Sustaining International Education with Metaverse-Based Learning for Chinese: A Systematic Review (2019–2023)

Xie Xiaoning[1], Melor Md Yunus[1], Karmila Rafiqah M. Rafiq[2]

[1]Faculty of Education, UniversitiKebangsaan Malaysia Bangi 43600, [2]Faculty of Education, Universiti Teknologi MARA. Puncak Alam Campus, 42300
Email: Malaysia:melor@ukm.edu.my, Malaysiakarmilarafiqah@gmail.come
Corresponding Author Email: p130383@siswa.ukm.edu.my

Abstract
Metaverse technology is highly immersive and intelligent, which can be perfectly integrated into international Chinese education, promote the innovation and development of traditional international Chinese education, improve the efficiency of foreign students in learning Chinese characters, and better help foreign students to improve their Chinese language ability and proficiency. Therefore, this review systematically identifies trends in m-learning related to International Chinese Education using 4 databases, namely Web of Science (Wos), Scopus, Science Direct and Taylor & Francis e-Journals (PPV).A total of 13 articles were identified through a systematic search of"Chinese learning" OR "Chinese education" OR "Chinese courses" AND "metaverse" OR "metaverse-Based Learning" OR "techniques"OR "International Chinese Education"13 articles were extracted from the 332 articles available between 2019 and 2023, taking into account the exclusion and inclusion criteria.First, important findings indicate the ways in which metaverse technologies are used in international Chinese education, which are grouped into six categories in this review. Second, the difficulties in international Chinese education are mainly related to pinyin, strokes of Chinese characters and the lack of Chinese learning environment. Overall, this review is valuable for practitioners to understand the ways in which metaverse technology can be applied in international Chinese education and to identify the points of difficulty in international Chinese education so that international Chinese education can be sustainable in the future.
Keywords: International Chinese Education, Metaverse, Higher Learning, Techniques

Introduction
International Chinese language education has significant cross-national, cross-cultural, and cross-time and space characteristics. Compared with other disciplines and majors, its talent training goals also have more prominent integration of knowledge, skills, and literacy. However, its teaching process lacks obvious characteristics. Both interactivity, immersion and practicality restrict the development of international Chinese education. Its personnel

training objectives also emphasize knowledge, skills, and literacy integration, but its teaching methodology lacks the clear interactive, immersive, and practical constraints that would otherwise limit the field's growth.The incorporation of the metaverse into international Chinese education thus have many benefit: the metaverse can effectively spur innovation and transformation of the Chinese learning experience, mode, environment, etc. because of its immersive and real sense, interactivity and sociality, freedom and openness, etc.;

This study aims to evaluate the literature in order to systematically identify metaverse strategies that can be used in Chinese education abroad. The following general questions guided the analysis of the following literature:

Question 1: How can Metaverse technology be used in international Chinese language education?

Question 2: What are the difficulties in international Chinese language teaching?

By addressing these issues, this study hopes to support the evolution of teaching strategies and methods as well as offer insights and recommendations for international Chinese education organizations on how to integrate metaverse technology into international Chinese education.

Development trend of Chinese international education based on metaverse

Meta-universe technology includes advanced extended reality technology, digital twin technology, artificial intelligence technology and advanced equipment, and has functions and advantages that traditional online virtual worlds do not have, such as a high degree of immersion, sharing and co-creativity, integration of the real and the imaginary and entertainment, etc. which can break the boundaries between the real and virtual worlds, and empower the innovation and development of education and teaching both online and offline. Relying on the advanced technology of the metaverse to build an educational metaverse can develop and change the traditional ways and means of education and teaching, and create a freer virtual world for learningWu & Hao, (2023) Therefore, in international Chinese language education, making full use of the digital twin and augmented reality technologies of the metaverse, reconstructing or reproducing real virtual scenes in teaching, breaking the time and space limitations, and helping students to create all kinds of free and interesting teaching scenes, both online and offline, to meet the needs of teaching and to give full play to the features and advantages of the metaverse, such as its high degree of immersiveness, fun and intelligence, in order to better complete the teaching and learning work (Zhang et al., 2022). advantages of the meta-universe to better complete the teaching work.

Methods

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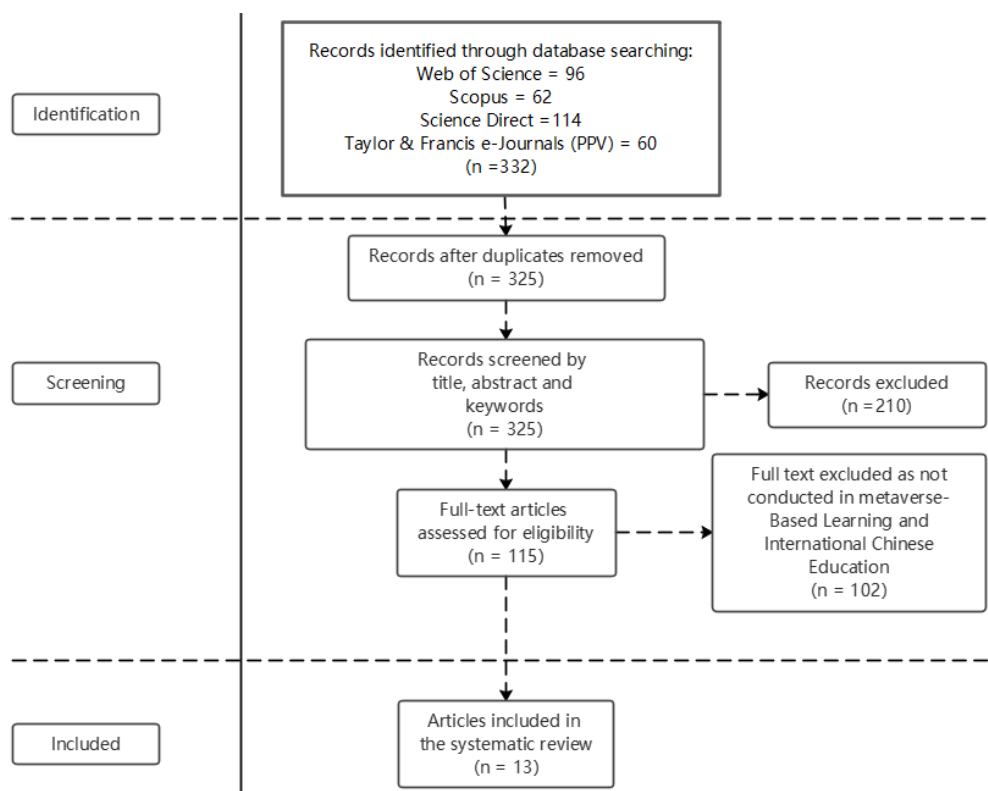
Figure 1. PRISMA systematic review adapted from

Identification

The first step is to select four suitable databases (Web of Science (WoS), Scopus, Science Direct, and Taylor & Francis e-Journals (PPV).) Table 1 below shows the search strings used for each database in this study.

Table 1
Search String

Database	KeywordUsed
Scopus	TITLE-ABS-KEY(("Chinese learning" OR "Chinese education" OR "Chinese courses" AND "metaverse" OR "metaverse-Based Learning" OR "techniques"OR "International Chinese Education"))
WebofScience	TS =("Chinese learning" OR "Chinese education" OR "Chinese courses" AND "metaverse" OR "metaverse-Based Learning" OR "techniques"OR "International Chinese Education")
ScienceDirect	metaverse-Based Learning AND Chinese learning AND International Chinese Education AND techniques
Taylor & Francis e-Journals (PPV)	metaverse-Based Learning AND Chinese learning AND International Chinese Education AND techniques

*: Search String

Screening

The search results of the selected databases showed that before 2019, relevant articles were very sparse and not clearly oriented. Since 2019, the number of articles on Chinese international education research based on Yuan University has increased exponentially. However, there are not many systematic reviews after 2019. Therefore, 2019 to 2023 was used as one of the inclusion criteria. To ensure the quality of the research, only studies with empirical data published in journals were included in the review. In addition, only articles written in English were included to minimise misinterpretation，as shown in Table 2.

Table 2
Screening Condition

Criterion	Eligibility	Exclusion
Timeline	Between 2019 to 2023	<2019
Literature type	Articles from journals	Systematic reviews, books, chapters in a book, conference proceedings
Language	English	Non-English
Scope	Related to metaverse-Based Learning and International Chinese Education	Not related to metaverse-Based Learning and International Chinese Education

After careful screening according to inclusion and exclusion criteria, 13 articles are likely to be included in this systematic review. Although the proceedings and book chapters were reviewed, they were excluded as not comprehensive enough.

Included

The articles for this systematic review revolved around "Sustaining International Education with Metaverse-Based Learning for Chinese". as shown in Table 3.

Based on the table above, 8 articles were chosen from Scopus , 3 from WoS, 1 from Science Direct and 1 from Taylor & Francis e-Journals (PPV).

The aims of these studies are related to international education based on the metaverse. Most of the studies have been conducted at the higher education level, including universities and colleges [1,13]. Most of the studies have focused more on teaching Chinese characters using the intelligent features of metaverse technology [2, 3, 5, 7, 8, 10, 11, 13] and conducting intelligent tests and evaluations [1, 2, 3, 6, 7, 8, 11, 12].

Table 3
Summary

Study	Database	Aim	Samples	Findings
Dai, Q. (2023)	Scopus	This paper probes into the development, characteristics, advantages, disadvantages and problems of Chinese international education and teaching under the new media environment.	International school students	This study improves the correlation by improving the algorithm and provides a useful reference for international Chinese teaching.
Fan, J. (2023)	Scopus , wos	A model of future intelligent teaching environment based on meta-universe is proposed.	Students in the Faculty of International Education	The model combined with the meta-environment is constructed to solve the problems of poor interactivity and lack of social and cultural context in overseas Chinese teaching
Nie, Y. (2023)	Scopus ,wos	This paper discusses how to understand the theory of multimodal discourse analysis by teaching Chinese as a foreign language	Two classes of 2021 at a secondary school in Qingdao, China Supplementary survey: 200 questionnaires were distributed	In addition to the basic advantages of the research model, such as efficiency, speed, flexibility and specificity, the research model significantly improves students' overall academic performance, especially in listening, speaking and reading.
Zhang, Q. (2022)	Scopus ,wos	Combining virtual reality technology, we are exploring the role that immersive VR technology can play in international	X University School of International Education Chinese Class: 11 Chinese language learners from 8	The results show that the remote international Chinese teaching model based on the situational cognition theory has a positive impact on students' Chinese learning.

		Chinese language teaching scenarios.	different countries	
Shen, L., & Latif, F. (2022)	Scopus	The effectiveness of an expert system for international Chinese Language education based on artificial intelligence and machine learning algorithms.	Undergraduate students enrolled in Chinese universities	An expert system for international Chinese education based on artificial intelligence and machine learning algorithm is constructed, which can improve the effectiveness of international Chinese education teaching and has good results and data availability
Zhao, J. (2022)	Scopus	Construction of mobile environment for language learning in Chinese universities based on intelligent reinforcement learning (RLT) in wireless network environment.	Undergraduate students at the University	The results show that the accuracy rate of reinforcement learning is 98.78%, which improves the learning efficiency of the subjects.
Zhang, X. (2023)	Scopus	Research on the improvement path of international Chinese education management in colleges and universities based on big data technology	Faculty and students at the Institute of International Education	The results show that online education system can meet students' individual learning needs and improve learning results.
Zhang, X. (2023)	Scopus	the constructed Chinese international education	Teachers and Chinese learners of the four levels of	It can diversify to meet the Chinese learning needs of different groups of people and

		platform was analysed in terms of multiplicity and interactivity indicators.	ABCD in the Chinese Language International Education Platform (CLEP)	improve the teaching level of Chinese language education.
Shen, S. Y. (2023)	WoS	Exploring how developments in meta-universe and virtual reality (VR) technologies can improve Chinese language outreach	APP users	By optimising the algorithm, it allows traditional culture to break through the limitations of time and space.
Yuan, J., Liu, Y. Q., Han, X. C., Li, A. P., & Zhao, L. L. (2023)	WoS	This study aims to verify the effectiveness of VR tools in stimulating adult learners' English learning and expression through the practice of a pilot reform project.	VR practical pilot class (67 students) and control class (67 students)	the real experience in the virtual world can enhance the teaching and learning effect in the university classroom.
Shu, X. Y., & Gu, X. Q. (2023)	WoS	Explore how an intelligent education model supported by the Edu-Metaverse can improve student learning outcomes	60 students from Zhejiang Broadcasting University	The Edu-Metaverse empowered intelligent education model features highly immersive experiences, multimodal interactions, and highly free resource sharing and creation.
Southworth, J., Migliaccio, K., Glover, J., Glover, J., Reed, D.,	Science Direct	Integrate AI into traditional research university curricula.	6,000 students at the University of Florida.	The model is innovative in its 'cross-curricular AI' design, incorporating different learning methods and styles.

McCarty, C., Brendemuhl, J., & Thomas, A. (2023)				
Harrison, T. (n.d.). (2023)	Taylor & Francis e-Journals (PPV)	Leading EdTech developer and providing theoretical, conceptual and practical insights to help ensure the promise of vr enhanced character education is realized	University students	VR can provide character educators with four types of learning opportunities that are not possible in the traditional classroom.

Data Analysis Procedure

All selected articles are exported to the reference software Mendeley. matic analysis was performed to identify the main themes to answer the following questions

research questions:

Question 1: How can Metaverse technology be used in international Chinese language education?

Question 2: What are the difficulties in international Chinese language teaching?

This review provides an interpretive analysis of the articles and categorises the themes in response to the research questions.

According to the first research question, the ways in which meta-universe techniques are used in international Chinese education were classified into six categories. For the second research question, an explanation is given based on the characteristics of Chinese language mentioned in the article, which is divided into three parts of the reasons: the pinyin of Chinese characters, the strokes of Chinese characters and the lack of environment for learning Chinese language, and the difficulties of Chinese language international education are analysed based on these two parts.

Results

1.1. Question 1: How can Metaverse technology be used in international Chinese language education?

In this systematic review, there are six ways to apply metaverse technology in international Chinese education

1. Teaching Chinese characters using the intelligent features of metaverse technology
2. Learning Chinese characters using the immersive features of metaverse technology
3. Developing Chinese character games using metaverse technology
4. Using the social features of the metaverse
5. Using metaverse to enhance the cultural and interesting aspects of teaching Chinese characters

6. Using the metaverse for intelligent testing and evaluation

Table 4

The application of metaverse technology in the international approach to Chinese education

Type	Related articles
Teaching Chinese characters using the intelligent features of metaverse technology	[2,3,5,7,8,10,11,13]
Learning Chinese characters using the immersive features of metaverse technology	[4,8,9,10,13]
Developing Chinese character games using metaverse technology	[8,10]
Using the social features of the metaverse	[2,9]
Using metaverse to enhance the cultural and interesting aspects of teaching Chinese characters	[8,10,13]
Using the metaverse for intelligent testing and evaluation	[1,2,3,6,7,8,11,12]

As shown in Table 4, this review divides the ways in which metacosmic technologies are used in international Chinese language education into six categories.

First of all, most of the literature [2,3,5,7,8,10,11,13] collectively show that intelligent technology is an important support of meta-universe technology, so it is necessary to closely integrate artificial intelligence in meta-universe technology with Chinese character teaching. By combining international Chinese language teaching with meta-universe artificial intelligence, making full use of the advantages of meta-universe technology, further reflecting the three-dimensional and three-dimensional characteristics of Chinese characters, and enhancing the teaching effect through multi-sensory stimulation, we can improve foreign students' understanding of Chinese characters and visual input, enhance the intuitive and interesting teaching of Chinese characters, and improve the efficiency of Chinese character learning for students.

Second, some of the literature [4,8,9,10,13] mentioned the immersive features of metaverse technology as a way to learn Chinese characters, and these five articles focus more on the combination of VR or visualisation tools to integrate the virtual world with the real world in many ways and provide people with an immersive experience. For teaching Chinese characters to foreign students, metaverse technology can fully play its immersive features by creating a virtual world of Chinese characters through metaverse, which highly reproduces the environment in which Chinese characters are used in various real-life scenarios, such as near real life and work. Foreign students can incarnate themselves as the masters of the virtual world of metaverse with the most direct first-person perspective, immerse themselves in all kinds of things with Chinese labels, and communicate freely with all kinds of purely Chinese-expressive people around them, so that learners are immersed in the Chinese language experience, which can help learners to integrate into the target language environment faster, cultivate the formation of Chinese-expressive thinking, and improve the immediacy and effectiveness of Chinese language learning. Under the teacher's guidance, foreign students can enter a variety of corresponding virtual Chinese worlds, consciously or

unconsciously come into contact with scenarios with similar or even higher levels of Chinese proficiency, and participate in them to complete corresponding tasks or communicative activities. In this kind of immersive meta-universe world, from Chinese characters to vocabulary to paragraph expressions, point by point, foreign students can further deepen their mastery of the basic knowledge of Chinese characters and further use them, and gradually get familiar with the thinking of Chinese expressions, so that their Chinese characters and Chinese language skills will surely develop and improve rapidly.

Third, the use of meta-universe technology to develop Chinese character games in international Chinese language teaching, which is reflected in the literature [8,10], using meta-universe technology can develop games related to the function of Chinese character usage, and design a variety of Chinese character games with a strong sense of participation. In the process of playing various word games, students can not only consolidate the basic knowledge of Chinese character writing and pronunciation, but also further master the function and use of Chinese characters in vocabulary and sentences.

Fourth. Using the social function of metaverse in international Chinese language teaching, which is reflected in the literature [2, 9], metaverse has strong social and game functions, which will bring people a panoramic social perceptual experience, create the presence effect of the virtual and real scenes together, and especially provide people with real social and emotional experiences. The metaverse can provide people with social forms such as games, entertainment, work, life, etc., and provide people with a very realistic social perception experience. Metaverse has a powerful social function, and Chinese is an important tool for people to transmit information and an important means for people to achieve social functions. Therefore, international Chinese teachers can give full play to the social function of the meta-universe so that foreign students can use Chinese as a medium in the process of social activities or behavioural implementation. To guide foreign students to use Chinese in learning and learning by using Chinese.

Fifth. In the literature [8,10,13], the use of meta-universe to improve the cultural and interesting aspects of teaching Chinese characters was mentioned in common, where it was pointed out that the meta-universe technology can reproduce many historical stories related to Chinese characters through its digital regeneration technology, which can enable foreign students to learn Chinese characters and understand the stories behind the Chinese characters at the same time.

Sixth. Many literatures [2,3,5,7,8,10,11,13] collectively show the teaching method of using meta-universe for intelligent testing and evaluation, and most of these eight literatures are biased towards algorithmic research, involving meta-universe technology big data, artificial intelligence, blockchain and other technologies in their articles. For example, literature [10] collects data such as foreign students' problems and difficulties in the process of learning Chinese characters through big data, records students' long-term, real and accurate learning process, learning results and various related data, and then conducts intelligent evaluation, analysis and diagnosis through artificial intelligence technology to form a relatively complete and accurate visual analysis report, so as to make a multi-faceted and diversified evaluation in a timely manner. In [8], after analysing and discovering the problems of foreign students' Chinese characters learning through meta-universe technology, based on the results and evaluations of intelligent test, the teacher can have a clearer understanding of the foreign students' strengths and weaknesses in phonetics, morphology and meaning of Chinese characters, and then make full use of artificial intelligence, virtual reality and other

technologies to give the corresponding learning plans or suggestions to help the students to check the shortcomings and make up for the shortcomings.

1.2. Question 2: What are the difficulties in international Chinese language teaching?

This systematic review concludes that the difficulties in Chinese language international education are mainly in the following three areas

(1)Lack of Chinese learning environment (2)Pinyin of Chinese Characters (3)Strokes in Chinese Characters

Table 5

Difficulties in international Chinese language education

Type	Related articles
Lack of Chinese learning environment	[1,2,3,4,5,6,7,8,9,10,11,12,13]
Pinyin of Chinese Characters	[2,3,5,7,8,10,11,13]
Strokes in Chinese Characters	[2,3,5,7,8,10,11,13]

First of all, in most of the literature [1-13] dealing with international Chinese education based on the meta-universe, when it comes to the difficulties of Chinese education, they all focus on this problem, that is, the lack of Chinese learning environment, which is an unavoidable problem for international Chinese education. Foreign students from non-Chinese cultural circle countries, such as Africa, South America, etc., whose countries or regions lack the Chinese language background, naturally lack the Chinese character environment. Therefore, the chances of using and reproducing Chinese characters are very small, and can only be concentrated in a few classrooms, exams and homework, and the chances of using Chinese characters are very small, and only a few foreign students will spend a lot of time practising and using Chinese characters after class. Few foreign students will spend a lot of time practising and using Chinese characters after class. Nowadays, the addition of metacosmic technology is hoped to better solve this problem.

The second difficulty relates to the pinyin of Chinese characters, which has been mentioned in the literature [2,3,5,7,8,11,13] in the context of Chinese education, and which is one of the most important modules of Chinese language learning. Chinese characters are planar scripts of an ideographic nature, in which glyphs and syllables correspond to each other, and are morphemic scripts for recording morphemes; whereas the pinyin scripts used by most peoples in the world are epigraphic scripts, which mainly consist of a series of linearly arranged letters. Mr Liu Xun pointed out that Chinese characters are morphemic characters that record morphemes, and alphabetic pinyin characters that record phonemes are fundamentally different writing systems, and the difference between the two is enormous [2].

The third point of difficulty concerns the strokes of Chinese characters, Chinese characters have a large number of strokes and components and a complex morphological structure, and although they have a certain rationale, they are not very regular as they continue to evolve and simplify [2,3,5,7,8,10,11,13]. Even Chinese students struggle when they start to learn Chinese characters. It is even more difficult for foreign students, especially those from non-Chinese writing cultures, to learn Chinese characters because their native scripts are different in nature from Chinese characters, and their cognitive approaches to phonetics, morphology and meaning are very different. In international Chinese language education, the difficulty of teaching and learning Chinese characters is also a widely recognised issue.

Discussion

The results of the study highlight the ways in which metaverse technology can be applied in international Chinese education The ways of application include 1. Teaching Chinese characters using the intelligent features of metaverse technology 2. Learning Chinese characters using the immersive features of metaverse technology 3. Developing Chinese character games using metaverse technology 4. Using the social features of the metaverse 5. Using metaverse to enhance the cultural and interesting aspects of teaching Chinese characters 6. Using the metaverse for intelligent testing and evaluation

The above approaches are likely to be used on a larger scale in international Chinese language education in the future, linking metaverse technology and international Chinese language teaching more closely. The use of metaverse technology focuses more on combining learners' own interests and abilities, helping learners to understand their own learning progress and experience Chinese learning in depth, so as to achieve the role of facilitating learning, for example, the VR, artificial intelligence and big data apps listed in the article, which help learners to learn more conveniently from various aspects.

Next, this review also discusses the difficulties in international Chinese education, the reasons for which are summarised in three points, including: 1. Lack of Chinese learning environment2. Pinyin of Chinese Characters 3. Strokes in Chinese Characters. The first reason is that most of the international Chinese learners will face the problem, in addition, the Chinese pinyin and strokes are also the key point and difficult point of Chinese learning. Nowadays, the addition of Metaverse technology is to solve this problem better, and the use of Metaverse technology as a tool or an aid in international Chinese language education will have a positive impact on Chinese learners.

Finally, this review discusses the important significance of metaverse technology to the update and reform of Chinese character teaching methods in the international community. It can provide new ideas, methods and means for future Chinese character teaching, and has very broad application prospects.

One limitation of this review is that Metaverse technology is still in its infancy, the maturity and popularity of technology and equipment are limited, and the application of various technologies in education and teaching needs to be further strengthened; the application of Metaverse technology in actual teaching has a significant impact on investment , technology, equipment and teachers are relatively high, which is a heavy burden for each school or teaching point. In addition, Chinese international education involves many countries and regions. Due to the huge differences in economic and technological conditions between countries or regions, it is difficult for international students in many economically backward countries and regions to have the equipment and conditions to use Metaverse technology. These are Metaverse technology. The main challenges and difficulties in the practical application of space technology require continuous practice and exploration. The application of metadata technology in Chinese character teaching in international Chinese education still has a long way to go.

Conclusions

In summary, this systematic review related to international Chinese education based on the metaverse. Therefore, the gap of no systematic review on metaverse education and international Chinese education was filled. Web of Science (Wos), Scopus, Science Direct, and Taylor & Francis e-Journals (PPV), there 4 databases were used in this review, and 13 articles were finally included based on the aforementioned inclusion and exclusion criteria. The main

findings highlight the following two aspects of international trends in Chinese language education based on the meta-universe.

Question 1: How can Metaverse technology be used in international Chinese language education?

In this systematic review, there are six ways to apply metaverse technology in international Chinese education

1. Teaching Chinese characters using the intelligent features of metaverse technology

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3. Developing Chinese character games using metaverse technology

4. Using the social features of the metaverse

5. Using metaverse to enhance the cultural and interesting aspects of teaching Chinese characters

6. Using the metaverse for intelligent testing and evaluation

Question 2: What are the difficulties in international Chinese language teaching?

This systematic review concludes that the difficulties in Chinese language international education are mainly in the following three areas

1. Lack of Chinese learning environment

2. Pinyin of Chinese Characters

3. Strokes in Chinese Characters

Based on the findings of this review, there are more opportunities for meta-universe based Chinese international education research.

This study has some limitations. Since most of the meta-universe-based Chinese international education studies have focused on students in universities and colleges, this review does not mention the educational level as a trend. This limitation undoubtedly provides new opportunities for future research, especially in selecting different levels of meta-universe-based Chinese international education studies. Secondly, the articles in this review were obtained from high-impact journals in Web of Science and Scopus, as well as two secondary databases, namely Science Direct and Taylor & Francis e-Journals (PPV). Therefore, results may be slightly different if other databases such as Google Scholar and Dimension.Despite its limitations, this systematic review makes a significant contribution to meta-universe-based research on Chinese international education, benefits practitioners in related fields, and paves the way for future research. This review also fills the gaps in the sections on the application of metacosmic technologies in Chinese international education and the difficulties in Chinese international education, which are crucial for the sustainable development of metacosmic-based Chinese international education.

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