersive and engaging environment	Leaderboard competition, connections with friends and followers	Virtual reality, speech processing, human-like AI chatbot	Strong emphasis on conversational practice

based activities, matching, typing, rearranging, filling in the blank, multiple-choice, listening/reading comprehension, etc. Memrise stands out with its mnemonic approach, while using diverse test types and scheduled reminders to facilitate learning new words (Zhang 2019). Enhanced by VR technology, Mondly additionally provides dialog lessons and conversational chatbots (Fryer et al. 2020). Rosetta Stone does not rely on translation aid nor provide grammar instructions. Instead, through transitioning from receptive activity types (observation, listening, repetition) to productive activity types (matching, filling in the blank, constructing sentences), Rosetta Stone employs an immersive learning approach to assist students in language learning.

In the realm of special features, Busuu stands out by offering users the ability to craft personalized learning plans tailored to their specific language learning goals. Moreover, both Busuu and Mondly are equipped with progress tracking mechanisms (Gokturk 2017). Memrise and Duolingo's gamified learning experiences add an element of fun and interactivity to the language learning journey, making it more enjoyable and motivating for users (Nushi and Egbali 2017). Meanwhile, Babbel implements an adaptive learning system, ensuring that review sessions are tailored to individual learner performance.

Besides the strengths presented above, previous evaluation studies have pointed out the shortcomings of these platforms. For example, Rifkin (2003) noted the inability of Rosetta Stone to account for natural and acceptable variations in language. Lord (2015) stressed the importance of culture, pragmatics, and negotiation of meaning taught in class but absent in the self-paced stand-alone learning with Rosetta Stone. Finardi et al. (2016) showed that participants recognized that Duolingo may aid L2 learning to a certain extent, but agreed that a teacher is necessary to foster interaction and develop production skills in L2. According to Scholz (2018) and Zhang (2019), although Memrise's gamification elements may help maintain students' interest and engagement, it should only be used as an addition to a learner's other language learning experiences, instead of the sole source of L2 learning.

Through our survey, we observed that none of the widely used language learning platforms currently offers Fijian course. This research gap underscores the imperative to address less-commonly taught languages within the framework of our project. Building upon the inspiration drawn from Rosetta Stone, our platform's design is anchored in the natural approach and immersion method, incorporating principles from multimedia learning and communicative language teaching. To enhance the learning experiences, we integrate technologies such as speech evaluation, adaptive learning algorithms, and text-based chatbots. We also provide a learner community to foster a social learning environment where users can track and support each other's progress. Our learning content is both topic-based and authentic, complemented by interactive activities and timely reviews. Leveraging

spaced repetition, we facilitate effective memorization, and our progress tracking mechanisms empower learners to monitor their advancement. We steer clear of promoting rote memorization through translation and recognize the need to embrace natural language variations.

3 Research design

3.1 Research context

The participants in this project are undergraduate students preparing to learn a third foreign language in the university. As beginners to the language, these learners face the challenge of lack of target language teachers and learning resources, and the absence of immersive language environments. In the light of this understanding, we developed a smart mobile learning application dedicated for less-commonly taught languages. Our methodology draws inspiration from established language acquisition theories such as the natural approach (Krashen and Terrell 1983), the immersion method (e.g., Cummins 2009; Kinginger 2011; Wilkinson 1998), and the multimedia learning theory (Mayer 2018, 2022). Our goal is to create a learning platform that mirrors natural language acquisition, bolstered by immersive techniques and multimedia integration. To achieve this, our application is designed with a range of interactive learning activities and we leverage cutting-edge technologies like speech evaluation, adaptive learning algorithms, and script-based chatbots to offer dynamic and personalized language learning experiences.

3.2 Course syllabus design: notional-functional and communicative approaches

The notional-functional approach is a teaching method emphasizing the understanding of communicative meanings behind words and expressions rather than just learning of vocabulary and grammar knowledge (Council of Europe 2020; Ellis 2012; Richards and Rodgers 2001; Wilkins 1976). Since the target learners of the mobile learning application under study are beginners aiming to learn the language for real-life communications, the notional-functional approach is adopted in the language content design. Therefore, the syllabus is organized according to notions (topics and ideas) and functions (purposes for communication) rather than grammatical structures, enabling learners to practice language structures relevant to specific situations and ideas. CEFR A1-A2 level (Council of Europe 2020) is the intended language proficiency levels, which involves from helping learners to understand and use

familiar everyday expressions and very basic phrases for needs of a concrete type to helping learners to understand sentences and frequently used expressions related to areas of most immediate relevance (e.g., very basic personal and family information, shopping, local geography, employment).

In light of the common themes in CEFR A1-A2 level, four topics were decided on for this introductory course: *Daily Life, Hobbies and Interests, Study and Work, and Traveling*, which represent the domains of common communication needs in a foreign language environment. Each unit comprises four lessons, providing a well-rounded and comprehensive learning experience. Since the CEFR levels are fully defined in a structured set of illustrative ‘can-do’ descriptors,¹ the design of the lesson themes was guided by the abilities described in these descriptors. Furthermore, to enhance learner’s essential processing in multimedia learning, we followed the segmenting principle and divided each lesson into 3 to 5 modules with fine-grained themes. To sum up, the course structure of Unit 1 is shown in Figure 2 as an illustration.

The themes of all units and lessons are presented in Table 2, and the themes of all modules in lessons of Unit 1 are shown in Figure 2 as example. Each module contains 13 mobile screen pages on average. Overall, the course structure is arranged as follows: Unit > Lesson > Module > Screen page, where “screen page” is the smallest granularity. The course includes in total 64 modules, with 2,784 lines of text distributed in 828 screen pages. On average, 42 new words are introduced per lesson. The time needed to finish learning each lesson is around 1–1.5 h.

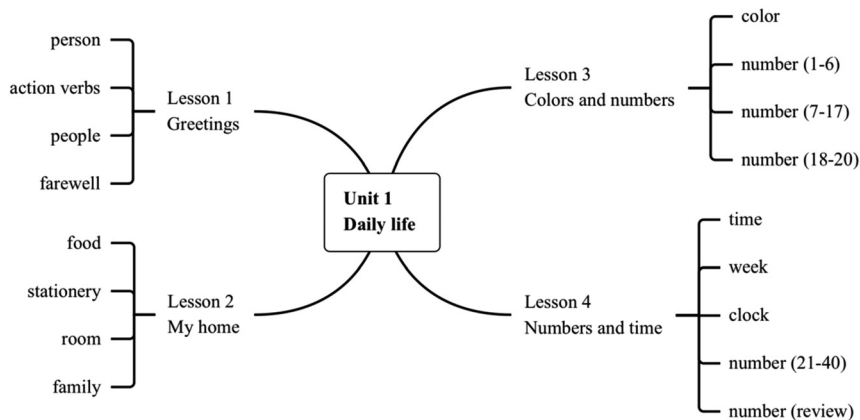


Figure 2: Course structure: each unit contains four lessons, and each lesson contains 3 to 5 modules.

¹ <https://www.coe.int/en/web/common-european-framework-reference-languages/the-cefr-descriptors>

Table 2: The themes of each unit and lesson.

	Unit 1 Daily life	Unit 2 Hobbies and Interests	Unit 3 Study and work	Unit 4 Traveling
Lesson 1	Greetings	Sport	Daily routine	Departure and arrival
Lesson 2	My home	Art	Personal information	Weather
Lesson 3	Colors and numbers	Food	School	Sightseeing
Lesson 4	Numbers and time	Shopping	Work	Seeing the doctor

3.3 Learning activity and system design

3.3.1 Learning activity design

Concerning the design of learning activity types, we followed the four key pedagogical principles for mobile-assisted language learning resource development (Yates and Palalas 2018). The principle of “make learning authentic” involved a strategic combination of text, native speakers’ audio recordings and real-world images, to deepen learners’ comprehension through visual context. For the principle of “connecting resources to theory”, we adopted the natural approach, the immersion method and the multimedia learning theory, and the learning activities specifically incorporated the principles of spatial contiguity, temporal contiguity, and modality from multimedia learning theory (Mayer 2001). Further, the “learning by doing” principle is realized through 13 activity types, categorized into “receptive” and “productive” sets, aligning with varying cognitive processes from remembering and understanding to applying, as per the revised Bloom’s Taxonomy (Anderson and Krathwohl 2001; Bloom 1956). Lastly, to “balance individual and social learning”, a learner community was established to foster group and peer interactions (detailed in Section 3.3.2).

More concretely, the “receptive” activities aim to introduce new content or aid in review, engaging learners through viewing, listening, and oral repetition. On the other hand, the “productive” activities are tailored for applying learned knowledge, prompting learners to match audio, text, and images or construct sentences based on audio or image cues, which reflects the cognitive theory of multimedia learning (see Figure 1). Detailed visual representations of some activity types are showcased in Figures 3 and 4 (the text is written in Fijian). Each activity type is presented on a

single screen page, utilizing landscape format for content display. To ensure clarity, each page accommodates a maximum of four images or text blocks. These carefully selected images consist of photographic pictures obtained from a licensed online image library, for which we have secured a commercial-use license.

To ensure a dynamic immersive learning experience, our pedagogical design is multifaceted. Firstly, to delineate the scope of vocabulary and sentence structures covered in this course, we referenced content from the six language learning platforms we surveyed and incorporated thematic vocabulary lists from resources like the Cambridge English exam syllabi. Secondly, aiming to reduce learners’ cognitive load, we meticulously regulated the introduction of new words and syntactic structures. Each sentence in “receptive” learning activities was carefully annotated to highlight the appearance of new linguistic elements, ideally limiting each sentence to the introduction of a singular new word or syntactic structure. A list of Fijian vocabulary, sentence patterns, key grammar concepts, and discourse functions was

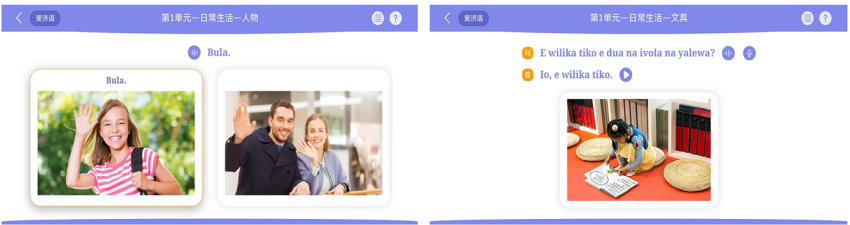


Figure 3: Receptive activity types (learning behaviour: viewing, listening, and oral repetition).

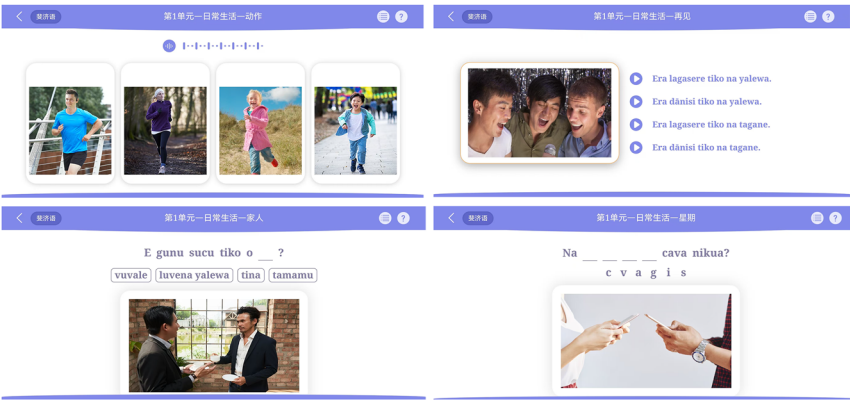


Figure 4: Productive activity types (learning behaviour: match audio, text, and images or construct sentences based on audio or image cues).

compiled for each lesson. These summaries not only facilitated record-keeping but also allowed for systematic content recycling. Thirdly, to foster learners’ autonomy, we maintained a gradual and steady learning pace. Beginning with frequently used daily words and short phrases, the course gradually progressed towards more complex sentence structures. New nouns were introduced alongside corresponding images, while verbs were contextualized within sentences constructed around familiar nouns. The strategic repetition of sentences with similar structures served to reinforce learners’ grasp of grammatical concepts progressively. Fourthly, by strategically designing clues, we prompt learners to apply existing knowledge to deduce the unknown, fostering an environment that encourages hypothesis verification and the development of language network (Kovács and Sik-Lányi 2014). Throughout the course, learning content is systematically revisited in “productive” activities, facilitating step-by-step advancement for learners.

3.3.2 System design

In essence, the platform adopted a classical three-tier application architecture (Eckerson 1995), comprising:

- 1) A graphical user interface tier responsible for content presentation and learner interaction;
- 2) A business logic tier handling commands, logical decisions, and computations. It manages data transfer between the interface and data tiers (see Table 3);
- 3) A data tier dedicated to storing, retrieving, and transferring information.

Implementing this architecture brings multiple benefits, such as reduced dependencies between components, and improved maintainability and scalability of the system.

Table 3: User interface and business logic tier of the platform.

User interface tier			Mobile platform
			Course learning interface
			Learner community
			Learner’s personal center
Business logic tier	Basic operation		Learning-related technologies
	Course and knowledge management		Speech evaluation
	User and class management		Adaptive learning
	Statistics of learning behaviour and results		Script-based chatbot

To aid learner navigation through course levels (unit, lesson, module), we crafted a landscape navigation map (see Figure 5). Utilizing iconic images from corresponding countries, we embedded cultural elements into the map. Learners can switch between units by clicking the four circles on the left. On the right, lessons are depicted along a wave-like path, and modules are represented by icons accompanied by thematic names. As learners complete a module, its icon transitions from semi-transparency to opacity. A red pin marks the last accessed module, providing a clear reference for learners' progress.

In each lesson, clicking the first icon (“导学” or “learning guidance”) reveals a page briefly outlining the lesson's primary learning objectives in Chinese. Clicking the last icon (“总结” or “summary”) at the lesson's conclusion presents a page summarizing newly acquired words, sentence structures, accompanied by corresponding images, audios, and Chinese translations (see Figure 6, a “translation” button controls translation visibility). These pages are crafted to efficiently guide learners through the course and allow swift review of language knowledge when necessary.

Clicking on a module icon initiates the learning process, with each page corresponded to a specific learning activity. In “receptive” activities, audios play sequentially. To complete the activity, learners read aloud after the audios: click the microphone icon to start recording, read the content, and click the icon again to stop recording. Our speech evaluation mechanism assesses learner's pronunciation to provide a binary result: successful (as depicted in Figure 7) or failed. Learners can attempt repeating each audio twice at most and have the option to listen repeatedly to the original audio before recording.

Upon completion of an activity, the entire content reappears in a slightly altered format (refer to Figure 8), enabling two kinds of actions. Firstly, for both “receptive” and “productive” activities, learners can: view texts and repeatedly listen to audio; access text translations by clicking the “translation” button and toggle between English/Chinese/French translations (Translations for the three languages were provided due to their ease of availability). While the learning process is primarily immersive, the



Figure 5: Navigation map of the Fijian course.



Figure 6: Summary page at the end of each lesson.



Figure 7: The animation effect for a successful repeating according to the speech evaluation.

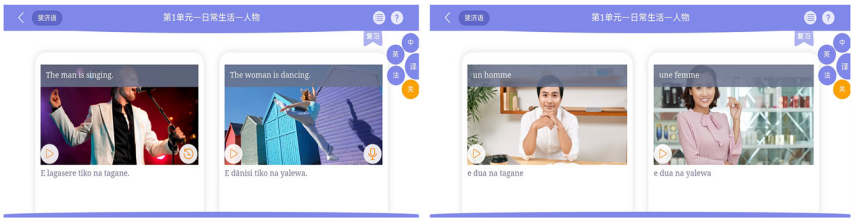


Figure 8: The interface when a learner accomplishes an activity.

inclusion of multilingual translations satisfies the conscious study needs of adult second language learners, addressing concerns raised by Lord (2016) regarding potential ambiguity conveyed solely through images in autonomous learning with Rosetta Stone. Secondly, in “receptive” activities, learners can listen to their successful pronunciations, or retry repetitions until achieving success. Screen page navigation allows learners to freely swipe right for the next page, swipe left for the previous page, or access a specific page via the menu button in the top-right corner.

To promote social learning, the platform offers a learner community (refer to Figure 9), enabling learners to track their current lessons and compare their progress with peers in the same language class. A histogram displays the count of learners with completion rates lower than, equal to, or higher than the current learner. Additionally, learners can curate a “friend list” by selecting classmates from a leaderboard, which ranks learners based on their course completion rates.

At the end of the navigation map, a dynamic unit-level learning report is accessible (refer to Figure 10). This report outlines the learners’ cumulative learning hours, course completion rate, accuracy in “productive” activities (termed as “exercise accuracy” subsequently), and a ranking list based on exercise accuracy within the current unit.

Within the learner’s personal center, the platform presents various learner-related details, including the ongoing lesson, course completion rate, exercise accuracy, and the count of acquired words and sentence structures. Learners can share suggestions or pose platform-related queries directly to the research team from this center. Furthermore, they are allowed to download course-related images and audios to their mobile devices, expediting material loading speeds.

3.3.3 Supporting technologies

Three primary technologies supporting the less-commonly taught language learning in this platform are speech evaluation, adaptive learning, and script-based chatbot, succinctly outlined as follows.

In “receptive” activities, learners can listen to standard pronunciation and receive immediate feedback upon repeating the speech. To enable this, the speech evaluation module utilizes a signal analysis approach, ensuring generic speech assessment without relying on specific speech resources. This approach caters well to less-commonly taught language learning and various learner age groups. Future plans involve developing an evaluation system based on neural network-driven speech processing techniques, leveraging a growing collection of speech resources for more comprehensive pronunciation assessment. Additionally, this module features a real-time playback function enabling learners to compare their recordings with those of native speakers, significantly enhancing learning efficiency. A



Note: as the primary users of the platform are Chinese students, the interface is presented in Chinese.

Figure 9: Learner community. Note: as the primary users of the platform are Chinese students, the interface is presented in Chinese.

dual-mode evaluation strategy was implemented: the relaxed mode sets lower standards, fostering confidence, ideal for early learning stages. Once learners master the language’s basic phonetics, they can opt for the strict mode to further refine pronunciation, which is accessible in the learner’s personal center.

We utilized adaptive learning technology to facilitate personalized course reviews tailored to learners’ most recent performance. This function’s development



Figure 10: Unit-level learning report at the end of the navigation map.

is rooted in extensive learner behavioral and performance big data. The system meticulously stores and analyzes diverse learning-related data – learning start times, page learning statuses, exercise submission times, exercise results, speech evaluation outcomes, and more. Upon clicking the “Adaptive review” button in the navigation map, the adaptive learning system dynamically recommends a curated set of pages suitable for individualized review. This selection comprises two types of learned pages: 1) pages where the latest exercise accuracy fell below 100 %; 2) a maximum of 10 “receptive” activity pages with low memory retention values, computed following the Ebbinghaus Forgetting Curve (Ebbinghaus 1964). This personalized approach ensures that each learner could receive a timely and precise review aligned with their recent learning performance. The reviewing interface mirrors the standard learning interface (refer to Figure 11), with the addition of an “复习中” (means “reviewing”) icon displayed in the top-left corner.



Figure 11: Adaptive course reviewing interface.

Upon completing each unit, the application offers learners an opportunity to reinforce acquired knowledge through textual chat with a script-based chatbot. This feature serves to alleviate learners' communication apprehension by providing a simulated environment for repeated practice. At the conversation's outset, learners can opt for two chat modes: 1) the robot guides the conversation, posing one question at a time and providing feedback based on learner responses; 2) the learner takes the lead, asking the robot one question at a time (with the robot responding briefly). This mode aids in practicing interrogative sentences learned within the unit.

Technologically, the chatbot is constructed using Flask (Dwyer et al. 2017) and AJAX (Eichorn 2006), ensuring seamless communication between the web server and the learner. This interactive chat function aims to enhance learners' language practice and confidence in a controlled setting.

4 Fijian language learning: learner experiences

Following the completion of the online courseware, we conducted a study during the winter vacation of 2023 to assess the platform's efficacy in facilitating the learning of less-commonly taught languages, specifically Fijian in our context.

4.1 Participants

Ten Chinese students from a university in Beijing participated voluntarily in the study, consisting of six females and four males, with an average age of twenty-two. All participants were native Mandarin speakers, with English as their first foreign language, and had an average of 15 years of English learning experience. Among them, three specialized in foreign language studies (including two postgraduate students), while seven majored in other disciplines such as Computer Science and Finance. Additionally, a Chinese teacher, proficient in Fijian, was invited to deliver an online Fijian lesson each week for students during the study.

4.2 The teaching experiment

Before the experimental learning phase, an online meeting was organized, involving the learner participants, the Chinese teacher, and the research team. During this session, we introduced the research background, the platform's design rationale, and the learning approach. Learners received the platform's user manual and a default learning plan beforehand. The study spanned four weeks, aiming for one module

completion daily and one lesson weekly. Embracing a flipped-class model (Bergmann and Sams 2012), the study combined autonomous platform-based learning with a weekly live online tutorial conducted by the teacher. At the end of learning, a questionnaire was administered to the ten students to collect their feedback on learning with the Fijian language application facilitated with a weekly tutorial. Additionally, we also conducted an online group interview where six learners and one tutor shared their learning and teaching experiences with the Fijian language learning application.

4.3 Research methods

As mentioned in 4.2, two research methods, namely a questionnaire and an online group interview, were undertaken to evaluate the efficacy of the Fijian language learning application.

Drawing on the surveys used in Ji (2022) and Xu (2018), the questionnaire comprises a series of 5-point Likert-scale questions associated with the 6E framework measuring mobile learning experience (ranging from “1-very dissatisfied” to “5-very satisfied”). This 6E framework encompasses six stages of mobile learning experience: enticement, entertainment, engagement, empowerment, enlightenment, and enhancement.

Specifically, the concept of “Enticement” pertains to initial product impressions, such as content relevance and user-friendly interface, shaping the questionnaire’s first four questions (see Appendix A for details). “Entertainment” evaluates emotional responses like interest, satisfaction, and enjoyment, influencing questions 5 to 7. “Engagement” captures behavioral actions, including searching, exercising and interacting, linked to questions 8 and 9. “Empowerment” focuses on further behavioral aspects like clear goals and learner autonomy, associated with questions 10 to 12. “Enlightenment” addresses cognitive outcomes such as inspiration and awareness, reflected in questions 13 and 14. Lastly, “Enhancement” assesses performance outcomes like knowledge and skills, encapsulated in question 15.

The questionnaire was administered to the ten participants online anonymously, and the completion rate is 100 %. Participants’ responses to the objective questions were analyzed via SPSS.

Six students and the Fijian language tutor joined in the online group interview at the end of the last tutorial (Note: the other four students could not participate in the interview due to their other commitments). The interview was conducted in Chinese and extended for about 30 min. Both the tutor and the students were invited to reflect on their experiences with the application and to suggest areas for future

development. With the participants' prior permission, the interview was recorded, transcribed and translated into English.

A qualitative approach was used in the analysis of the open-ended questions in the questionnaire and interview responses. They were analysed manually and coded into broad themes using a thematic analysis method (Braun and Clarke 2006).

4.4 Results

In this part, participants' experiences on the Fijian language learning application are reported on the basis of their responses in the questionnaire, supported with the data from the group interview.

Participants first answered how they discovered the Fijian language course on this platform, with all ten indicating recommendations from teachers or classmates. Subsequently, their enticement experience was gauged through three 5-point Likert-scale questions, focusing on content relevance, interface appeal, and navigation ease. The results showed a sum of average score of 12.3/15, reflecting an 82 % satisfaction rate at this stage. This includes an 84 % satisfaction level ($M = 4.2$, $SD = 0.63$) for the overall course content and quality evaluation.

The Fijian language application assisted my learning greatly. In particular, my listening and speaking skills in Fijian improved a lot. (Interview, Student No.9)

In terms of entertainment, we assessed three aspects: interest arousing, satisfaction, and the pleasure of learning Fijian through the platform. The Likert-scale results showed an overall 86 % agreement level (sum of average score 12.9/15), indicating a positive reception to the course's ability to stimulate interest, meet learning needs, and provide an enjoyable experience. Notably, the interest arousing rate scored 92 % ($M = 4.6$, $SD = 0.52$), underscoring the course's effectiveness in captivating the learners' attention, which might be due to its requiring students to guess the meaning of the words and sentences through the given clues such as known words and images as advocated in the natural approach (Krashen and Terrell 1983) and the immersive method (Cummins 2009; Kinginger 2011; Wilkinson 1998) influencing its design discussed in 2.1.

It is my first time of using an app to learn a language from scratch. It is a very different and novel experience! I immersed myself in learning Fijian (with sounds and images provided), noting down the points that I do not understand and waiting for the weekly tutorial class for explanations and clarifications to see whether I have really guessed the meaning of words correctly based on the pictures provided. If not, I can give suggestions for course improvement. (Interview, Student No.9)

My way of learning is the same as Student No. 9. I tried to guess the meaning of a word based on the given image. If I failed to guess the meaning, I will note it down, then waiting for the weekly tutorial to ask the tutor, to verify whether my guesses are correct or not. (Interview, Student No. 7)

The preceding students' quotes indicated that they were engaged in immersive learning, exploring the connection between pictures and word meanings. They eagerly awaited the weekly tutorial, where tutors would help them review and answer their questions. In this flipped-class model (cf. Bergmann and Sams 2012), students previewed the content and then used the tutorial to clarify their understanding and verify their learning, which had no doubt aroused their interest in learning.

With regard to engagement, the questionnaire first gauged the daily time participants devoted to the Fijian course. Findings showed that 80 % of the students spent about 0.5–1 h each day, while the rest dedicated less than 30 min. The survey then asked participants to rate the course exercises and tasks, resulting in an overall satisfaction rate of 86 % ($M = 4.3$, $SD = 0.48$), reflecting positive engagement with the course content.

On empowerment, the course was evaluated on clarity of requirements, success opportunities, and learner autonomy, showing a satisfactory rate of around 82.7 % (sum of average score 12.4/15). The platform's support for autonomous learning received an average score of 3.8 ($SD = 1.23$). During the online group interview, the participants highlighted the influence of their early English learning experiences, especially regarding explicit grammar instruction. They felt this aspect was less supported in the platform's independent learning environment. The weekly online classes led by the teacher, covering grammar, phonetics, pragmatics, and culture, were highly appreciated, complementing their self-directed studies.

In relation to enlightenment, learners expressed a high level of inspiration and awareness in learning Fijian, with an 85 % agreement rate (sum of average score 8.5/10). Although the average score of 4.6 ($SD = 0.70$) suggested a strong inclination to explore the language further, a lower average score of 3.9 ($SD = 0.88$) in mastering language fundamentals such as phonetics, vocabulary, and grammar pointed to potential areas for course enhancement, which is also voiced in the online group interview as below.

We can only guess the meaning of a sentence, but do not know much about its grammar, or the use of prepositions and articles, particularly for Fijian language, a less-commonly taught language. It would be good if relevant knowledge about grammar are included. (Interview-Student No. 6)

Moving to the enhancement stage, participants concurred at 70 % ($M = 3.5$, $SD = 0.71$) that they could engage in basic daily conversations after completing the course. This

was particularly notable considering they had only finished a single unit, which was just a quarter of the introductory course in this study. This finding was also echoed by the tutor in the interview.

I am also teaching Fijian to campus students in the classroom; nevertheless, students in this class surprised me in our first meeting with their accurate pronunciation in Fijian. Therefore, I think the Fijian language learning application helps students greatly with the learning of the language. I am particularly impressed that prior to my teaching, the students have figured some grammar points out themselves through the application and its English-Chinese translation. I was also very struck by their level of Fijian and their strong comprehension of the language, which indicates the efficacy of the Fijian language learning application in assisting students with learning a totally new language and understanding a lot of content. (Interview-Tutor)

The tutor's positive feedback indicated the efficacy of the application in improving students' pronunciation, knowledge and comprehension of Fijian.

The questionnaire also included four open-ended questions (see Appendix A). Among the respondents, 60 % (N = 10) commended the course for its appropriateness in introducing the Fijian language and appreciated its clear and progressive course design.

By incorporating everyday vocabulary, dialogues, and contexts, the course is very suitable for learners who have never been exposed to Fijian to get started. (Questionnaire-Student No. 10)

The content is organized in a step-by-step manner, tailored to the learning habits of beginners. The structure is quite logical and allows for timely review. (Questionnaire-Student No. 5)

Half of the respondents suggested that grammar explanations should be incorporated.

The course is designed in line with the natural language acquisition method, which is quite innovative. However, I personally suggest that grammar explanations should be added for students who need them. (Questionnaire-Student No. 7)

It would be better to add some simple grammar explanations, for example at the end of each unit. Especially for the long and complex sentences, it is difficult to understand them simply by guessing and memorizing. (Questionnaire-Student No. 9)

Other recommendations included integrating aspects of the country's history and culture, introducing customizable exercises for revising learned vocabulary, and enhancing the speech evaluation feedback.

I suggest adding a page introducing cultural knowledge in each lesson. (Questionnaire-Student No. 2)

I hope that the pronunciation feedback could be improved, such as pointing out which syllable is not correctly pronounced, or refining the evaluation categories into: failing, passing, and excellent. (Questionnaire-Student No. 6)

With platform enhancements, the primary suggestion was to improve image design, including better alignment with text, replacing images with short videos for abstract concepts, and simplifying the interface's visual complexity.

The images and background colors on the navigation interface are too complex. We recommend unifying the hue and simplifying the background design. (Questionnaire-Student No. 10)

Users also recommended smoother page navigation and adaptive page sizing for different mobile devices. Additional features like a daily attendance tracker and an online chat function for user interaction were also proposed.

In the final part of the questionnaire, participants shared their thoughts on recommending the platform, summarizing its advantages and areas for improvement. They praised its unique language offerings, beginner-friendly content, multimedia resources, and cost-effective learning. Meanwhile, they pointed out areas needing enhancement, such as the inclusion of more grammar explanations, additional practice activities, improved image-text alignment, and higher speech evaluation accuracy.

This software is in line with the learning habits of language beginners, which emphasizes listening, speaking, and reading. The corresponding pictures help strengthen the memory. Its teaching method of natural language acquisition enables students to quickly master daily communication terms, while getting rid of the dullness and rigidity of traditional phonetic and grammar learning. (Questionnaire-Student No. 7)

The advantage of the course is that it features native speakers' real voices and starts teaching the language through listening and speaking. The drawback is that there are no grammar explanations, making it difficult to apply the knowledge to new situations. (Questionnaire-Student No. 1)

Students had a high opinion of weekly online tutorial included in the teaching experiment.

I feel the weekly online tutorial by our Fijian teacher is extremely beneficial to my learning! The amount of knowledge is just right and doesn't impose a heavy burden. (Questionnaire-Student No. 6)

Overall, the study revealed that the online platform was effective in facilitating the learning of the Fijian language among the Chinese university students under study, with high satisfaction rates across various aspects of the learning experience. The flipped-class model, combining autonomous learning with weekly

online tutorial covering grammar, phonetics, pragmatics, and culture, was well-received. Participants appreciated the course's clear and progressive design but highlighted the need for more explicit grammar instruction and other enhancements. The study's findings suggest that while the platform is successful in engaging and inspiring learners, there are opportunities for further improvement to better support the mastery of language fundamentals and enhance the overall user experience.

4.5 Discussion

Mirroring the approach of popular language learning platforms, this project integrates the natural approach of foreign language learning (Krashen and Terrell 1983; Richards and Rodgers 2001), the immersion method (e.g., Cummins 2009; Kinginger 2011; Wilkinson 1998), the multimedia learning theory (Mayer 2022), and key pedagogical principles for mobile-assisted language resource development (Yates and Palalas 2018) in its design. Innovatively, it includes adaptive learning for personalized reviews, on-demand auxiliary translations in English/Chinese/French, and a unique speech evaluation module using the signal analysis method, particularly effective for less-commonly taught languages. This approach, diverging from traditional methods focused on phonetics and grammar, not only rapidly boosts students' confidence in listening and speaking skills, as evidenced by generally positive learner feedback, but also garners recognition for its effectiveness from the Fijian language teacher.

Meanwhile, students showed a distinct interest in grammar learning, advocating for a balanced focus on reading and writing skills as well. As the course advanced and linguistic complexity increased, a need for grammar explanations became evident. This study underscores the importance of tailoring grammar instruction to align with learner preferences and goals, balancing the need for structured language mechanics with practical, contextual language use for an optimized learning experience, which echoed the findings from previous studies showing that explicit grammar instruction can significantly improve language accuracy (e.g. Norris and Ortega 2000).

The effectiveness of the survey statistics in this study might have been influenced by the limited number of participants. However, this limitation was mitigated by the inclusion of the online group interview and the subjective questions in the questionnaire aimed to maximize feedback collection from students and the teacher. It is also crucial to note that the study focused solely on one unit, comprising four lessons within a four-week period. The subsequent units, characterized by more

diverse and complex dialogue scenarios and intricate language structures, were not part of the study. Consequently, the effectiveness of the teaching script and activity design for the higher-level content remained to be tested and validated in future study.

5 Conclusion and implications

This study presented a university project designing and applying mobile learning for less-commonly taught languages in China. The rationale, course design, technology support, and student learning experiences were reported and discussed. The platform, guided by the natural approach, immersion method, multimedia learning theory, and the four key pedagogical principles for mobile-assisted language learning resource development, was designed to simulate target language environments and provide ample practice and instant feedback via speech evaluation and adaptive learning.

The most significant contribution of this project is the development of mobile learning solutions for less-commonly taught languages, which are not covered by existing popular language learning applications. This is particularly important for protecting language and cultural diversity, aligning with the UN's Sustainable Development Goal of *Quality Education: ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all*. The second contribution, given the very limited resources available for the target language, is the adoption of the natural approach and the immersion method via the alignment of sounds, words, pictures, and images, along with AI-supported learning technologies such as automated speech assessment and adaptive learning.

During this project, we encountered various research challenges with implications for future work. Firstly, finding qualified collaborators for less-commonly taught languages posed a challenge, exacerbated by potential disruptions in online communication. Secondly, ensuring the progressive nature and regular recycling of target language scripts demanded extensive discussions on the learning content, new knowledge introduction frequency, and activity design rationale. Thirdly, the platform development involved numerous decisions to be made at every stage, from user interface design to back-end functionality, prompting regular group meetings between design and development teams. Fourthly, striving for authenticity aligned with the immersion method led to predominantly using real-world images in the course. However, sourcing specific images to precisely match text meaning in online

libraries proved challenging, requiring the creation of cartoon or synthetic images by our graphic designer in some cases.

The platform is currently aimed at use by registered students at the university and will be open to the public in the future. Moreover, inspired by the success of Fijian mobile language learning platform, twelve more less-commonly taught languages have been developed over the past two years. Future research could explore the organic integration of grammar instruction with natural and immersive learning methods in the platform. Investigating the effectiveness of different grammar instruction approaches for diverse learners and assessing their impact on language proficiency and motivation is crucial. Exploring formative tests for aiding self-assessment is also necessary. Additionally, extending the application's use for more other less-commonly taught languages and its role in enhancing language learning beyond classrooms could be explored in future studies.

Research funding: This study was funded by the Project of Discipline Innovation and Advancement (PODIA)-Foreign Language Education Studies (Ref: 2020SYLZDXM011), the Fundamental Research Funds for the Central Universities (Ref: 2020QD005), the Project of Artificial Intelligence and Human Languages Lab at Beijing Foreign Studies University (Ref: 2020SYLZDXM040), and the National Emerging Humanity and Social Sciences Research and Reform Practice Project “Developing Undergraduate Programs in Foreign Languages and Artificial Intelligence” (Ref: 2021060009).

Appendix A: The learner questionnaire used in the Fijian language learning experiment

Please answer the following questions. For questions starting with Please rate, rate your mobile learning experience in using Fijian online learning application by circling the response that most represents your view in the scale below.

1. Very dissatisfied
2. Dissatisfied
3. No opinion
4. Satisfied
5. Very satisfied

1.	How did you know the Fijian online learning application?					
2.	Please rate the level of course content and quality.	1	2	3	4	5
3.	Please rate the aesthetics level of the interface design.	1	2	3	4	5
4.	Please rate the level of easy navigating.	1	2	3	4	5
5.	Please rate the level of interest-arousing in learning Fijian language.	1	2	3	4	5
6.	Please rate the level of learning need being satisfied.	1	2	3	4	5
7.	Please rate the level of learning pleasure.	1	2	3	4	5
8.	How long do you use this platform every day?					
9.	Please rate the level of satisfaction towards the learning activities.	1	2	3	4	5
10.	Please rate the level of clearness of the learning objectives and the evaluation criteria.	1	2	3	4	5
11.	Please rate the level of being empowered with success opportunities, e.g. feedback, improvement, or rewards.	1	2	3	4	5
12.	Please rate the level of being empowered with learner autonomy, e.g. self-discipline, self-direction, self-control.	1	2	3	4	5
13.	Please rate the level of being inspired to deepen the learning of this language.	1	2	3	4	5
14.	Please rate the level of having obtained a better understanding of basic language knowledge (phonetics, vocabulary, grammar, etc.).	1	2	3	4	5
15.	Please rate the level of being able to carry out simple conversational communication in daily life after taking the course.	1	2	3	4	5
16.	How would you evaluate the content and structure of the Fijian language course?					
17.	What additional content or features would you wish to see integrated into this platform?					
18.	What recommendations or feedback do you have to enhance and refine the platform?					
19.	How would you recommend this platform to others? (Highlighting its strengths and weaknesses)					

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[Post online publication correction added on 7 May 2025: journal title “*Language, Learning and Technology*” was updated to “*Language Learning & Technology*” throughout the reference list.]

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