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Enhancing International Students' Learning of Chinese Cultural Artifacts through Immersive Virtual Reality: Effects on Achievement and Self-Efficacy

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ABSTRACT: This study investigated the effects of immersive virtual reality (IVR) on international students' learning of Chinese cultural artifacts. A 2×2 true experimental factorial design was employed, with 146 international students from East Asian and Southeast Asian backgrounds recruited from a comprehensive university in China and randomly assigned to either an immersive VR or nonimmersive VR (NVR) condition. Learning achievement and self-efficacy were assessed using validated instruments. Two-way ANOVA revealed a significant main effect of learning mode on both achievement and self-efficacy, with higher scores in the IVR condition than in the NVR condition ($p < .001$). No significant main or interaction effects were observed for student regional background, indicating that the effects of IVR were consistent across groups. Overall, the findings indicate that immersive VR is an effective and inclusive instructional approach for culturally situated learning among international students.

Keywords: Immersive virtual reality, Achievement, Self-Efficacy, International student (East Asia vs. Southeast Asia), Chinese cultural artifacts, Experimental design.

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INTRODUCTION

International students constitute an increasingly important population in higher education worldwide, contributing not only to institutional diversity but also to intercultural exchange and academic vitality. Despite these contributions, international students often encounter distinct learning challenges related to language barriers, unfamiliar pedagogical practices, and limited prior exposure to host-country cultural content (Andrade, 2006). These difficulties are especially pronounced in courses that emphasize local culture, where learners must interpret historically and culturally embedded knowledge through unfamiliar symbols, narratives, and spatial representations. Recent research on international students has shown a strong correlation between academic adjustment and learning outcomes as well as between motivation and self-efficacy, which further supports the need for pedagogical aids that address both cognitive and affective learning barriers (Handrianto, 2026; Mejri et al., 2026). In the context of Chinese higher education, learning about cultural artifacts plays a key role in introducing international students to Chinese history, values, and artistic traditions. However, this type of learning can place substantial cognitive demands on international students, as it involves abstract cultural concepts, specialized terminology, and three-dimensional forms that are often conveyed through two-dimensional images or text-based explanations. When instruction relies primarily on lectures or static materials, international students may find it difficult to develop meaningful mental representations, which can adversely affect learning outcomes and confidence in their ability to succeed.

From a cognitive standpoint, these challenges can be understood through cognitive load theory, which emphasizes the limits of working memory when instructional materials generate excessive extraneous processing demands (Sweller, 1998). Multimedia learning theory further suggests that learning is enhanced when verbal explanations are integrated with meaningful visual representations that support mental model construction. As a result, instructional approaches that offer rich visual and spatial representations may be especially

advantageous for international students engaging with culturally complex learning content.

Recent advances in educational technology have highlighted the potential of immersive virtual reality (IVR) to support learning by enabling learners to interact with content in realistic, three-dimensional environments. Prior research suggests that immersive VR can enhance understanding in learning tasks that require spatial cognition and experiential engagement, such as science education, medical training, and cultural heritage learning (Radianti et al., 2020). For international students, IVR may function as a supportive learning environment by providing concrete visualizations and interactive experiences that reduce reliance on linguistic explanations alone. In this way, IVR can be viewed not as a technological novelty but as a pedagogical tool that may help international students overcome barriers associated with culturally and linguistically demanding learning contexts (Chu et al., 2026). Recent findings from international students in advanced learning settings in China indicate that perceptions of technological support and confidence in online learning significantly contribute to improving learning outcomes (Li & Baba Rahim, 2026). Empirical evidence suggests that immersive VR environments can produce stronger learning outcomes than nonimmersive or desktop-based instructional systems can, particularly when learning tasks involve spatial exploration, object manipulation, and experiential engagement (Jensen & Konradsen, 2018; Makransky & Petersen, 2019). These findings suggest that immersion and interactivity, rather than novelty alone, contribute to learning effectiveness when VR is appropriately designed.

In addition to cognitive outcomes, international students' learning experiences are closely associated with psychological factors, particularly self-efficacy, defined as learners' beliefs about their ability to successfully carry out learning tasks (Barnett, A. (2014). Self-efficacy has been shown to shape students' effort, persistence, and academic engagement and is especially relevant for international students who must adjust to unfamiliar academic and cultural settings. Prior research has shown that higher levels of academic self-efficacy are linked to better psychosocial adjustment and academic functioning among international students (Poyrazli et al., 2002; Zhang & Goodson, 2011). Accordingly, instructional approaches that enhance both learning achievement and self-efficacy may be especially beneficial for this group.

In educational psychology, self-efficacy is closely associated with self-regulated learning, goal setting, and academic resilience (Zimmerman, 2000). Learners with higher self-efficacy are more likely to employ effective learning strategies and persist when they encounter challenging tasks. These relationships are particularly relevant for international students, whose learning tasks often involve additional linguistic and cultural demands.

Although immersive VR has been increasingly applied in higher education and cultural heritage learning, several gaps remain. First, much of the existing research focuses on domestic students or general learner populations, with limited attention given to international students as a distinct group. Second, relatively few

studies employ true experimental designs with sufficient sample sizes to support causal inferences. Third, while learning performance is typically examined, fewer studies explicitly investigate self-efficacy as an outcome in culturally situated learning contexts involving international students. Addressing these gaps is essential for understanding how technology-supported learning can contribute to international students' academic success and confidence in host-country learning environments.

To address these issues, the present study examines the effects of an immersive virtual reality-based learning intervention on international students' learning of Chinese cultural artifacts. Using a true experimental pretest–posttest control-group design with approximately 140 international students, this study investigates whether immersive VR can enhance (a) learning achievement and (b) self-efficacy related to Chinese cultural artifact learning. By focusing on international students as the target population, this study contributes empirical evidence to research international student support and culturally inclusive pedagogies.

Hypotheses

H₁: International students engaging with IVR will obtain notably superior posts achievement scores in the understanding of Chinese cultural artifacts compared to those learning through NVR.

H₂: International students engaging in IVR demonstrate notably greater self-efficacy compared to those who participated in NVR.

The advantage of IVR over NVR is evident among international students from both East Asia and Southeast Asia. The self-efficacy advantage of IVR over NVR is evident among international students from both East Asia and Southeast Asia.

LITERATURE REVIEW

International Students and Culturally Situated Learning

International students' learning experiences are shaped by the intersection of academic demands and sociocultural adjustment. Previous research has indicated that international students may experience difficulty understanding course content that assumes implicit cultural knowledge or depends heavily on culturally specific references (Andrade, 2006). In culturally situated courses, such as those focusing on history, art, or heritage, these challenges may be intensified because learners must interpret meanings embedded in cultural symbols, practices, and spatial forms. Prior studies suggest that instructional materials lacking sufficient cultural contextualization can increase cognitive load and reduce engagement among international students, thereby negatively affecting learning outcomes.

Systematic reviews on international students' adjustment indicate that academic success is closely associated with instructional support, which involves the recognition of learners' cultural and linguistic backgrounds (Zhang & Goodson, 2011). From this perspective, effective pedagogical approaches for international students should emphasize making learning content more accessible, concrete, and experientially meaningful, particularly in culturally complex and conceptually abstract domains.

Immersive Virtual Reality (IVR) as a Support for Learning

Immersive virtual reality has been extensively examined as a technology-enhanced learning environment that allows learners to engage with content through presence, interaction, and spatial immersion. A comprehensive systematic review by Radianti et al. (2020) revealed that immersive VR is particularly effective for learning tasks involving spatial understanding, experiential exploration, and complex visual information. In contrast to traditional instructional media, IVR allows learners to actively explore three-dimensional objects and environments, which can facilitate deeper understanding and engagement.

In the context of cultural heritage and artifact learning, immersive technologies have been shown to increase learners' interest and comprehension by allowing them to examine artifacts from multiple perspectives and within simulated historical contexts. Such affordances are especially relevant for international students, as IVR can externalize spatial and visual information that might otherwise need to be inferred through language-dependent explanations. As a result, immersive VR may help reduce learning barriers and support equitable access to culturally situated knowledge.

In the domain of cultural heritage and artifact learning, immersive virtual environments have been found to enhance learners' sense of presence, contextual understanding, and interpretive engagement. Research on virtual heritage suggests that enabling learners to explore cultural artifacts within simulated historical settings can support deeper conceptual understanding and foster stronger emotional engagement with cultural content (Roussou, 2004; Sylaiou et al., 2010; Champion, 2015). Such features are especially valuable for international students, who often have limited prior exposure to the cultural and historical backgrounds represented by artifacts from the host country.

Self-Efficacy in International Students' Learning

Self-efficacy theory emphasizes that learners' beliefs about their capabilities play a critical role in shaping learning behavior and academic performance (Barnett, A. (2014). Higher levels of self-efficacy are linked to greater persistence, adaptive strategy use, and resilience when facing challenges. For international students, self-efficacy is especially important because academic tasks are often situated within unfamiliar cultural and linguistic contexts (Nguyen & McGregor, 2025).

Research has demonstrated a positive relationship between academic self-efficacy and international students' psychosocial adjustment and academic functioning. For example, Poyrazli et al. (2002) reported that higher levels of academic self-efficacy were associated with better adjustment among international graduate students. Similarly, a systematic review by Zhang and Goodson (2011) identified self-efficacy-related constructs as important predictors of international students' adjustment outcomes. The findings indicate that instructional interventions for international students should address both cognitive outcomes and learners' confidence in their ability to succeed.

Immersive VR, self-efficacy, and learning achievement

Immersive VR environments may support self-efficacy development by providing repeated mastery experiences, immediate visual feedback, and opportunities for autonomous exploration. According to self-efficacy theory, mastery experiences are the most influential source of efficacy beliefs (Barnett, A. (2014); Usher & Pajares, 2008). When learners successfully interact with complex content in immersive environments, they may develop greater confidence in their ability to understand and perform related learning tasks.

When considered collectively, cognitive load theory, multimedia learning theory, and self-efficacy theory offer a coherent justification for the current intervention. By showcasing Chinese cultural artifacts as interactive three-dimensional objects instead of fixed two-dimensional representations, IVR has the potential to alleviate unnecessary cognitive burden and facilitate the development of more precise mental models. These decreased processing requirements can facilitate the successful completion of tasks; such successful interactions serve as mastery experiences, which are a fundamental source of self-efficacy. Consequently, IVR is anticipated to enhance achievement by facilitating cognitive processing and bolstering self-efficacy by enabling international students to engage successfully with content that is culturally unfamiliar.

Research on virtual heritage indicates that simulated historical environments allow learners to explore cultural artifacts in ways that promote deeper conceptual understanding and stronger emotional engagement (Roussou, 2004; Sylaiou et al., 2010; Champion, 2015). These affordances are particularly beneficial for international students, who may have limited prior familiarity with the cultural and historical contexts of artifacts from the host country.

METHOD

Research Design

This study employed a 2×2 true experimental quantitative factorial design to examine the effects of an immersive virtual reality (IVR) learning intervention on international students' learning outcomes. The two independent variables were the learning mode (immersive virtual reality vs. nonimmersive virtual reality) and the moderator variable (East Asian vs. Southeast Asian students). The dependent

variables were learning achievement and self-efficacy related to Chinese cultural artifact learning.

A true experimental design with random assignment was adopted to enhance internal validity and allow causal inference regarding the effects of the intervention (Takona, J. P. (2024). The factorial design further enabled examination of potential interaction effects between instructional condition and students' regional background.

Participants

A total of 146 international students from a comprehensive university in China participated in the study. On the basis of their self-reported country of origin, they were grouped into two regions: East Asia (e.g., Korea and Japan) and Southeast Asia (e.g., Thailand, Vietnam, and Indonesia). The participants were then randomly assigned to either the immersive VR condition or the nonimmersive VR condition.

A priori power analysis was conducted using G*Power 3.1 to estimate the minimum required sample size. With a medium effect size ($f = .25$), an alpha level of .05, and a desired statistical power of .80, the calculated sample size requirement was achieved and slightly exceeded, indicating sufficient power to detect both main and interaction effects (Faul et al., 2009).

Learning Contents

The learning materials included Chinese cultural artifacts related to traditional craftsmanship, everyday life, and historical significance. Each artifact was selected to illustrate key aspects of form, structure, decorative features, and cultural meaning that are central to introductory Chinese culture courses for international students. Identical materials were used for both the experimental and control groups to ensure equivalent instructional exposure.

Intervention

The investigation lasted seven weeks, including weekly 30 min sessions. Students in the immersive VR group investigated Chinese cultural items in a head-mounted virtual environment, allowing three-dimensional viewing, manipulation, and guided discovery. A nonimmersive VR (NVR) condition was characterized as a desktop-based virtual learning environment on a flat computer screen for clarity in replication. Students used a regular computer interface to interact with artifact material, textual explanations, and observation activities, without using a head-mounted display, stereoscopic immersion, or embodied spatial navigation. Both conditions were taught by the same certified instructor using the same lesson design, objectives, timetable, task sequence, and time allotment. This strategy was used to exclude teacher influences and confirm that reported differences were attributable to learning mode, not instructional methods.

Research Instruments

Two instruments were used in this study. The researcher designed a multiple-choice test with one right answer per question to assess learning achievement and understanding of Chinese cultural items.

The discussion covered artifact identification, structural traits, and cultural significance. An expert examination by two teachers with vast expertise in teaching Chinese culture to international students validated the content validity. The internal consistency of the achievement test was evaluated using the Kuder–Richardson Formula 20 (KR-20), a method for dichotomous measures. A KR-20 coefficient of 0.81 indicates acceptable internal consistency in the study (Kuder & Richardson, 1937).

To assess students' self-efficacy, a modified version of the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al., 1991) was used to assess their perceived ability to learn and perform academic tasks. The items were designed to increase students' confidence in understanding, identifying, and communicating content linked to Chinese cultural objects. All the items were rated on a five-point Likert scale. An internal consistency assessment using Cronbach's alpha revealed strong reliability ($\alpha = .88$), exceeding the commonly accepted threshold of .70 (Nunnally & Bernstein, 1994). The modified self-efficacy scale showed satisfactory internal consistency among international students in this study.

Procedure

Prior to the collection of data, formal ethical approval was secured from the Institutional Research Ethics Committee of the host university in China [approval number: NNU20260976 + date: September 24th, 2025], ensuring that all procedures adhered to institutional guidelines for research involving human participants. At the outset of the study, participants undertook a pretest to assess their learning achievements. Participants were subsequently allocated at random to either the immersive VR group or the nonimmersive VR group. After the seven-week intervention, every participant underwent the posttest, which involved the use of identical instruments. Participation was entirely voluntary, and informed consent was secured before the commencement of data collection.

Data Analysis

The data were analyzed using IBM SPSS Statistics. Descriptive statistics were calculated for all the variables. Two-way analysis of variance (ANOVA) was performed to assess the main and interaction effects of learning conditions and regional background on learning achievement and self-efficacy. Statistical significance was set at $p < .05$. Effect sizes were reported using partial eta squared (η^2) to indicate the magnitude of observed effects (Cohen, 1988).

Two-way ANOVA is considered robust to moderate violations of normality and homogeneity of variance when group sizes are approximately equal, as in the

present study (Field, 2018; Tabachnick & Fidell, 2019). Reporting effect sizes alongside p values is recommended to support meaningful interpretation of practical significance (Lakens, 2013).

RESULTS

The descriptive statistics in Table 1 indicate that students in the IVR learning mode achieved higher postachievement scores ($M = 89.32$) than those in the NVR mode did ($M = 60.55$). Within the IVR group, East Asian students ($M = 88.75$, $SD = 6.37$) and Southeast Asian students ($M = 89.86$, $SD = 7.22$) demonstrated similar levels of performance. Similarly, in the NVR condition, postachievement scores were similar between East Asian ($M = 61.08$, $SD = 7.65$) and Southeast Asian students ($M = 60.00$, $SD = 8.11$).

Table 1: Descriptive Statistics of Postachievement

Learning Mode	Region	N	M	SD
IVR	East Asia	36	88.75	6.37
IVR	Southeast Asia	37	89.86	7.22
NVR	East Asia	37	61.08	7.65
NVR	Southeast Asia	36	60.00	8.11

Levene's test of homogeneity of variance was not significant, $F(3, 142) = 0.62$, $p = .604$, indicating that the assumption of equal variance was met.

Two-way ANOVA was conducted to examine the effects of learning mode and international student status on postachievement. The main effect of learning mode was statistically significant, $F(1, 142) = 556.94$, $p < .001$, partial $\eta^2 = .80$, indicating that students in the IVR condition achieved significantly higher scores than those in the NVR condition did (Table 2). However, the main effect of international student status was not significant, $F(1, 142) = 0.00$, $p = .989$, partial $\eta^2 = .00$. The interaction between learning mode and international student status was also not significant, $F(1, 142) = 0.81$, $p = .369$, partial $\eta^2 = .01$. The overall model explained approximately 80% of the variance in postachievement scores ($R^2 = .80$).

Table 2: Two-way ANOVA Results for Postachievement

Source	df	F	p value	Partial η^2
Learning mode	1	556.94	< .001	.80
International student	1	0.00	.989	.00
Learning mode \times International student	1	0.81	.369	.01

Descriptive statistics are presented in Table 3. Students in the IVR learning mode demonstrated substantially higher self-efficacy scores ($M = 64.18$) than

those in the NVR mode did ($M = 57.75$). Within the IVR group, East Asian students ($M = 64.92$, $SD = 12.29$) and Southeast Asian students ($M = 63.43$, $SD = 9.78$) performed comparably. Similarly, in the NVR condition, postachievement scores were similar between East Asian ($M = 56.81$, $SD = 8.78$) and Southeast Asian students ($M = 58.69$, $SD = 10.03$).

Table 3: Descriptive Statistics of Self-Efficacy

Learning Mode	Region	N	M	SD
IVR	East Asia	36	64.92	12.29
IVR	Southeast Asia	37	63.43	9.78
NVR	East Asia	37	56.81	8.78
NVR	Southeast Asia	36	58.69	10.03
Total	East Asia	73	60.81	11.33
	Southeast Asia	73	61.09	10.71
	Total	146	60.95	10.71

Before conducting the two-way ANOVA, the homogeneity of variance assumption for self-efficacy was examined using Levene’s test. The mean-based Levene’s test was statistically significant, $F(3, 142) = 2.771$, $p = .044$, suggesting a slight violation of the homogeneity assumption. However, the median-based test was not significant, $F(3, 142) = 2.559$, $p = .058$ (adjusted df: $p = .058$), indicating that the violation was marginal. Given the balanced cell sizes across groups (approximately $n = 36-37$ per cell), the results of the subsequent two-way ANOVA were considered sufficiently robust.

To further ensure robustness, a Welch-type sensitivity comparison was performed for the self-efficacy learning-mode contrast because of the marginal result regarding homogeneity. This supplementary analysis corroborated the same substantial conclusion, with IVR students indicating significantly greater self-efficacy than NVR students did, $t(140.44) = 3.79$, $p < .001$. Therefore, the difference in marginal variance was unlikely to increase Type I error in a manner that would change the interpretation of the self-efficacy results.

Two-way ANOVA was conducted to examine the effects of learning mode and international student status on self-efficacy (Table 4). The results showed that the overall model was statistically significant, $F(3, 142) = 5.077$, $p = .002$, with $R^2 = .097$ (adjusted $R^2 = .097$), indicating that the model explained 9.7% of the variance in self-efficacy. With respect to the main effects, learning mode had a significant effect on self-efficacy, $F(1, 142) = 14.226$, $p < .001$, partial $\eta^2 = .091$, suggesting that self-efficacy differed significantly across learning modes. In contrast, the main effect of the international student group was not significant, $F(1, 142) = 0.014$, $p = .907$, partial $\eta^2 = .000$, indicating that there was no significant difference in self-efficacy between East Asian and Southeast Asian students. In addition, the interaction effect between the learning mode and the international student group was not significant, $F(1, 142) = 0.978$, $p = .324$, partial $\eta^2 = .007$.

These findings indicate that the effect of the learning mode on self-efficacy did not significantly differ across the two international student groups.

Table 4: Two-way ANOVA Results for Self-efficacy

Source	df	F	p	Partial η^2
Learning mode	1	14.226	< .001	.091
International student	1	.014	.907	.000
Learning mode \times International student	1	.978	.324	.007

In summary, two-way ANOVA revealed a significant main effect of learning mode on achievement and self-efficacy, with better performance in the IVR group than in the NVR group. No significant main or interaction effects were found for international student groups, indicating that the effect of the learning mode was consistent across groups. These results show that the differences in achievement and self-efficacy were due to the learning mode and did not vary between the two student groups. The large effect size for achievement (partial $\eta^2 = .80$) indicates a strong effect of immersive VR on learning outcomes, whereas the moderate effect size for self-efficacy (partial $\eta^2 = .091$) indicates a smaller, although meaningful, effect on learners' confidence.

DISCUSSION

Interpretation of Findings

This study examined whether the learning mode (IVR vs. NVR) and international student group (East Asia vs. Southeast Asia) influenced students' postintervention performance in terms of achievement and self-efficacy. The results revealed three clear patterns.

First, learning mode had a significant main effect on achievement and self-efficacy, with higher scores in the IVR condition than in the NVR condition. These findings suggest that the IVR-based learning environment provided a more effective learning experience for the target outcome measured by self-efficacy. A possible explanation is that IVR may offer stronger immersion, richer contextual cues, and more engaging interactions, which can support understanding and performance in culturally oriented learning tasks. These results are consistent with earlier experimental research demonstrating that immersive VR enhances both learning outcomes and learner confidence relative to nonimmersive formats (Parong & Mayer, 2018; Makransky et al., 2019). Immersion and spatial interaction appear especially beneficial for conceptually complex and culturally contextualized content. More specifically, the spatial interaction provided by IVR

may have assisted international students in overcoming certain language barriers and unfamiliar pedagogical practices mentioned in the Introduction. Instead of relying solely on verbal explanations or a teacher-focused approach, students can engage in direct observation, rotation, and examination of artifacts. This hands-on interaction enables support for culturally unfamiliar meanings through visual, embodied, and experiential cues.

Second, the main effect of the international student group was not significant. In practical terms, this means that East Asian and Southeast Asian students performed similarly in terms of achievement and self-efficacy overall. These encouraging results suggest that the instructional design may have been broadly accessible and suitable for students from different regional backgrounds. This similar performance might also be connected to the choice of cultural artifacts utilized in the intervention. Owing to the emphasis on traditional craftsmanship, everyday life, and broader cultural meanings rather than on specialized historical knowledge, the materials may have diminished prior background advantages and offered a more neutral entry point for international students from East Asia and Southeast Asia.

Third, the interaction effect between the learning mode and international student group was not significant. Although the profile plot showed a slight crossing trend, this pattern was not statistically meaningful. Therefore, the advantage of IVR over NVR appears to be consistently observed across both international student groups, rather than benefiting one group substantially more than the other.

In addition, the model accounted for a modest but meaningful proportion of the variance in self-efficacy ($R^2 = .097$), indicating that the learning mode plays an important role but does not fully explain students' outcomes. Other factors, such as prior experience with VR, language proficiency, learning motivation, and digital literacy, may also influence self-efficacy and should be examined in future research.

Implications for International Students' Support

These findings have several implications for the support of international students in higher education, especially in culturally and linguistically demanding learning contexts.

First, IVR can be used as an inclusive support tool. Because the IVR advantage was found across both East Asian and Southeast Asian students, institutions may consider IVR as a broadly applicable instructional support strategy rather than a group-specific intervention. This is particularly relevant for international student cohorts with diverse backgrounds.

Second, IVR may strengthen academic adjustment through contextualized learning. For international students, unfamiliar cultural content and learning environments can create barriers to engagement. IVR-based instruction can reduce these barriers by providing more concrete, visual, and interactive

experiences, which may help students build confidence and understanding more quickly.

Third, support services should combine technology with pedagogy. IVR itself is not enough; its effectiveness depends on instructional design. Universities should provide i) clear learning goals and task guidance, ii) pretest orientation and vocabulary support, iii) structured reflection after VR learning, and iv) opportunities for peer discussion and feedback.

Fourth, staff training is essential. Teachers and support staff need practical training in how to integrate IVR into coursework meaningfully, including how to scaffold international students' learning and how to monitor participation and learning outcomes.

Finally, equity and access should remain priorities. If IVR is adopted more widely, institutions should ensure that all students can access the necessary devices, software, and technical support. This is especially important for international students who may face financial or technological constraints.

Limitations and Future Research

First, the study focused on the outcome variables achievement and self-efficacy in a specific instructional context. Although the results are useful, they may not fully represent broader learning outcomes such as long-term retention, transfer of learning, or behavioral engagement.

Second, the sample was limited to two regional groups (East Asia and Southeast Asia). While this comparison is meaningful, international students are highly diverse. Future research should include a wider range of national, linguistic, and cultural backgrounds to improve generalizability.

Third, the intervention period may have been relatively short. Short-term gains do not necessarily indicate durable learning effects. Future studies should include delayed posttests to examine whether the IVR advantage remains over time.

Fourth, the current analysis was based on group differences but did not account for possible learner-level covariates. Variables such as prior VR experience, English proficiency, academic discipline, and digital literacy may influence outcomes. Future studies could use ANCOVA, mixed ANOVA, or multilevel modeling to provide a more refined analysis.

Finally, quantitative results alone cannot fully explain why IVR produced better outcomes. Future research should adopt a mixed-methods approach, incorporating interviews, learning logs, or classroom observations to explore students' perceptions, challenges, and learning processes in greater depth.

CONCLUSION

This study shows that IVR can transcend its role as merely a technology-enhanced presentation tool; it can act as an inclusive pedagogical bridge for international students engaging with culturally unfamiliar content. By allowing students to engage spatially with Chinese cultural artifacts, the immersive virtual reality format facilitated enhanced achievement and self-efficacy compared with the nonimmersive approach. Furthermore, the lack of notable differences among regional groups indicates that the intervention was effectively accessible to both East Asian and Southeast Asian student participants in the study. The broader implication is that culturally situated learning in international higher education should not depend exclusively on language-intensive lectures or fixed visual materials. For higher education administrators, the findings advocate for the allocation of resources to IVR as an integral component of a broader strategy aimed at enhancing support for international students, especially in programs where students are required to grasp unfamiliar cultural, historical, or spatial concepts. For those involved in instructional design, it is essential to integrate IVR with well-defined learning objectives, guided observation tasks, vocabulary support, reflection, and equitable access to devices. This approach ensures that immersive technologies contribute to improved learning outcomes and bolster students' confidence rather than functioning as standalone technological enhancements.

Overall, the study enhances the Journal of International Students by demonstrating the design of immersive learning environments that effectively support culturally diverse student populations. Future studies should investigate long-term retention, diverse international student populations, and individual learner characteristics such as previous VR experience, language skills, and digital literacy. However, the current findings suggest that thoughtfully crafted IVR can serve as an effective resource for inclusive, confidence-enhancing, and culturally sensitive teaching.

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Disclosure of AI Use

AI-assisted tools were used solely for language refinement and grammatical editing of the manuscript. No AI tools were used for data analysis, hypothesis

formulation, interpretation of results, or decision-making. The authors take full responsibility for the content of this manuscript.

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