

Sustaining Chinese Education with Online VR Technology: A Systematic Review (Memperkasakan Pendidikan Cina dengan Teknologi VR Dalam Talian: Tinjauan Sistematik)

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ABSTRACT

This systematic review explores the emerging role of online virtual reality (VR) technology in international Chinese language education, addressing the growing need to enhance educational sustainability through innovative methods. This review identifies key trends and applications of VR in Chinese education by analysing literature from the Web of Science (WoS) and Scopus databases. A systematic search using specific keywords led to the selection of 19 relevant articles out of 526 published between 2020 and 2024, following strict inclusion and exclusion criteria. The findings reveal three primary VR applications in international Chinese education: Virtual Reality Chinese Live Streaming Classrooms, Digital Venue Tours, and Chinese Simulation Training. The review also highlights significant challenges in international Chinese language education, including linguistic and cultural differences, the complexity of Chinese character strokes, pronunciation difficulties, and vocabulary acquisition. This review provides valuable insights for educators and practitioners, emphasizing how VR technology can be effectively integrated into international Chinese language education to overcome these challenges and ensure sustainable learning outcomes.

Key Words: *Virtual Reality, International Chinese Education, Educational Sustainability, Innovative Teaching Methods, Systematic Review*

ABSTRAK

Kajian sistematik ini meneroka peranan teknologi realiti maya (VR) dalam talian yang semakin berkembang dalam pendidikan bahasa Cina antarabangsa, menangani keperluan yang semakin meningkat untuk memperkasakan keberlanjutan pendidikan melalui kaedah inovatif. Kajian ini mengenal pasti trend utama dan aplikasi VR dalam pendidikan bahasa Cina dengan menganalisis literatur daripada pangkalan data Web of Science (WoS) dan Scopus. Pencarian sistematik menggunakan kata kunci khusus telah membawa kepada pemilihan 19 artikel yang relevan daripada 526 artikel yang diterbitkan antara tahun 2020 dan 2024, mengikut kriteria inklusi dan eksklusi yang ketat. Hasil kajian menunjukkan tiga aplikasi utama VR dalam pendidikan bahasa Cina antarabangsa: Kelas Siaran Langsung Realiti Maya Cina, Lawatan Tempat Digital, dan Latihan Simulasi Cina. Kajian ini juga menyoroti cabaran-cabaran penting dalam pendidikan bahasa Cina antarabangsa, termasuk perbezaan linguistik dan budaya, kerumitan strok aksara Cina, kesukaran sebutan, dan pemerolehan kosa kata. Kajian ini memberikan pandangan yang bernilai kepada pendidik dan pengamal, menekankan bagaimana teknologi VR boleh diintegrasikan dengan berkesan ke dalam pendidikan bahasa Cina antarabangsa untuk mengatasi cabaran-cabaran ini dan memastikan hasil pembelajaran yang berdaya tahan..

Key Words: *Realiti Maya, Pendidikan Antarabangsa Cina, Kelestarian Pendidikan, Kaedah Pengajaran Inovatif, Kajian Sistematik*

INTRODUCTION

In recent years, the Chinese language has experienced rapid globalization, leading to a significant expansion in international Chinese language education. However, this expansion has revealed critical imbalances in the distribution of teaching institutions, educators, and resources, as well as the scattered and extensive nature of the learner population. Given these challenges, it has become evident that relying solely on traditional face-to-face classroom instruction is insufficient to meet the global demand for Chinese language learning. This situation necessitates a major transition towards Internet-based online teaching. The advancement of Internet technology has introduced a new platform for teaching Chinese as a foreign language, fostering innovation in pedagogical concepts and methodologies. The integration of Internet technology into Chinese language education has precipitated profound changes in teaching philosophies, methods, and characteristics, thereby making online teaching a viable and effective alternative to traditional classroom environments (Xu, 2023; Liu, 2020; Ly, 2021). The emergence of mobile Internet and the development of educational apps have further enhanced the flexibility and efficiency of Chinese language instruction, benefiting both educators and learners (Liu, 2020).

The COVID-19 pandemic has further accelerated the transition from offline to online teaching, underscoring the critical role of online platforms in ensuring the continuity of education. This shift has not only created new employment opportunities for international Chinese teachers but also promoted the growth of online Chinese education platforms (Ly, 2021; Yu, 2022). The digital era has introduced substantial transformations in education, providing learners with expanded resources and diversified learning pathways, which are crucial for the effective teaching of Chinese as a foreign language (Yuan, 2023). Additionally, the combination of information technology with Chinese language instruction has led to the creation of a new digital teaching environment, increasingly recognized for its potential to enhance the quality and accessibility of Chinese language education on a global scale (Wang, 2018). The utilization of online teaching methods, including Massive Open Online Courses (MOOCs) and other digital platforms, has proven effective in engaging learners and offering a comprehensive understanding of both the Chinese language and culture (Kong, 2021).

In summary, the globalization of the Chinese language, coupled with advancements in Internet technology, necessitates a transition towards online teaching to address the growing global demand for Chinese language education.

This approach not only mitigates the imbalance in resource distribution but also capitalizes on the advantages of digital technology to enrich the learning experience for students worldwide. However, online teaching presents several challenges, including the absence of a traditional classroom atmosphere, an insufficient language communication environment, limited interactivity, and weak classroom management, all of which significantly impede the effectiveness of online education (Xie, 2022). The root causes of these challenges are complex and multifaceted. On one hand, the communicative effectiveness of teachers is considerably diminished when non-verbal cues such as expressions, eye contact, gestures, and movements are transmitted via electronic screens. On the other hand, the physical detachment of students from the classroom environment leads to a disconnection between their immediate surroundings and the virtual teaching scene, undermining their sense of immersion. Furthermore, students are required to forcefully shift their focus from their physical environment to the teaching content displayed on a small electronic screen and maintain this focus for prolonged periods, which contradicts the natural tendencies of human cognition. Virtual Reality (VR) technology offers a promising solution to these challenges in the context of international Chinese language education.

Research indicates that Virtual Reality (VR) can create immersive and interactive learning environments that significantly enhance student engagement and motivation. Specifically, the use of VR in language education has been demonstrated to stimulate learners' interest and improve their performance by providing authentic cultural scenarios and interactive experiences (Zhang, 2022a; Liu, 2023; Xie et al., 2019). Tools like Google Cardboard and Expeditions have proven effective in advanced Chinese language classes, offering realistic views that pique interest and encourage exploration of the target culture (Xie et al., 2019). Systematic reviews of VR applications in language learning underscore its potential benefits, including enhanced linguistic development, improved communication skills, and increased motivation, all within immersive and authentic learning contexts (Liu, 2023; Zheng et al., 2022; Ma, 2018). However, challenges remain, particularly regarding the technical configuration and pedagogical foundation necessary to optimize the use of VR in language education (Ma, 2018; Parmaxi, 2020).

Furthermore, research suggests that VR-supported language education can enhance learners' communication strategies while reducing the reliance on resource-deficit strategies, thus enriching learning opportunities (Yang et al., 2022). The positive correlation between VR and immersion-based language teaching is well-documented, with significant improvements observed in student learning outcomes (Xie et al., 2022). VR technology enables the

transition of the classroom from an offline to an online environment, effectively overcoming the constraints of spatial and temporal distances. Enhancements in network speed and server capacity contribute to a more equitable distribution of teachers and resources across cyberspace. Moreover, VR technology bridges the gap between the virtual teaching environment and the real-world context, ensuring a seamless learning experience (Han, 2022). The limitations of online teaching often stem from the information loss associated with electronic screens, the disconnect between teaching environments and students' physical settings, and the tendency for students' attention to waver.

VR technology mitigates these challenges by allowing teachers to convey information through movements, gestures, and other visual media, free from the constraints of traditional electronic screens. This technology reproduces the virtual classroom in a manner that reduces information loss and fosters full integration between the teaching scene and the real-world environment, addressing the issue of attention transfer across different settings. Recent studies have emphasized the potential of VR to enhance the online learning experience. For example, VR technology has been shown to create immersive environments that minimize external distractions, thereby concentrating learners' focus on educational activities and improving interaction and engagement between teachers and students (Lam et al., 2021; Li et al., 2021). Additionally, VR's ability to simulate real-world environments and scenarios is particularly beneficial in disciplines requiring practical, hands-on experience (Montagud et al., 2022; Maheshwari & Maheshwari, 2020). The use of VR in education is also associated with improved learning outcomes, heightened motivation, and better knowledge retention (Pirker & Dengel, 2021; Pellas et al., 2020).

Furthermore, VR's capacity to provide a sense of presence and co-presence in a virtual space significantly enhances the quality of interaction and situational awareness, which are often lacking in traditional online learning platforms (Montagud et al., 2022; Mystakidis et al., 2021). This immersive experience helps maintain student attention and engagement, addressing one of the critical challenges of online education (Canniff & Cliburn, 2022; Parmaxi, 2020). VR technology offers a promising solution to the limitations of online teaching by providing an immersive, interactive, and engaging learning environment that effectively bridges the gap between virtual and physical learning spaces. When learners use VR glasses to experience virtual reality scenes created by panoramic cameras, they gain an immersive experience that closely replicates real-life settings. This immersion affords learners

greater freedom in choosing their perspectives when engaging with Chinese conversation scenes, truly realizing a learner-centered approach. Such an immersive experience enhances learners' comprehension of specific conversational contexts, thereby leading to improved learning outcomes (Algerafi et al., 2023; Hamilton et al., 2020; Pirker & Dengel, 2021).

Considering the following overarching questions, we conducted the following literature analysis:

1. Question 1. How can online virtual reality technology be used in international Chinese language education?
2. Question 2: What are the difficulties in international Chinese language teaching?

This research seeks to explore these questions to advance teaching strategies and methodologies, while also providing organizations involved in international Chinese language education with valuable insights and recommendations for integrating virtual reality (VR) technology into language instruction. A task-based teaching model has been developed on the "China Island" within the "Second Life" platform, utilizing various teaching resources and VR technology to deliver virtual Chinese language courses (Shen & Latif, 2022). Additionally, East China Normal University and Shanghai Sanda College have jointly created the International Chinese Education Meta-Universe, which offers immersive virtual 3D teaching and living environments, alongside a variety of multi-dimensional teaching tools and interactive learning and social scenarios. This practical application of VR technology enables a fully immersive 3D experience, thereby creating new opportunities for international Chinese language education. Moreover, VR technology has become increasingly significant in the teaching of Chinese phonetics (Zhang, 2022b). It has been effectively employed in the instruction of consonants and vowels, the differentiation of commonly confused sounds, and the teaching of tonal and phonetic variations. By creating a simulated learning environment, VR enhances the sense of immersion for Chinese language learners, thereby increasing their engagement and improving their learning outcomes.

METHODOLOGY

This systematic review follows the preferred reporting project approach for Systematic Review and Meta-Analysis (PRISMA), As shown in Figure 1.

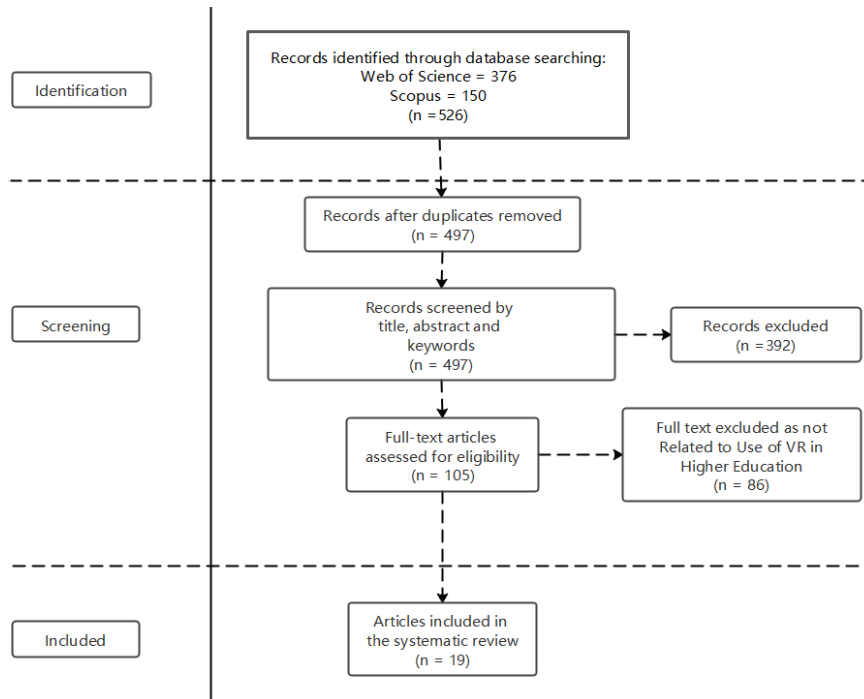


Figure 1. PRISMA systematic review IDENTIFICATION

First, two suitable databases were selected (Web of Science (WoS), Scopus,). Table 1 shows the search strings used for each database in this study.

Table 1. Search String

Database	Keywords
Scopus	TITLE-ABS-KEY ((“VR” OR “Virtual Reality*” OR “Immersive Technology” OR “VR technology “ AND “Chinese learning” OR “Chinese education” OR “Chinese courses” OR “International Chinese Education” AND “appliance*” OR “use*” OR “Technical Applications*” AND “benefit*” OR “Advantage*”))
Web of Science	TS =(“VR” OR “Virtual Reality*” OR “Immersive Technology” OR “VR technology “ AND “Chinese learning” OR “Chinese education” OR “Chinese courses” OR “International Chinese Education” AND “appliance*” OR “use*” OR “Technical Applications*” AND “benefit*” OR “Advantage*”)

*: Search String

SCREENING

Prior to 2020, relevant publications were both limited in number and lacked clear focus, as evidenced by the search results from the selected databases. However, beginning in 2020, there has been a marked increase in publications related to Chinese foreign language education research conducted at Yuan University. Despite this growth, systematic reviews remain relatively scarce in the post-

2020 period. Therefore, this study focused on publications from 2020 to 2024. To ensure research quality, only empirical studies published in peer-reviewed journals were included. Additionally, as shown in Table 2, only English-language publications were considered to reduce the potential for misinterpretation.

Table 2. Screening Condition

Criterion	Eligibility	Exclusion
Timeline	Between 2020 to 2024	<2020
Literature type	Articles from journals	Systematic reviews, books, and chapters in a book, conference proceedings
Language	English	Non-English
Scope	Related to VR and International Chinese Education	Not related to VR and International Chinese Education

After a thorough screening process based on specific inclusion and exclusion criteria, 19 articles were deemed suitable for inclusion in this systematic review. Although book chapters and conference proceedings were initially assessed, they were ultimately excluded due to the lack of comprehensive reviews within those sources.

INCLUDED

The articles selected for this systematic review focus on the theme of “Sustaining International Education through Online Virtual Reality Learning Technology for Chinese Language Instruction.” The studies included in the review are listed in Table 3. As shown in Table 3, 10 articles were sourced from Scopus and 9 from the Web of Science (WoS),

chosen for their high-quality contributions to the field of education. The primary focus of these studies is the integration of online virtual reality technology in international education. Most of the research has been conducted at the higher education level, encompassing universities and colleges (Onjewu, 2024; Xie, 2022). A significant portion of the studies concentrated on the teaching of Chinese characters, utilizing the intelligent features of VR technology (Shi et al., 2023; Rosendahl & Wagner, 2024; Yahaya et al., 2024; Lee & Hsu, 2021; Wang & Devitt, 2022; Ma, 2024; Wang, 2022; Chen, 2021; Xie, 2022; Liu, 2021; Li et al., 2022), as well as on the administration of intelligence tests and evaluations (Yan & Singh, 2023; Chan et al., 2022; Onjewu, 2024; Han, 2022; Wang, 2021; Zhang, 2022).

Table 3. Summary

Study	Database	No.	Aim	Samples	Findings
Shi et al. (2023)	Scopus	1	Conduct a systematic review to identify new trends in research on iVR-assisted foreign language (FL) education, as well as the benefits and challenges of this approach.	The samples in the 38 studies included: 29 studies with college students, including some for specific purposes like nursing, geography, and tourism 1 study with FL teachers 3 studies did not specify the participants	The research has expanded from focusing only on adult learners to including younger learners as well and has investigated a wider variety of language skills.
Yan & Singh (2023)	Scopus	2	Explore the relationships between self-monitoring, self-management, and beliefs about mobile-assisted language learning and language skills improvement among college students.	329 college students in Shanghai, China	Mobile assistive language learning has a big impact on the education industry.
Rosendahl & Wagner (2024)	Scopus, WoS	3	The purpose of this study was to understand the potential of 360° video technology in education and teaching.	44 scientific articles	360° videos provide five key added values as a teaching-learning medium
Yahaya et al. (2024)	Scopus, WoS	4	This study aims to investigate students' perceptions of AI chatbots' efficacy in resolving concerns in virtual classes.	376 questionnaires	To boost students' confidence and desire to use the technology, university administrators should teach students the fundamentals of learning as well as enough about the possibilities of the system.

Lee & Hsu (2021)	Scopus	5	The study aimed to propose a "Makeup AR" learning approach and examine its interaction with students' active and reflective learning styles.	70 students	In vocational cosmetology classes, the usage of Makeup AR increased students' self-efficacy, decreased their cognitive load, and improved the effectiveness of their learning.
Wang & Devitt (2022)	Scopus	6	Identify linguistic and cross-cultural outcomes for CFL learners	71 papers	There is a clear research gap regarding young CFL learners and learners at intermediate/ advanced proficiency levels.
Chan et al. (2022)	Scopus	7	The study's objectives were to identify gaps in the body of literature already in existence and to give a bibliometric mapping of research on Chinese as a Foreign Language (CFL) over three decades.	289 journal articles published in 95 journals over three decades	Identification of gaps in the existing CFL research literature.
Lo (2023)	Scopus	8	The study aims to explore teachers' perspectives on teaching English as a second language in virtual classrooms during the COVID-19 pandemic in Hong Kong, and to uncover how teachers view the potential for improving online English language teaching in the future.	6 English teachers at a university in Hong Kong	The study also examines how teachers think online English language teaching could be improved for future emergencies and moving forward.
Onjewu (2024)	Scopus	9	analysed via the lens of cognitive load, and learning providers are provided with insights to help them balance the desire for technology utilisation in instructional designs with careful consideration.	looking into 240 generation Z students in Nigeria and the UK	Only internet searching has a favourable impact on learning, even though another technological usage has a considerable influence overall.
Ma (2024)	Scopus	10	The research aims to explore the use of the Quizlet application in teaching Chinese as a foreign language.	60 international students studying Chinese at a university in China	The use of Quizlet enhanced Chinese listening, speaking, and reading skills, and promoted student engagement.
Wang (2022)	WoS	11	The aim was to increase students' capacity to learn English.	The samples were two groups of university freshmen: an experimental group that used VR-based immersive education, and a control group that used standard multimedia and conventional teaching techniques.	- The experimental group using VR and constructivist teaching methods had an average English level 2.8 points higher than the control group using traditional multimedia and teaching methods. - The VR and constructivist approach can genuinely increase students' English levels.
Chen (2021)	WoS	12	The purpose of this study was to explore the conceptual differences in teachers' use of interactive spherical video virtual reality (VRDW) in descriptive writing teaching.	21 secondary teachers in Hong Kong	The distribution of teachers' conceptions shows that most focused on improving writing skills and promoting learning participation, while fewer had the most sophisticated conception of cultivating positive values and writer identity.
Xie (2022)	WoS	13	The paper aims to explore the combination of immersion-based English teaching with virtual reality (VR) technology.	106 English major students from a Chinese school were selected as the samples for a 16-week quasi-experimental study, with 3 hours of instruction per week, for a total of 48 hours.	Immersion-based language learning and VR technology have a strong beneficial link.
Han (2022)	WoS	14	The goal is to research how virtual reality and English instruction may work together to provide an immersive English learning environment.	The samples in Lijuan Han (2022) were learners who used the VR English learning system developed in the study.	Over 80% of learners believed the avatar learning method improved their English abilities and the teacher-student relationship. 85% of learners believed they could improve their interest in daily English learning in the virtual simulation

Wang (2021)	WoS	15	This study aimed to determine whether the VPS-VR approach can improve reading comprehension performance, learning motivation and attitudes of English learners and reduce their English learning anxiety in the context of inclusive and quality education for all in the context of achieving United Nations Sustainable Development Goal 4.	The samples in this study were 98 college students	The VPS-VR approach improved students' EFL reading comprehension, particularly in the areas of information location and text comprehension, compared to the VR and traditional instruction approaches.
Ma (2021)	WoS	16	This article primarily examines the immersive context teaching approach for teaching English at a college using VR technology, which is based on artificial intelligence and machine learning. Enhancing pupils' capacity to learn English is the goal.	Two freshman classes at a university	- Using VR technology-based immersive virtual context teaching, grounded in constructivism theory, improved students' English level compared to traditional teaching methods. - The experimental group scored 2.8 points higher on average than the control group. The VR-based immersive teaching approach can improve students' English level.
Zhang (2022)	WoS	17	Using A-frame and JavaScript (JS) language to design task-based Chinese teaching courseware based on virtual reality technology.	The foreign pupils enrolled in X University's junior Chinese course	It was shown that microlessons for teaching and learning Chinese to speakers of other languages can increase students' motivation to study, have positive interaction effects, and help them perform better.
Liu (2021)	WoS	18	The objective is to deeply analyze and study the English listening teaching combined with wireless communication microprocessor and virtual environment	Two groups of students studying English	Virtual reality (VR) scenarios that replicate real-world situations considerably raised students' interest in learning and enhanced the efficiency of classroom instruction.
Li et al. (2022)	WoS	19	The goal is to understand and invest in the impact of distance learning on practical skills to form effective approaches to using virtual reality in education.	Teachers and students of art	The results of the study showed that learning Chinese calligraphy in VR time and space had an impact on students' understanding and imagination, but not on students' operational ability.

DATA ANALYSIS PROCEDURE

All selected articles were exported to referencing software, specifically Mendeley. A thematic analysis was conducted to identify the key themes that would address the following research questions:

- a. **Question 1:** How can online virtual reality technology be utilized in international Chinese language education?
- b. **Question 2:** What are the challenges associated with international Chinese language teaching?

This review provides an interpretive analysis of the articles, organizing the themes according to the research questions. For the first research question, the applications of online VR technology in international Chinese language education were classified into three distinct categories. For the second research question, the analysis was grounded in the linguistic characteristics of the Chinese language as discussed in the articles. The challenges were categorized into four main areas: linguistic and cultural differences, the complexity of Chinese character strokes, pronunciation difficulties, and vocabulary-related issues. These four categories served as the foundation for analysing the challenges encountered in international Chinese language education.

RESULTS

Question 1: How can online virtual reality technology be utilized in international Chinese language education?

In this systematic review, the use of VR technology in international Chinese language education is categorized into three distinct areas:

a. Virtual Reality Chinese Live Streaming Classroom

This category encompasses the use of VR to create immersive live-streaming environments where students can participate in real-time Chinese language classes. This approach simulates the experience of a physical classroom while leveraging the interactive capabilities of VR technology.

b. Digital Venue Tour

This category involves the use of VR for virtual tours of significant cultural and historical sites in China. These digital tours offer students an immersive experience, allowing them to explore and engage with the cultural context of the language they are learning.

c. Chinese Simulation Training

This category includes VR-based simulation exercises designed to replicate real-life scenarios, enabling students to practice their Chinese language skills in a controlled, virtual environment. These simulations immerse students in everyday situations that require the use of Chinese, helping them develop practical language proficiency.

Table 4. The Application of Online Virtual Reality Technology in The International Approach to Chinese Education

Type	Related articles
Virtual Reality Chinese Live Streaming Classroom	(Shi et al., 2023; Rosendahl & Wagner, 2024; Yahaya et al., 2024; Lee & Hsu, 2021; Wang & Devitt, 2022; Ma, 2024; Wang, 2022; Chen, 2021; Xie, 2022; Liu, 2021, Li et al., 2022)
Digital venue tour	Yan & Singh, 2023; Lee & Hsu, 2021; Chan et al., 2022; Lo, 2023; Ma, 2024; Xie, 2022; Zhang, 2022
Chinese simulation training	Chan et al., 2022; Lo, 2023, Han, 2022; Ma, 2021; Zhang, 2022

As outlined in Table 4, this review classifies the use of online VR technologies in international Chinese language education into three primary categories.

First, a substantial portion of the literature (Shi et al., 2023; Rosendahl & Wagner, 2024; Yahaya et al., 2024; Lee & Hsu, 2021; Wang & Devitt, 2022; Ma, 2024; Wang, 2022; Chen, 2021; Xie, 2022; Liu, 2021, Li et al., 2022) focuses on the application of virtual reality live classroom technology. This technology involves creating a virtual reality classroom using a panoramic camera. According to Rosendahl & Wagner (2024), this type of classroom captures the spatial image of the physical classroom through a panoramic camera and transmits it to remote students, who use VR glasses to experience the sensation of being physically present in the teaching environment. The construction of a virtual reality classroom comprises two key components: the physical teaching site and the virtual reality interface (Ye et al., 2017). In the context of the rapid globalization of the Chinese language, VR live classrooms, built on panoramic camera technology, effectively address challenges such as the unequal distribution of teaching resources, the geographic dispersal of learners, and the limitations of establishing physical courses or teaching sites on a large scale.

However, as Wang (2022) highlights, challenges remain with VR live classrooms, particularly regarding the clarity of panoramic cameras and VR glasses, the stability of VR live platforms, and network latency issues. Domestic platforms for VR live streaming are still in their infancy, primarily meeting only testing demands. Development remains limited, with network latency being a significant concern, and a dedicated VR classroom live-streaming platform has yet to be fully developed. As platforms continue to evolve, resolving network latency issues and gradually enhancing features like document sharing and annotation will significantly improve the online VR classroom experience.

Second, several studies (Yan & Singh, 2023; Lee & Hsu, 2021; Chan et al., 2022; Lo, 2023; Ma, 2024; Xie, 2022; Zhang, 2022) explore digital venue tours, a critical aspect of VR technology. Digital venue tours aim to create immersive and innovative virtual learning environments and realistic teaching scenarios that fully immerse students in the virtual space. Through observation, learning, and exploratory exercises guided by the teacher, these environments stimulate student interest and enhance the effectiveness of self-directed learning. Digital venues are primarily constructed using Web3D technology in

conjunction with big data, significantly increasing self-learning efficacy and fostering student engagement.

Third, other studies (Chan et al., 2022; Lo, 2023; Han, 2022; Ma, 2021; Zhang, 2022) focus on Chinese simulation training, where VR technology is employed to design various simulation scenarios that allow students to engage in practical exercises within a simulated environment. VR technology provides auditory, visual, and tactile experiences that closely replicate real-world conditions. For example, Wang (2021) suggests that this approach can assist teachers in guiding students through practical operations and training. Using stereoscopic glasses, helmets, and interactive controls, students engage in human-computer interactions that simulate real-world experiences, encouraging exploration of different training methods. When combined with theoretical knowledge provided by teachers, this approach enhances students' operational proficiency, aligning with the demands of contemporary educational reform. Thus, VR technology facilitates the development of a new teaching model that integrates theoretical instruction with practical application in the evolving educational landscape.

What are the challenges associated with international Chinese language teaching?

This systematic review concludes that the challenges faced in international Chinese language education predominantly fall into four key areas: linguistic and cultural differences, the complexity of Chinese character strokes, pronunciation difficulties, and vocabulary acquisition. These areas represent significant obstacles that educators and learners must navigate to achieve effective and sustainable learning outcomes in Chinese language instruction across diverse international contexts.

Table 5. Difficulties In International Chinese Language Education

Type	Related articles
Linguistic and cultural differences	(Shi et al., 2023; Yan & Singh, 2023; Yahaya et al., 2024; Onjewu, 2024; Ma, 2024; Liu, 2021; Li et al., 2022)
The strokes of Chinese characters	(Yan & Singh, 2023; Onjewu, 2024; Ma, 2024; Wang, 2022; Chen, 2021; Xie, 2022)
Pronunciation difficulty	(Rosendahl & Wagner, 2024; Yahaya et al., 2024; Lee & Hsu, 2021; Chen, 2021; Xie, 2022; Han, 2022; Wang, 2021; Ma, 2021; Zhang, 2022; Liu, 2021)
vocabulary	(Shi et al., 2023; Wang & Devitt, 2022; Chan et al., 2022; Wang, 2022; Han, 2022; Liu, 2021)

Firstly, the majority of the literature on international Chinese language education, particularly those grounded in

meta-cosmology (Shi et al., 2023; Yan & Singh, 2023; Yahaya et al., 2024; Onjewu, 2024; Ma, 2024; Liu, 2021; Li et al., 2022), identifies linguistic and cultural differences as a significant challenge. These differences pose an inherent obstacle in the field of international Chinese language education. For native speakers of Indo-European languages, the grammatical structure, word order, and expressions in Chinese differ markedly from their own languages. For instance, Chinese lacks word inflection and instead conveys grammatical relationships through word order and auxiliary words. Language is a vessel for culture, and many Chinese expressions and cultural nuances are difficult for non-native speakers to grasp. A lack of understanding of the cultural context further exacerbates the challenges of learning the Chinese language. Currently, the integration of VR technology is being explored as a potential solution to better address these challenges.

Secondly, the complexity of Chinese character strokes presents another significant challenge, as noted in the literature (Yan & Singh, 2023; Onjewu, 2024; Ma, 2024; Wang, 2022; Chen, 2021; Xie, 2022). This aspect of Chinese language education is one of the most crucial components of Chinese language learning. Chinese characters, with their numerous strokes and intricate morphological structures, can be difficult to master. Although Chinese characters follow certain logical rules, their complexity—compounded by ongoing developments and simplifications—remains daunting. Even native Chinese speakers often struggle when first learning these characters. For foreign students, particularly those from non-Chinese character backgrounds, learning Chinese characters is even more challenging due to the differences in their native scripts and the distinct cognitive approaches required for understanding phonetics, morphology, and meaning.

The third challenge concerns Chinese pronunciation, a critical aspect of Chinese language learning, as highlighted in the literature (Rosendahl & Wagner, 2024; Yahaya et al., 2024; Lee & Hsu, 2021; Chen, 2021; Xie, 2022; Han, 2022; Wang, 2021; Ma, 2021; Zhang, 2022; Liu, 2021). Chinese characters are ideographic, with each glyph representing a syllable and recording a morpheme. In contrast, pinyin, a phonetic script widely used by non-native speakers, consists of a linear arrangement of letters. This fundamental difference makes learning Chinese pronunciation particularly challenging for most learners. Lastly, vocabulary presents a substantial challenge in Chinese language education. According to the literature (Shi et al., 2023; Wang & Devitt, 2022; Chan et al., 2022; Wang, 2022; Han, 2022; Liu, 2021), the vast number of Chinese characters poses a significant hurdle. While some characters have simple structures and are relatively easy to learn and memorize, others are complex and more difficult to grasp. Learning Chinese characters involves memorizing a large number of glyphs and their

corresponding pronunciations, which is especially challenging for non-native speakers. Additionally, the Chinese language has an extensive vocabulary, with many words having multiple meanings. Learners must not only memorize a vast number of words and phrases but also understand their usage in various contexts.

DISCUSSION

The findings of this study highlight the significant potential of online virtual reality (VR) technology in advancing international Chinese language education. The results suggest that the integration of online VR technology can play a crucial role in this field, with three primary application methods identified: 1) Virtual Reality Chinese Live Streaming Classroom, 2) Digital Venue Tours, and 3) Chinese Simulation Training. These methods are expected to become increasingly prevalent in international Chinese language education, facilitating a closer integration of online VR technology with language teaching practices. The application of online VR technology is particularly effective in aligning with learners' interests and abilities, enhancing their understanding of their learning progress, and providing an immersive Chinese language learning experience. This multifaceted approach supports learning from various perspectives and enhances the overall convenience of language acquisition.

The review also addresses the key challenges in international Chinese language education, which are categorized into four main areas: 1) Linguistic and cultural differences, 2) The complexity of Chinese character strokes, 3) Pronunciation difficulties, and 4) Vocabulary acquisition. Among these, the complexity of Chinese characters, pronunciation challenges, and vocabulary learning are identified as critical obstacles in Chinese language education. The study emphasizes that online VR technology holds substantial promise for the modernization and reform of international Chinese language teaching, particularly in the instruction of Chinese characters. This technology offers new perspectives, methodologies, and tools for future Chinese character education, with a wide range of potential applications. However, the adoption of online VR technology is still in its early stages, with limitations in the maturity and widespread availability of the necessary technology and equipment. Implementing VR technology in education requires significant investment in resources, technical expertise, equipment, and trained educators, which poses a considerable burden on schools and teaching centers.

Furthermore, the varying economic and technological conditions across different countries and regions present additional challenges. In economically disadvantaged

areas, students may lack access to the necessary equipment and infrastructure to utilize online VR technology. Consequently, there is still a long way to go before online VR technology can be widely implemented in international Chinese language education programs, particularly in the teaching of Chinese characters. These challenges underscore the need for ongoing research and practical efforts to overcome the obstacles associated with the use of this technology in educational settings.

CONCLUSIONS

In conclusion, this systematic review synthesizes research on international Chinese language education utilizing online virtual reality (VR) technology, effectively addressing the existing gap in the literature where no prior systematic review had focused on this intersection. The review draws on two major databases, Web of Science (WoS) and Scopus, ultimately including 19 articles that met the established inclusion and exclusion criteria. The main findings of the review reveal two key aspects of international trends in Chinese language education facilitated by online VR technology. This review addresses two primary research questions related to the application of online virtual reality technology in international Chinese language education. The first question examines the various ways in which online virtual reality technology can be employed to enhance Chinese language learning. Three prominent applications are identified: Virtual Reality Chinese Live Streaming Classrooms, Digital Venue Tours, and Chinese Simulation Training. The second question explores the challenges associated with international Chinese language teaching. The findings highlight four main obstacles: linguistic and cultural differences, the complexity of Chinese character strokes, pronunciation challenges, and difficulties in vocabulary acquisition. These challenges underscore the need for innovative solutions to improve the effectiveness of Chinese language education on a global scale.

The findings of this review pave the way for new research directions in international Chinese language education, particularly concerning the use of online VR technology. However, this study has certain limitations. Most of the reviewed research focuses on undergraduate students in universities, neglecting to consider different educational levels as a potential area of investigation. This gap presents an opportunity for future research to explore the application of online VR technology in Chinese language education across various educational levels. Additionally, the articles reviewed were sourced from high-impact journals indexed in WoS and Scopus, which may introduce a degree of bias. Including other databases,

such as Google Scholar, might produce different findings. Despite these limitations, this systematic review makes a significant contribution to the field of international Chinese education by examining it through the lens of online VR technology. It offers valuable insights for educators and researchers, laying the foundation for future studies. Moreover, the review addresses critical gaps in understanding how online VR technology can be integrated into international Chinese language education and the challenges that need to be addressed. These insights are crucial for advancing the sustainable development of international Chinese language education through the use of online VR technology.

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