Understanding Cross-Cultural User Experience in Virtual Reality Across Presence, Emotion, and Interaction

Thanh-Thao Sophie Nguyen Thi[1], Maurizio Vergari[1], Sebastian Möller[1,3], Jan-Niklas Voigt-Antons[2] and Tanja Kojić[1]

[1]Technical University Berlin, Quality and Usability Lab, Berlin, Germany
[2]Hamm-Lippstadt University of Applied Sciences, Immersive Media Lab, Lippstadt, Germany
[3]German Research Center for Artificial Intelligence (DFKI), Berlin, Germany

Abstract

Virtual reality (VR) is increasingly used across domains such as education, training, and cultural applications, highlighting the need for inclusive user experience (UX) design for diverse global audiences. However, cross-cultural differences in UX within immersive environments remain underexplored. This work investigates how users from Eastern, Western, and mixed cultural backgrounds perceive culturally themed VR experiences. A mixed-method user study ($N = 25$) was conducted using two VR experience types: culturally themed 360° videos and interactive roleplay conversations with AI avatars. User experience, presence, and emotional responses were measured using UEQ-S, IPQ, and SAM questionnaires, complemented by qualitative feedback. Results indicate that cultural background significantly influences hedonic experience and emotional responses. While pragmatic quality showed limited cultural variation, significant interaction effects were observed for hedonic quality across video types. Presence measures showed smaller cultural differences overall, but emotional responses, particularly dominance and arousal, varied significantly between cultural groups. These findings highlight the importance of considering cultural background when designing VR experiences. Incorporating culturally adaptive interaction and narrative elements may support more inclusive and engaging immersive systems for global user populations.

Keywords

Virtual Reality, Cross-Cultural User Experience, Immersive Environments, Presence, Emotional Response, Human-Computer Interaction

1. Introduction

Virtual reality (VR) has experienced rapid technological advancements in recent years, gaining increasing attention across multiple domains. As VR technology becomes more accessible and affordable, it reaches a broader audience and creates opportunities to enhance applications ranging from education and healthcare to global business and entertainment [1]. This development highlights the growing importance of user experience (UX) research in VR to ensure that systems are inclusive and suitable for diverse user populations. If VR experiences are designed based on specific cultural assumptions, they may not translate well across regions, potentially leading to mismatches in user expectations, satisfaction, and engagement. As a result, culturally inclusive VR design requires careful consideration, acknowledging that cultural differences have influence in immersive environments. Cross-cultural differences in UX remain an important yet underexplored topic, particularly in VR, where immersion can amplify culturally sensitive aspects of interaction. At the same time, VR research has traditionally focused on technological capabilities. However, recent work highlights the need to explore VR beyond technical performance, particularly regarding its influence on behaviour and real-world interaction contexts [2]. Additionally, the growth of VR in the cultural sector demonstrates its potential not only in entertainment and gaming. Virtual simulations of historical and cultural environments can enrich learning and engagement, enabling users to interact with content that enhances understanding of global heritage [3]. As VR continues to evolve, its societal and cultural impact may become as significant as its technological progress.

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1.1. Cross-Cultural Models and Communication Patterns

Culture can be described as the combination of roles, beliefs, and contextual influences that shape how individuals think, behave, and form their identity within a social group [4]. In this sense, culture influences how people interpret and interact with the world, affecting both individual behaviour and collective social norms. Because culture shapes entire societies, many models have been developed to describe and compare cultural characteristics.

One of the most widely used frameworks is Hofstede's cultural dimensions theory, which explains how societal values influence behaviour and social structures [5]. The original model includes four main dimensions: power distance, uncertainty avoidance, individualism versus collectivism, and masculinity versus femininity. Later, long-term orientation and indulgence were added as additional cultural dimensions [6]. Research has also identified broader differences between Eastern and Western cultures. Eastern cultures, often associated with East Asian countries such as Japan, China, and Korea, typically emphasize group harmony and maintaining relationships. Western cultures, often linked to North America and Western Europe, tend to prioritize self-expression and individual goals [7, 8]. Emotional preferences also differ. Western cultures often value high-arousal emotions such as excitement, while Eastern cultures often prefer lower-arousal emotional states such as calmness and balance [7]. These cultural differences are also reflected in communication styles. High-context cultures, commonly associated with Eastern societies, rely more on implicit communication, symbolism, and contextual cues. In contrast, low-context cultures rely on direct and explicit communication [9]. Although these cultural models mainly describe interpersonal communication, they provide useful insights for Human-Computer Interaction (HCI) and VR design, even if direct translation remains challenging [10]. Understanding these differences is therefore important for developing VR applications that are engaging and culturally inclusive.

1.2. User Experience in Cultural Contexts

User experience (UX) design considers a wide range of user characteristics, including demographic factors, knowledge, abilities, and prior experience, in order to design systems that meet user needs [1]. Among these factors, culture plays a central role because it shapes values, expectations, and behavioural norms that influence how users perceive and interact with technology. Cultural values influence many aspects of design, including navigation structures, colour use, imagery, and communication style. Research on cultural web design shows that users often prefer interfaces that include cultural markers reflecting their own background. This can improve both performance and satisfaction, as users feel more comfortable and connected to the design [11, 12]. Integrating these cultural markers can therefore improve usability and communication effectiveness, especially in cross-cultural digital environments [13]. Despite this, cross-cultural UX research in immersive environments is still limited. Cultural elements may have an even stronger impact in VR, where immersive environments can increase emotional engagement with narratives and settings. Incorporating culturally relevant elements into VR experiences may therefore support more meaningful and engaging interactions for diverse user groups.

2. Objectives

The main objective of this work is to evaluate how users from different cultural backgrounds perceive and interact with VR environments. Due to the scope of the study, the focus is placed on Eastern and Western cultural contexts. By investigating cultural differences in design preferences, communication styles, and interaction behaviour in VR settings, this study aims to examine how cultural factors influence user experience and to derive insights for culturally inclusive VR UX design. Based on this motivation and the reviewed literature, the following research questions are addressed:

- **RQ1**: How does the VR experience differ between Western, Eastern, and mixed cultural backgrounds in relation to interaction techniques and design preferences?

Figure 1: Example screenshots from the 360° video stimuli: (a) Western shopping experience in Canada; (b) Eastern shopping experience in Japan.

- **RQ2**: How do users from Western, Eastern, and mixed cultural backgrounds differ in their interaction with and perception of VR environments, as reflected in usability, presence, and emotional responses?
- **RQ3**: How do Western, Eastern, and mixed cultural backgrounds influence user satisfaction and emotional engagement during role-play interactions with AI avatars in VR?

3. Methods

3.1. Study Design

In order to investigate how cultural background influences user experience in virtual reality, the study followed an experimental mixed-methods design. Participants were categorized into three cultural groups: Eastern, Western, and mixed cultural background. At the same time, all participants experienced every experimental condition. This within-subject design allowed us to examine how individuals from different cultural backgrounds respond to the same stimuli and interaction tasks. The independent variables were participant cultural background and the cultural context of the VR content. Dependent variables included user experience, presence, and emotional responses. These were collected using standardized questionnaires and open-ended feedback questions. The study primarily focused on quantitative analysis, while qualitative responses were used to support interpretation and provide additional cultural context that may not be visible in numerical scores alone. All study sessions were conducted in controlled indoor environments using Meta Quest Pro headsets. This ensured consistent visual and interaction quality across participants. The controlled setup also reduced external distractions and helped improve the reliability of the collected data.

Participants viewed eight 360° videos hosted on YouTube, evenly divided between Eastern and Western cultural contexts. The videos were selected to represent different cultural environments and communication styles, allowing participants to experience culturally distinct immersive settings.

The video stimuli covered four thematic categories: cultural markets, social dining experiences, shopping environments, and nature design. For each category, Eastern and Western videos were paired to reflect differences in cultural values such as power distance, collectivism versus individualism, and high- versus low-context communication [5, 9].

The selected videos included locations such as Sensoji Temple and the Basel Christmas Market, Chinese New Year dinner and cruise dining scenarios, Asakusa shopping street and Tsawwassen outlet mall, as well as Chinese classical gardens and Keukenhof garden. Each video lasted approximately 30 seconds. This duration was chosen to provide sufficient immersion while avoiding fatigue or discomfort. It also aligns with recommendations for minimizing VR-induced discomfort such as cybersickness [14].

In addition to video viewing, participants completed three interactive roleplay conversations in VR using AI-generated avatars. Each interaction lasted approximately 1–2 minutes, depending on the conversation dynamics. The roleplay scenarios simulated realistic social situations, including cultural

Figure 2: AI avatar roleplay environment.

celebrations, conflict resolution, and delivering negative feedback. The controlled VR setup ensured consistent presentation of facial expressions, body language, and voice behaviour across all participants.

3.2. Participants

A total of 25 participants took part in the study. Participants were recruited to represent three cultural groups: Eastern, Western, and mixed cultural background. Nine participants (36%) identified with Western cultures (primarily Germany), five participants (20%) with Eastern cultures (including China, Vietnam, and South Korea), and eleven participants (44%) identified with mixed cultural backgrounds. Participants were required to have at least B2-level English proficiency according to CEFR guidelines [15], as English was the study language. Most participants were university students ($n = 21$). The mean age was 22.7 years ($SD = 1.72$), with ages ranging from 20 to 27 years. The gender distribution included 16 male (64%) and 9 female (36%) participants. Most participants described themselves as technically confident. While prior VR experience was recorded, it was not required.

3.3. Experimental Setup and Study Procedure

The study was conducted using the Meta Quest Pro, a standalone wireless VR headset supporting six degrees of freedom tracking and integrated spatial audio. The device enables controller-based interaction and room-scale boundary tracking, allowing participants to interact naturally within the virtual environment. Two types of VR content were used. First, participants experienced culturally themed 360° videos.[1] These videos were selected to represent different cultural communication styles and value systems based on established cultural models [5, 9]. Second, participants interacted with AI-driven avatars using the VirtualSpeech[2] platform, which enables realistic conversational interaction using voice, gestures, and movement-based communication.

Participants were recruited based on cultural background to ensure balanced representation across groups. After providing informed consent, participants completed demographic questionnaires and received an individual participant ID. The experiment followed a standardized sequence consisting of three main phases:

- **Initial Cultural Video Exposure:** Participants viewed the first set of culturally themed 360° videos. After this exposure, user experience and presence were assessed using the User Experience Questionnaire Short Version (UEQ-S) and the Igroup Presence Questionnaire (IPQ). The UEQ-S measures pragmatic and hedonic quality using bipolar adjective pairs on a 7-point scale and has

[1] https://www.youtube.com/watch?v=GUeI2iINhpY, https://www.youtube.com/watch?v=CJlc2liRjNM, https://www.youtube.com/watch?v=H2GjEnjTITA, https://www.youtube.com/watch?v=xocvNAcZWPo, https://www.youtube.com/watch?v=OCvWdU0bNgc, https://www.youtube.com/watch?v=TayxcTe-npI, https://www.youtube.com/watch?v=UQt2l5gVuo8, https://www.youtube.com/watch?v=2vpNSjWSd-0

[2] https://virtualspeech.com/ai-practice?ref=home

demonstrated strong reliability across domains [16, 17]. The IPQ measures perceived presence, including spatial presence, involvement, and realism, and is widely validated for immersive VR environments [18].

- **Counterbalanced Cultural Video Exposure:** Participants viewed a second video set representing the opposite cultural context. After this exposure, participants again completed UEQ-S and IPQ questionnaires. In addition, qualitative feedback was collected to capture perceived cultural differences and subjective impressions that may not be reflected in quantitative scores.
- **Roleplay Interaction Phase:** Participants completed three VR roleplay interactions using AI-generated avatars. After these interactions, participants again completed UEQ-S and IPQ questionnaires to evaluate user experience and presence during social interaction tasks. Emotional responses were additionally measured using the Self-Assessment Manikin (SAM), which captures valence, arousal, and dominance on a 9-point pictorial scale and is well suited for cross-cultural studies due to its language-independent design [19].

Finally, participants provided open-ended feedback describing how their cultural background influenced their behaviour and perception during the VR interactions.

The order of video presentation was counterbalanced across participants to reduce order effects. Each session lasted approximately 45–60 minutes, with an additional 15 minutes required for preparation and setup.

3.4. Data Analysis

Quantitative data were analysed using descriptive statistics and inferential statistical testing. Repeated-measures ANOVA was used to analyse video condition effects, while one-way ANOVA was applied to compare cultural group differences during roleplay interactions. Prior to statistical testing, data were checked for normality and sphericity assumptions.

4. Results

To make the results section clearer and easier to understand, the following sections focus only on statistically significant effects. Results that were not statistically significant are not described in detail.

4.1. 360° Video Exposure

UEQ-S

For the scores of UEQ-S, a 1 to 7 point Likert scale was used and transformed into a -3 to $+3$ scale, aligning them with the standardized scoring approach of the UEQ [20].

Overall quality. Eastern participants rated Western videos overall the highest ($M = 1.78$, $SD = 0.78$), while Western participants rated Eastern videos the highest ($M = 1.28$, $SD = 0.76$). Mixed participants showed little indifference between the two video types, with a mean score of $M = 0.864$ ($SD = 0.69$) for Western videos and a slightly higher mean score of $M = 0.955$ ($SD = 1.01$) for Eastern videos. While there is no significant difference in overall user experience between the two video types, the change in user experience across the videos differs significantly by cultural group ($F(2, 22) = 8.016$, $p = 0.002$, partial $\eta^2 = 0.42$).

Hedonic quality. Eastern participants reported the highest mean for hedonic quality rating watching Western videos ($M = 1.500$, $SD = 0.637$). A decline for this group is evident after watching the Eastern videos going from a mean of $M = 1.500$ to $M = -0.250$ ($SD = 0.71$). In contrast, Western participants reported the lowest mean for Western videos ($M = -0.333$, $SD = 0.829$) and the highest mean for Eastern videos ($M = 1.000$, $SD = 1.068$). Mixed participants fall in the middle again with a mean of 0.295 ($SD = 1.182$) for Western videos and 0.455 ($SD = 1.474$) for Eastern videos. There is no significant difference between the two video types, but the change in hedonic quality across phases is significantly influenced by cultural group ($F(2, 22) = 10.931$, $p < 0.001$, partial $\eta^2 = 0.498$).

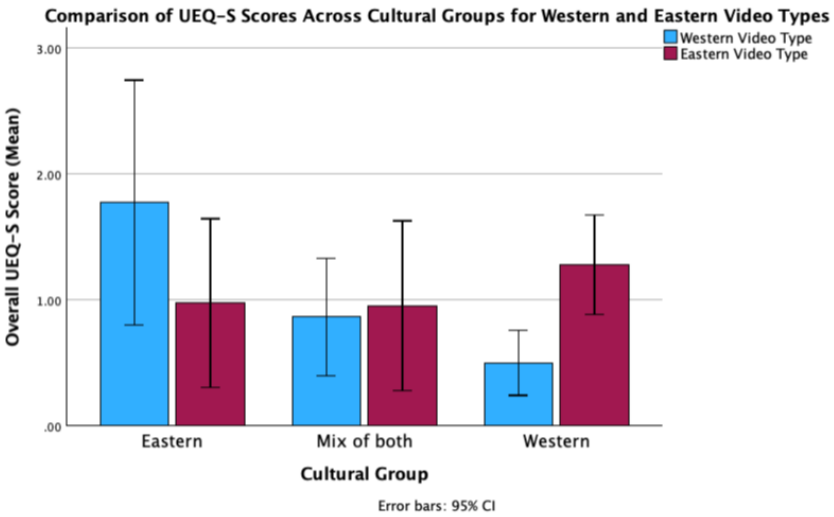

Figure 3: Mean UEQ-S Scores for Overall User Experience for Western and Eastern Video Types across Cultural Groups (Eastern, Western, and Mixed). Whiskers denote 95% confidence intervals.

Table 1
Significant effects of *Video_Type* and *Culture* on UEQ-S dimensions during video exposure.

Parameter	Effect	df_n	df_d	F	p	η^2_G
Video_Type * Culture	OverallQuality	2	22	8.016	.002	0.422
Video_Type * Culture	HedonicQuality	2	22	10.931	<.001	0.498

IPQ

The original 1 to 7 Likert scale was transformed into a 0 to 6 scale for the analysis to ensure consistent interpretation and facilitate data analysis across different studies [18]. Across IPQ dimensions, significant effects were observed for overall IPQ, involvement, and realism.

Overall IPQ. Mixed participants rated the IPQ overall the highest for Eastern videos ($M = 3.50$, $SD = 0.75$) with a slight decrease when watching Western videos ($M = 3.06$, $SD = 0.52$). Western participants had the lowest overall presence rating ($M = 2.88$, $SD = 0.30$), which improves while watching Eastern videos ($M = 3.46$, $SD = 0.45$). Eastern participants reported slightly lower IPQ scores for Western videos ($M = 2.98$, $SD = 0.36$) compared to Eastern videos ($M = 3.21$, $SD = 0.60$). The **overall difference in IPQ ratings between the two video types is significant** ($F(1, 22) = 15.51$, $p < 0.001$, partial $\eta^2 = 0.41$).

Involvement. Eastern participants experienced an increase in involvement scores from watching Western videos ($M = 2.95$, $SD = 0.45$) to Eastern videos ($M = 3.10$, $SD = 0.52$). Mixed participants showed the largest mean increase, from ($M = 2.73$, $SD = 0.45$) to ($M = 4.14$, $SD = 1.19$). Western participants also reported higher involvement in the Eastern videos ($M = 3.72$, $SD = 1.04$) compared to the Western videos ($M = 3.03$, $SD = 0.51$). There is a **significant increase in involvement between the two video types** ($F(1, 22) = 9.853$, $p = 0.005$, partial $\eta^2 = 0.31$).

Realism. Eastern participants displayed an increase in perceived realism from Western videos ($M = 2.25$, $SD = 0.64$) to Eastern videos ($M = 2.55$, $SD = 0.27$). Mixed participants increased from 2.25 ($SD = 0.76$) to 2.86 ($SD = 0.83$), while Western participants rated realism lower for Western videos ($M = 2.03$, $SD = 0.44$) than for Eastern videos ($M = 2.81$, $SD = 0.63$). There is a **significant increase in realism between the two video types** ($F(1, 22) = 20.13$, $p < 0.001$, partial $\eta^2 = 0.48$).

Table 2
Significant effects of *Video_Type* on IPQ dimensions during video exposure.

Parameter	Effect	df_n	df_d	F	p	η^2_G
Video_Type	OverallIPQ	1	22	15.512	<.001	0.414
Video_Type	INV	1	22	9.853	.005	0.309
Video_Type	REAL	1	22	20.133	<.001	0.478

Table 3
Significant effects of *Culture* on IPQ dimensions during roleplay interaction.

Parameter	Effect	df_n	df_d	F	p	η^2_G
Culture	G1_B	2	22	4.551	.022	0.293

Table 4
Significant effects of *Culture* on SAM dimensions during roleplay interaction.

Parameter	Effect	df_n	df_d	F	p	η^2_G
Culture	Arousal	2	22	4.603	.021	0.295
Culture	Rev_Dominance	2	22	38.766	<.001	0.779

4.2. Interactive Roleplay Conversation

For the roleplay phase, significant group differences were observed for general presence and for the emotional dimensions arousal and dominance. Other questionnaire dimensions did not show significant effects and are omitted.

IPQ

General Presence. Mixed participants had the highest mean rating ($M = 4.73$, $SD = 1.01$), while Eastern participants reported the lowest mean score ($M = 2.80$, $SD = 1.30$), and Western participants fell in between ($M = 3.78$, $SD = 1.39$). There is a **significant difference in General Presence scores between cultural groups** ($F(2, 22) = 4.55$, $p = 0.02$, partial $\eta^2 = 0.29$).

SAM

Arousal. Eastern participants reported the highest arousal levels ($M = 7.00$, $SD = 0.71$), while mixed participants reported the lowest ($M = 4.55$, $SD = 2.62$). Western participants reported arousal levels similar to Eastern participants ($M = 6.67$, $SD = 0.71$). ANOVA revealed a **significant difference in arousal ratings between cultural groups** ($F(2, 22) = 4.60$, $p = 0.021$, partial $\eta^2 = 0.30$).

Dominance. Western participants reported the highest dominance ratings ($M = 7.00$, $SD = 1.22$), while mixed participants reported the lowest ($M = 3.00$, $SD = 1.00$). Eastern participants reported moderate dominance levels ($M = 5.60$, $SD = 0.55$). ANOVA revealed a **highly significant effect of cultural background on dominance ratings** ($F(2, 22) = 38.77$, $p < 0.001$).

5. Discussion

This study examined how cultural background influences user experience, presence, and emotional responses in VR across passive cultural exposure (360° videos) and interactive social VR scenarios (AI avatar roleplay). Overall, cultural background mainly affected experiential and emotional aspects of VR, while pragmatic usability aspects remained relatively stable across groups.

Cultural Effects on Hedonic and Pragmatic User Experience. The interaction between video type and cultural group shows that cultural background influences how users evaluate culturally themed

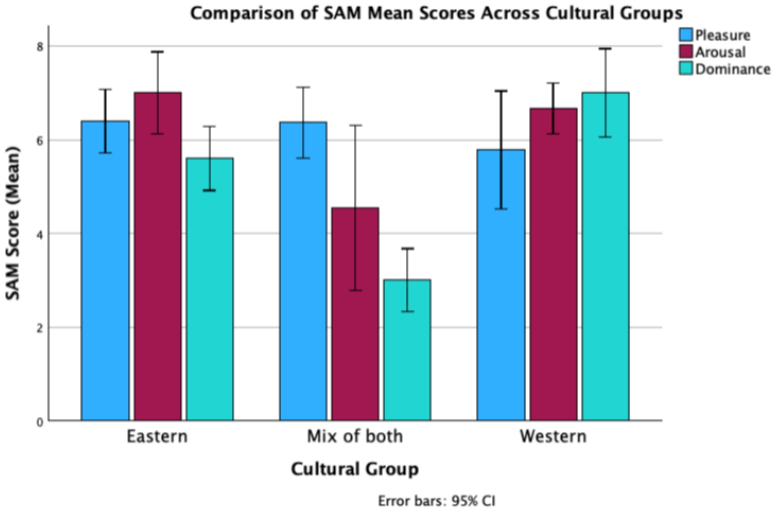

Figure 4: Mean SAM Ratings for Pleasure, Arousal, and Dominance across Cultural Groups (Eastern, Mixed, Western). Whiskers denote 95% confidence intervals.

VR content. Users generally reported higher hedonic quality for culturally unfamiliar content, indicating that cultural novelty can increase engagement through curiosity and emotional stimulation. This interpretation is consistent with previous research showing that cultural context shapes communication preferences, media interpretation, and emotional engagement [9].

In contrast, pragmatic quality showed no significant cultural differences. Usability-related aspects of VR interaction therefore appear to be transferable across cultural contexts. This aligns with UX theory describing usability as a fundamental component of user experience that is less influenced by cultural background compared to emotional or experiential factors [21]. From a design perspective, this means that core interaction usability can remain consistent, while emotional engagement strategies may require cultural adaptation.

Overall, the findings indicate that cultural background mainly influences experiential and emotional layers of VR interaction rather than functional interaction performance. This pattern is consistent with cross-cultural frameworks such as Hofstede's cultural dimensions and emotional arousal preference models [6, 7, 9].

Cultural Effects on Presence, Realism, and Immersion. Presence measures remained relatively stable across cultural groups, highlighting the strong influence of technical system properties and perceptual immersion factors. At the same time, consistently higher realism ratings and slightly higher presence ratings for Eastern videos across groups indicate that cultural familiarity and narrative richness can still influence perceived authenticity and engagement.

Rather than directly changing presence levels, cultural content appears to influence how meaningful and believable virtual environments are perceived. This highlights the importance of combining culturally relevant content with interaction design and social realism when developing culturally adaptive VR environments. From a broader XR perspective, cultural background may influence how users interpret and respond to immersive environments, even when technical system quality is comparable across conditions.

Cultural Effects in Social VR Interaction. Cultural differences were more visible in the interactive VR scenarios. Eastern participants reported higher overall UX ratings, while mixed participants showed the highest presence-related scores. Exposure to multiple cultural frameworks may increase adaptability to different virtual environments, which is consistent with previous cross-cultural UX findings [11]. Differences in general presence across cultural groups indicate that cultural background can influence the fundamental sense of social presence in VR. Lower presence and involvement scores reported by Eastern participants may reflect expectations for subtle contextual communication cues that were not fully represented in the AI avatar interaction [9].

Emotional response results also show cultural differences. Western participants reported the highest dominance levels, indicating a stronger sense of control during interaction. This aligns with Hofstede's power distance dimension, where Western cultures are generally associated with lower power distance and stronger expectations of personal agency [5, 7]. Qualitative feedback supports this interpretation, as Eastern participants more frequently reported discomfort with direct confrontation scenarios. Interestingly, Eastern participants reported the highest pleasure and arousal levels. Immersive VR environments may therefore temporarily shift emotional responses beyond typical cultural baseline preferences, potentially due to increased sensory richness and emotional immersion [7]. This highlights the potential of VR to strengthen emotional engagement across cultural contexts. Across all groups, pleasure ratings remained consistently high, indicating strong overall acceptance of the VR experience. Differences in arousal and dominance, however, underline the importance of considering cultural variation in emotional response when designing VR interactions. Mixed participants reported lower dominance and arousal levels, which may reflect a balancing effect of exposure to multiple cultural contexts. This pattern indicates increased emotional flexibility and adaptive interpretation of interaction scenarios.

Implications for Cross-Cultural VR Design and Future XR Systems. The findings highlight several implications for VR design. VR systems should support culturally adaptive communication and emotional interaction styles, particularly in social VR scenarios. Adjustable feedback style, communication directness, and interaction pacing may help accommodate users from different cultural backgrounds. Culturally unfamiliar content can be used to increase engagement in educational or training contexts, while culturally familiar content may support comfort and long-term usability. Effective cross-cultural VR design should therefore address not only visual and narrative elements, but also interaction behaviour and emotional pacing.

As XR systems continue to develop toward global platforms with AI-driven agents and shared virtual environments, cultural adaptation will likely become increasingly important. Future XR systems may benefit from adapting communication style, emotional intensity, and interaction structure to better match user expectations across cultural contexts.

Overall, the results highlight the importance of culturally sensitive design approaches for developing inclusive and scalable VR experiences.

Limitations. Several limitations should be considered when interpreting these results. First, the sample size was relatively small and consisted mainly of university students, which may limit generalizability to broader populations. Second, cultural group categorization was based on self-identification and grouped multiple national backgrounds, which may mask intra-cultural differences. Additionally, exposure time to each VR scenario was relatively short, which may have limited long-term presence or emotional adaptation effects. The study also relied primarily on self-report measures, which may be influenced by individual interpretation or response bias. Finally, the study used a single VR platform and hardware setup, which may limit transferability of findings to other VR systems or interaction designs.

6. Conclusion

Overall, the findings indicate that cultural background mainly shapes emotional and experiential aspects of VR, while functional usability remains relatively consistent across user groups. Hedonic quality ratings differed depending on cultural familiarity, indicating that culturally unfamiliar content can increase engagement and emotional stimulation. In contrast, pragmatic quality remained relatively stable across groups, suggesting that core usability principles can be applied across cultural contexts. Presence measures were generally comparable across cultures, although realism and social presence showed some variation depending on cultural expectations and communication style. Emotional response measures revealed the strongest cultural differences, particularly for dominance and arousal during social interaction scenarios.

These findings highlight the importance of considering cultural factors when designing VR experi-

ences, especially in social and emotionally engaging contexts. While functional usability may remain stable across user groups, emotional engagement, communication style, and interaction behaviour may require cultural adaptation to better support diverse users. Future work should investigate larger and more culturally diverse samples, longer exposure times, and more varied social interaction scenarios. Understanding how cultural expectations shape interaction in immersive environments will become increasingly important as VR and XR technologies are deployed to global user populations.

Declaration on Generative AI

The authors have not used any Generative AI tools.

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