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UNDERSTANDING USER ACCEPTANCE OF AUGMENTED REALITY IN ENHANCING CHINESE LANGUAGE LEARNING AMONG UNDERGRADUATE STUDENTS

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Abstract:

This study explores user acceptance of an augmented reality (AR) application designed to enhance Chinese language learning among students, particularly Malay and Indian learners. By integrating AR features into a digital eBook, the application offers interactive visualisations, real-time pronunciation guidance, and multimedia support, providing a more engaging alternative to traditional textbooks and passive video learning. Users can scan Chinese characters to trigger 3D objects, audio, and video overlays that aid in vocabulary retention and speaking fluency. A survey of 40 respondents was conducted to assess key factors affecting user acceptance. The findings indicate high levels of acceptance and satisfaction, with users highlighting the application's effectiveness in improving their understanding and pronunciation of Chinese vocabulary. Future improvements will focus on integrating mouth animation and advanced speech modelling to personalise the learning experience further and increase user engagement.

Keywords:

Augmented Reality, Chinese Language Learning, Educational Technology, Interactive eBook, Pronunciation Support, Mobile Learning, Language Acquisition, User Experience

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Introduction

Nowadays, smartphones have become an essential part of people's lives, and several advanced technologies can be used on them, such as Augmented Reality (AR). Smartphone-based augmented reality has become a popular concept in recent years. Augmented reality is a direct or indirect view of a physical, real-world environment whose elements are augmented by computer-generated sensory input, such as sound, video, or graphics(Che Amran et al., 2025). It is related to a broader, more common concept called mediated reality, in which a computer modifies the view of reality. As a result, the technology functions by enhancing one's current perception of reality.

In other words, AR is a technology that overlays virtual objects onto the real world, allowing people to interact with computer-generated content in real-world environments (Lu et. al., 2025). AR has three main features: the combination of virtual objects and the real world, real-time interaction, and 3D registration (Othman et al., 2024). It has progressed from research projects to mainstream applications across several fields, such as business, entertainment, sports, and tourism, that create tangible, exciting experiences. Educators and technical developers also exploit the capabilities of AR technologies to enable new forms of learning in various subjects.

The goal of this project is to develop an Augmented Reality Application named Chinese Vocabulary that enables people to learn some simple Mandarin words. The application was developed with Vuforia and Unity, which will provide an e-book created in PowerPoint containing 28 words. The e-book has 30 pages and covers pronouns, nouns, verbs, polite expressions, and more. Users can download the E-book and use their smartphone with Vuforia and Unity installed to scan pages for words; then the tutorial, in video form, will pop up. However, users need to follow the Chinese Vocabulary profile in Vuforia and Unity before they scan the words in the E-book. The tutorial in video form was created using Meitu's Anime Avatar, in which the character was in a cartoon style. Two characters will appear in the video tutorial: a handsome boy and a pretty girl. They will teach users by pronouncing the words in Mandarin and explaining their meanings in English. There will also be sentences for those words to help users better understand how to use them in structured sentences.

The objective of "Augmented Reality Application Chinese Vocabulary" is to provide a fun, engaging learning environment for users. The target users of this app are standard students who use it to learn vocabulary. It is more fun to learn in apps that include text, pictures, videos, audio, and animation. With this app, they will be more active in remembering the words.

Literature Review

Augmented reality has garnered significant attention across various educational domains, including language instruction, due to its capacity to overlay digital information onto the real world, thereby enriching learning environments (Rheingold, 1991, p. 44; Xie et al., 2024). This immersive technology enables an interactive experience in which virtual elements blend seamlessly with physical surroundings, fostering enhanced engagement and comprehension (Christou et al., 2025). Specifically, in the context of language learning, AR applications can provide contextualised vocabulary acquisition and grammatical practice through interactive simulations and real-world overlays (Schorr et al., 2024). This integration of digital content with the physical world creates a dynamic learning space, distinguishing AR from other digital technologies like virtual reality by maintaining a connection to the learner's immediate

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environment (Rheingold, 1991, p. 45). While AR has demonstrated effectiveness across various educational settings, its application to language learning, particularly for non-alphabetic languages such as Chinese, remains a relatively underexplored domain (Xie et al., 2024, p. 1257). This review endeavours to consolidate and critically analyse the existing literature on the utilisation of AR in Chinese language education, identifying current trends, pedagogical benefits, and research gaps (Huang et al., 2021). To this end, this review systematically examines empirical studies on AR for language learning, distilling benefits, challenges, and practical design principles (Schorr et al., 2024). Although numerous studies have explored the general application of AR in language acquisition, a comprehensive understanding of its specific impact on Chinese language learning, considering the unique linguistic challenges, is still developing (Schorr et al., 2024). However, recent meta-analyses have begun to quantify the effectiveness of AR in language learning across various contexts, highlighting both linguistic and affective gains among participants (Wu et al., 2024). These analyses suggest that AR-based learning materials enhance motivation, attitudes, and self-efficacy, alongside improving linguistic proficiency (Wu et al., 2024). The unique features of AR, such as contextual visualisation and interactivity, hold substantial promise for enhancing language education (Huang et al., 2021). This is particularly true for complex subjects or those that are difficult to visualise, where AR can engage multiple learning pathways simultaneously through visual, auditory, and kinesthetic experiences (Rheingold, 1991, p. 36). This multi-sensory approach facilitates a more profound and memorable learning experience, directly addressing challenges often encountered in traditional language instruction (Rheingold, 1991, p. 36). This integration offers versatile resources for developing linguistic competencies, such as listening, speaking, reading, and writing, as well as improving grammar and vocabulary (Parmaxi et al., 2024). Indeed, the increasing number of publications on AR in education underscores its rising prominence and potential to transform traditional language learning into a more engaging experience, boosting student satisfaction and engagement (Marrahí-Gómez & Belda-Medina, 2024). This transformative potential is further evidenced by studies indicating that AR can significantly improve students' learning outcomes and motivation in language acquisition (Huang et al., 2021). This is especially pertinent for English as a Second Language education, where AR technologies have been shown to overcome traditional learning barriers and improve vocabulary retention and overall academic performance (Pérez-Jorge et al., 2025).

Research Methodology

Phase 1: Analysis

In this phase, the problem is identified and described. The target audience and the objectives will also be determined in this phase. The target audience for this AR Chinese Vocabulary application is those who want to learn Mandarin. The tool to develop has also been chosen, and we will use Vuforia and Unity to develop the apps, PowerPoint to create the E-book, and Meitu's Anime Avatar to create the animation video.

Phase 2: Design

In this phase, the process is designing the graphics, audio, images, and text. Sketching and drawing the storyboard to achieve the objectives is also part of this phase. In this mobile AR Chinese Vocabulary application, when users scan the pages of the E-book using their smartphone with Vuforia and Unity installed, a video animation with an audio tutorial will pop up. In this phase, it will also define the hardware and software requirements for developers and users. Developers use a laptop or PC with the software installed to build the mobile AR Chinese

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Vocabulary application. In contrast, users use a smartphone, as the developers will create a mobile-based AR Chinese Vocabulary application.

Phase 3: Development of the Prototype

In this phase, with the already designed architecture, the prototype of the AR Chinese Vocabulary application will be developed to see what it will look like and which features we need to change. Given the previous phase, the apps' volatile requirements should be mentioned, and the agile methodology should be used. Using modern and up-to-date software and technologies to turn the idea of apps into a working product. Moreover, in this phase, arts, images, video, animation, models, and audio are all the content needed to create the applications. Several developers will work together to design and develop the AR Chinese Vocabulary application. They will design and create the E-book using PowerPoint, and it will include 28 words with their meanings and sentences. They will insert and combine multimedia elements, such as text and images, that are appropriate for the E-book to ensure it is attractive to users. Below is the figure for the E-book AR Chinese Vocabulary application.

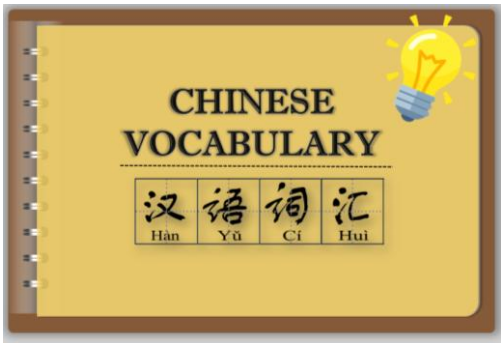

Figure 1: The Cover Page of the E-book

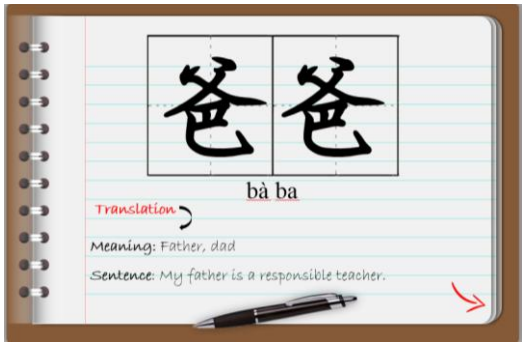

Figure 2: The Words with Meaning and A Sentence

Furthermore, they will be using Vuforia and Unity to scan in all the word pages in the E-book and save it in the Vuforia and Unity Chinese Vocabulary profile, which enables users to follow their profile in Vuforia and Unity and scan for the word pages in the E-book. Suppose users did not follow the Chinese Vocabulary profile. In that case, they will not be able to see the video animation tutorial, even though they have scanned the word pages in the E-book by using Vuforia and Unity.

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Figure 3: The profile of Chinese Vocabulary

In addition, developers will do the video animation by using Meitu's Anime Avatar. They will create two characters, a boy and a girl, and then record their voices to teach how to pronounce the words correctly and provide example sentences for those words. They record in Mandarin and English for the video animation tutorial, making it easier for users to learn.

Figure 4: Boy Character

Figure 5: Girl Character

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Figure 6: Result When Users Scan the Word Pages in the E-book

Phase 4: Implementation

In this phase, it will involve testing the effectiveness of the mobile AR Chinese Vocabulary application with users. During this phase, users should understand how to scan the words in an E-book. Testing will be made for users to use the prototype before the evaluation phase.

Phase 5: Evaluation

Evaluation is the last phase for the development of the mobile AR Chinese Vocabulary application. This phase involves evaluating the mobile AR Chinese Vocabulary application that has been developed. The evaluation of this process will assess data from pre- and post-tests collected from users. Users will determine whether this AR Chinese Vocabulary application is practical for them. The evaluation process will also involve gathering user feedback to improve the effectiveness of the AR Chinese Vocabulary application.

Respondents

It shows that 40 respondents have completed the gender survey. 51.3% of the 40 respondents are female, and 48.7% are male. It shows that Gender is almost average. It shows that the three races participated in this survey. 53.8% of respondents are Malay, 43.6% are Chinese, and only 2.6% are Indian. Most of the respondents are Malay. Forty respondents have completed our semester survey. It shows that 15.4% are in semester 1-2, 51.3% are in semester 3-4, 23.1% are in semester 5-6, and 10.3% are in semester 7 and above. It shows that most participants in the evaluation survey are in semesters 3 and 4, which is 51.3%. The total number of respondents

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to this survey is 40. 56.4% respondents chose "Yes", which means they had used any application for E-learning, including augmented reality applications. 43.6% respondents chose "No", which means they do not use any application for E-learning with an augmented reality application. It shows that most respondents, 56.4%, had used other types of applications for E-learning, such as augmented reality applications.

Result and Analysis

A total of 40 respondents participated in this study. The results are summarised below according to each evaluation item.

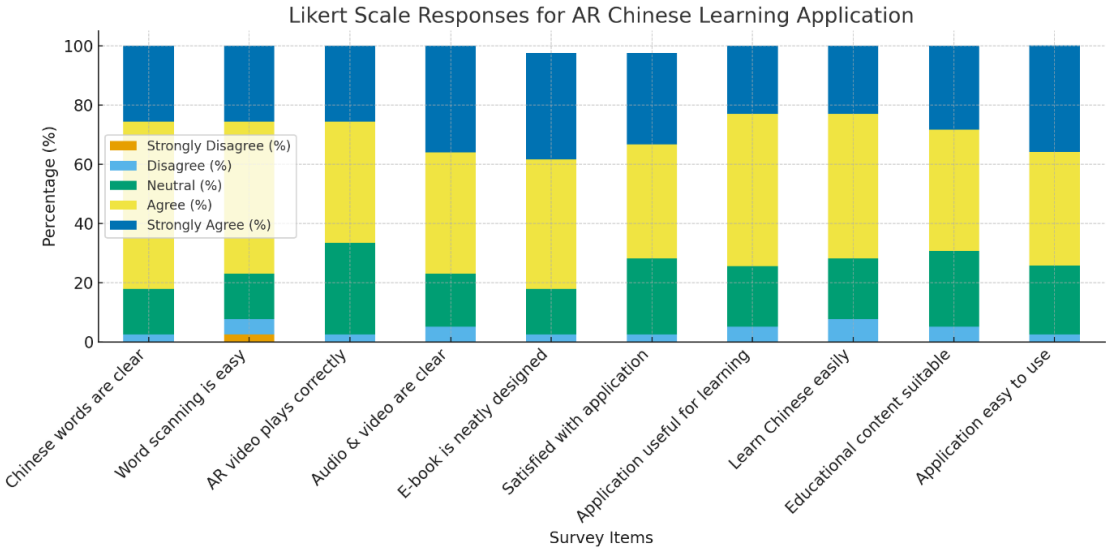

Figure 7: Likert Scale Responses for AR Chinese Learning Application

Chinese Words Are Clear.

Most respondents agreed that the Chinese words displayed in the application are visually clear and easy to read. A total of 56.4% of participants selected "agree, and 25.6% selected "strongly agree," demonstrating strong approval of text visibility. This suggests that the font size, contrast, and placement of Chinese characters are well designed. Good visual clarity is crucial in AR-based learning, as text must be readable both digitally and, in the user's, physical surroundings. Therefore, this result indicates that the application successfully supports the recognition and comprehension of Chinese words.

Word Scanning Is Easy.

The ease of scanning words using the AR feature received positive feedback from respondents. More than half (51.3%) agreed, and 25.6% strongly agreed, that the scanning function worked smoothly. This highlights the effectiveness of marker detection and tracking within the application. Reliable scanning is essential to ensure a seamless transition from printed material to AR content. Thus, users can access learning materials efficiently without experiencing frequent scanning failures.

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AR Video Plays Correctly.

AR video activation scored well, with 41% of respondents agreeing and 25.6% strongly agreeing that videos play correctly when words are scanned. This result demonstrates that the AR integration between printed words and multimedia playback is functioning as intended. Effective multimedia triggering enhances immersion, enabling learners to visualise content in real time. The low percentage of disagreement also indicates minimal technical interruptions. Overall, users experienced stable, prosperous AR activation during their interactions with the app.

Audio And Video Are Clear.

Respondents showed a favourable perception towards the clarity of both audio and video features. A combined 76.9% agreed or strongly agreed that no significant issues were encountered while multimedia elements were playing. Clear audio is necessary for correct pronunciation modelling, while high-quality visuals help maintain focus and engagement. These positive responses indicate that the application delivers a smooth, enjoyable multimedia learning experience. Such technical reliability supports continuous usage without frustration.

E-book Design Is Neat.

The design and layout of the e-book interface received strong approval from users, with 43.6% agreeing and 35.9% strongly agreeing. This suggests that the application offers a clean, structured, and visually appealing learning environment. Good design enhances usability by reducing cognitive load and making it easier for users to navigate learning materials. Aesthetic appeal is also important for motivation and engagement. Therefore, this finding reflects successful UI design that contributes positively to user satisfaction.

Satisfied with The Application

Overall satisfaction responses demonstrate that users had a positive experience with the AR learning application. A combined 69.3% of respondents agreed or strongly agreed that they were satisfied after using the app. This indicates that the application met or exceeded user expectations in terms of design, functionality, and content. Only a small percentage expressed dissatisfaction, showing that the application performs well overall. Satisfaction is a key factor in willingness to continue using technology for learning purposes.

The Application Is Helpful for Learning.

More than half of the respondents (51.3% agree; 23.1% strongly agree) felt that the application helped learn Chinese vocabulary. This highlights the educational value of AR in improving understanding and retention of language content. Respondents recognised that the interactive features provided meaningful learning support. These results align with existing evidence that technology-assisted learning enhances motivation and outcomes. Thus, the app successfully fulfils its purpose as a learning tool.

Learn Chinese Easily Using the App.

Respondents acknowledged that the application made Chinese language learning easier, as reflected by 48.7% agreement and 23.1% strong agreement. The positive responses indicate that users benefited from interactive visuals, multimedia aids, and context-rich learning. A small portion of neutral responses suggests that certain users may require more time to adapt to AR learning methods. Nonetheless, the majority found the approach beneficial. This highlights the potential of AR to simplify and support second language acquisition.

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Educational Content Is Suitable.

The educational content was considered appropriate for learners, with 41% agreeing and 28.2% strongly agreeing. This suggests that the vocabulary, multimedia elements, and learning tasks match the target users' skill level. Suitable content ensures that users are neither overwhelmed nor underchallenged, promoting better learning progression. This alignment between content and learner needs strengthens the application's instructional quality. It also supports continued engagement with the learning materials.

The Application Is Easy to Use.

Most respondents found the application easy to use, as shown by 38.5% agreement and 35.9% strong agreement. This indicates that the interface is intuitive and requires minimal instruction for users to interact with the app effectively. Ease of use is a critical usability component, particularly for first-time AR learners. Low disagreement rates show the interface has few technical or navigational barriers. This result confirms that the application is accessible even to users with limited technological experience.

The results indicate strong user acceptance of the AR Chinese learning application across visibility, interaction, usability, and learning effectiveness dimensions. First, the majority of respondents agreed that the Chinese words displayed in the application were visually clear and readable, and that the word scanning function worked effectively. This suggests that the visual recognition system and tracking performance are functioning well during AR interactions. Regarding multimedia reliability, respondents agreed that AR videos were triggered correctly upon scanning and that both audio and video elements played clearly. These findings demonstrate a stable AR technical performance, supporting a smooth learning experience. The e-book's interface design also received high approval ratings, indicating that users found the layout organised and visually pleasing. Additionally, respondents expressed positive levels of satisfaction, suggesting that the application successfully meets user expectations. Regarding educational impact, respondents agreed that the application helps them learn Chinese and that the provided content is suitable for their level. Moreover, many respondents indicated that the app made learning Chinese easier, reinforcing its effectiveness as a digital learning tool. Finally, the high agreement on ease of use indicates that the application's interface is user-friendly and requires minimal learning effort. Overall, the results demonstrate strong effectiveness in both usability and pedagogical value. However, the presence of neutral responses across several items suggests that some users may still require adaptation time or that further improvements to interaction design and guidance may enhance engagement and confidence. Future enhancements should consider optimising features that support first-time or less tech-savvy learners.

The analysis of Likert-scale responses indicates a generally high level of acceptance of the AR Chinese learning application across all measured constructs. In terms of visibility, the majority of respondents agreed that the Chinese text presented on the e-book interface was sufficiently clear to read and recognise for AR activation. This finding is supported by positive responses indicating that the word scanning feature functioned effectively for most users. Regarding multimedia functionality, respondents reported that AR videos were triggered correctly when scanned, and both audio and visual components were perceived as straightforward and functional. This highlights the application's technical reliability in delivering seamless AR interactions. The e-book design also received strong approval, suggesting that the layout and user interface enhance the user experience. Furthermore, satisfaction levels were consistently

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favourable, with respondents indicating that the application is easy to use and beneficial for learning Chinese vocabulary. The results also demonstrate that the educational content is relevant and suitable for learners, thereby supporting its effectiveness as a complementary language-learning tool. Collectively, these findings suggest that the application successfully integrates usability, content quality, and learning effectiveness, which are key components in ensuring a positive user experience in augmented reality-based language learning environments. However, a noticeable proportion of neutral responses across several items suggests that some users may still require adaptation to AR technology or that further refinements could enhance interaction efficiency. Future improvements may focus on enhancing user guidance, optimising interface design, and expanding multimedia elements to strengthen immersion and engagement.

Discussion

The findings of this study align closely with the existing literature, highlighting the pedagogical and technical strengths of augmented reality (AR) in language learning contexts. Overall, the results demonstrate strong user acceptance of the AR-based Chinese learning application across dimensions of visibility, interaction, usability, and learning effectiveness, reinforcing prior research on the benefits of AR-enhanced educational environments (Huang et al., 2021; Wu et al., 2024).

From a technical and usability perspective, the high agreement on the clarity of Chinese word displays and the effectiveness of the word-scanning function supports earlier assertions that AR's ability to overlay digital content onto the real world enhances comprehension and engagement (Rheingold, 1991, p. 44; Christou et al., 2025). Clear visual recognition and stable tracking are critical for sustaining immersive AR experiences, particularly in language learning, where accurate character recognition is essential. This finding is consistent with Schorr et al. (2024), who emphasise that contextualised and interactive AR environments can facilitate vocabulary acquisition by directly linking visual stimuli to linguistic meaning.

The positive responses regarding multimedia reliability—specifically, the correct triggering of AR videos and the clarity of audio and video components—further underscore the application's technical robustness. These results resonate with Parmaxi et al. (2024), who argue that well-integrated multimedia elements in AR environments can enhance multiple linguistic competencies, including listening and pronunciation. Moreover, the smooth playback of audio-visual elements supports Rheingold's (1991, p. 36) assertion that multi-sensory learning environments foster more profound and more memorable learning experiences by engaging visual, auditory, and kinesthetic pathways simultaneously.

In terms of interface design, respondents' favourable evaluations of the e-book layout and overall visual organisation underscore the importance of intuitive, aesthetically pleasing interfaces in AR learning systems. Marrahí-Gómez and Belda-Medina (2024) similarly report that learner satisfaction and engagement increase when AR applications are designed with clear structure and usability in mind. The strong satisfaction ratings and high agreement on ease of use observed in this study suggest that the application successfully lowers the cognitive and technical barriers often associated with emerging technologies, a factor that is particularly important for novice or less technologically confident learners.

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Regarding educational impact, the findings indicate that learners perceive the AR application as practical and suitable for learning Chinese. This non-alphabetic language presents unique challenges in character recognition and pronunciation. This supports Xie et al.'s (2024, p. 1257) observation that AR has significant potential for addressing the complexities of learning logographic writing systems, even though this area remains relatively underexplored. The results also echo Wu et al.'s (2024) meta-analysis, which highlights AR's positive effects on motivation, attitudes, and self-efficacy in language learning. The perception that the application makes learning Chinese easier suggests that AR's contextual visualisation and interactivity may reduce learning anxiety and enhance learner confidence, particularly at beginner or intermediate levels.

Despite these positive outcomes, the presence of neutral responses across several items indicates that not all users experienced immediate or complete engagement with the AR application. This finding aligns with Schorr et al. (2024), who note that learners may require an adaptation period when first exposed to AR-based learning environments. It also suggests that further refinements in interaction design, instructional scaffolding, and onboarding guidance could enhance usability and confidence, especially for first-time AR users. Enhancing guidance features and expanding interactive multimedia elements may also strengthen immersion and engagement, as recommended by Huang et al. (2021).

In summary, the discussion demonstrates that the results of this study are broadly consistent with existing literature, confirming AR's effectiveness in enhancing usability, learner satisfaction, and perceived learning outcomes in language education. At the same time, the findings contribute to the growing body of research on AR for Chinese language learning by providing empirical evidence of its pedagogical value while highlighting areas for future improvement. This reinforces the need for continued research and iterative design to fully realise the transformative potential of AR in non-alphabetic language learning contexts.

Conclusion

Mobile augmented reality is currently one of the fastest-growing areas of AR applications. AR technology is applied across a variety of fields, and AR Chinese Vocabulary applications are primarily educational. Questionnaires created in Google Forms have been distributed to UUM students who want to learn Mandarin to evaluate the effectiveness of the AR Chinese Vocabulary application based on their experience with it. Based on the results summarised from the collected data, most respondents have used an augmented reality application for E-learning. Most of them think the Chinese word in the AR Chinese Vocabulary application is clear enough to be viewed and can be scanned easily. Besides, they agree that the AR video works well when they scan the word, and both the audio and video play clearly without any problems. Furthermore, most of them agree that the e-books are designed neatly. Based on their perceptions, this application is helpful for learning because the educational content is suitable for them, and they can easily learn Mandarin with it. Overall, the application is easy to use and user-friendly, and most users are satisfied with it.

One such study demonstrated that students utilising AR tools for reading activities in Chinese as a Foreign Language contexts achieved higher scores compared to their pretest results and outperformed those using conventional reading methods, underscoring AR's efficacy in improving reading comprehension (Xie et al., 2024). This aligns with broader findings in English as a Foreign Language contexts, where AR has been shown to significantly enhance

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reading comprehension levels and increase learner engagement and willingness to utilize AR-based approaches (Ebadi & Ashrafabadi, 2022). Moreover, AR applications can transform traditionally passive learning activities into interactive experiences, leading to increased student collaboration and reduced anxiety levels (Wedyan et al., 2022).

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