



Потенциал использования виртуальной реальности в культурном образовании

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АННОТАЦИЯ

Введение. В сфере современного высшего образования формирование культурной компетенции приобретает все большее значение как важный аспект комплексного и всестороннего обучения. Растущая взаимосвязь мира, построенного на принципах глобализации, подчеркивает значимость людей, обладающих навыками эффективного общения и взаимодействия в различных культурных контекстах. *Целью данного исследования*, проходившего в три этапа, была оценка влияния погружения в виртуальную реальность на культурный интеллект, глобальную культурную осведомленность, открытость и культурную адаптивность студентов.

Участники и методы. В исследовании принимали участие 204 студента Финансового университета при Правительстве РФ, которые использовали гарнитуры Oculus 2 и видеоролики в формате 360° VR. Участники совершили виртуальные экскурсии по Иерусалиму и Токио, а их культурный интеллект был определен с помощью тестирования до и после проведения эксперимента. Для измерения изменений в культурном интеллекте и взаимосвязи между культурной осведомленностью и адаптивностью были использованы методы описательной статистики и корреляционный анализ Пирсона. Независимые t-тесты для парных выборок позволили сравнить участников виртуального погружения с контрольной группой, которая не участвовала в нем.

Результаты. Выявлено существенное повышение среднего балла культурных знаний о двух городах после погружения в виртуальную реальность. Баллы по Иерусалиму выросли, а результат t-теста ($t=6,98$, $p<0,001$) подтвердил это статистически значимое улучшение. Аналогичным образом, показатели VR-тура в Токио увеличились, результат t-теста составил $t=5,97$, $p<0,001$, что свидетельствует о значительном положительном влиянии VR-погружения на понимание студентами культурных особенностей.

Выявлено, что с ростом культурного интеллекта повышается и глобальная культурная осведомленность студентов ($r = 0,39$; $p < 0,05$). Независимые выборочные t-тесты, в которых сравнивались группа, проходившая VR погружение, и группа, не участвовавшая в занятиях в виртуальной лаборатории, выявили статистически значимые различия в средних баллах по обеим анкетам. По опроснику 1, оценивающему уровень культурного интеллекта, $t = 3,51$, $p < 0,001$. Согласно опроснику 2, посвященному глобальной культурной осведомленности, $t = 2,35$, $p < 0,02$. Данные результаты доказывают, что погружение в виртуальную реальность обогащает понимание участниками культурных аспектов и повышает их культурный интеллект и глобальную культурную осведомленность.

Заключение. Виртуальное погружение в разнообразные культурные контексты существенно повышает культурный интеллект, глобальную культурную осведомленность, открытость и адаптивность. Результаты исследования свидетельствуют о потенциале виртуальной реальности как мощного инструмента в культурном образовании, способствующего глубокому пониманию и приобщению к разным культурам. Исследование показывает ценность интеграции технологии виртуальной реальности в образовательные программы для улучшения взаимодействия студентов с другими культурами, что будет способствовать формированию более взаимосвязанного и культурно осведомленного мира.

КЛЮЧЕВЫЕ СЛОВА

виртуальная реальность, культурный интеллект, открытость, глобальная культурная осведомленность, культурная адаптивность, английский язык как иностранный

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Virtual reality immersion potential in cultural education

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ABSTRACT

Introduction. In modern higher education, the development of cultural competence is becoming increasingly important as a crucial aspect of comprehensive learning. The growing interconnectivity of the globalized world emphasizes the importance of the individuals who are equipped with the skills to interact and engage effectively in diverse cultural contexts. This study, conducted across three phases, aimed to assess the effects of VR immersion on cultural intelligence, global cultural awareness, openness, and cultural adaptability among students.

Study participants and methods. The study involved 204 students from the Financial University under the Government of the Russian Federation, using Oculus 2 headsets and 360° VR videos. Participants were subjected to VR tours of Jerusalem and Tokyo, and their cultural intelligence was evaluated through pre-test and post-test assessments. Descriptive statistics and Pearson correlation analyses were employed to measure changes in cultural intelligence and the relationship between cultural awareness and adaptability. Independent samples t-tests compared VR-immersed participants with a control group who did not experience VR.

Results. The findings indicate notable enhancements in mean cultural knowledge scores of two cities following VR immersion. The scores for Jerusalem increased and the t-test result of $t=6.98$, $p<0.001$ confirmed this statistically significant improvement. Similarly the Tokyo VR tour showed an increase with a t-test result of $t=5.97$, $p<0.001$, indicating a substantial positive effect of VR immersion on students' cultural understanding.

It was found that as students' cultural intelligence increases, so does global cultural awareness ($r = 0,39$; $p < 0,05$). Independent samples t-tests comparing the VR group with the non-VR group unveiled statistically significant differences in mean scores for both questionnaires. For Questionnaire 1, which measured CQ, the VR group scored a mean of 39.9 compared to 37.3 for the non-VR group ($t = 3.51$, $p < 0.001$, Cohen's $d = 0.49$). For Questionnaire 2, assessing global cultural awareness, the VR group scored 40.6, exceeding the non-VR group's score of 38.9 ($t = 2.35$, $p < 0.02$, Cohen's $d = 0.33$). These findings strongly indicate that VR immersion enriches participants' understanding of cultural aspects and enhances their CQ and global cultural awareness.

Conclusion. VR immersion in culturally diverse contexts notably enriches cultural intelligence, global awareness, openness and adaptability. These findings underline VR's potential as a powerful tool in cultural education, facilitating in-depth understanding and engagement across diverse cultural landscapes. The study underscores the value of integrating VR into educational programs to improve students' ability to engage with and understand diverse cultures, thereby promoting a more interconnected and culturally aware world.

KEYWORDS

virtual reality, cultural intelligence, openness, global cultural awareness, cultural adaptability, English as a foreign language

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INTRODUCTION

Language education is changing to adapt to the need for innovative and culturally-responsive teaching methods that align with global policy directives. According to UNESCO's report, digital technologies have the potential to transform education by making it more inclusive, equitable, and culturally responsive [1]. The report advocates for a reimagined educational landscape where technology not only bridges educational gaps but also enhances cultural understanding. This supports the call for education systems to overcome discrimination, marginalization, and exclusion, promoting a deeper appreciation for cultural diversity and global solidarity. The integration of English as a Foreign Language (EFL) with digital tools, particularly virtual reality (VR), illustrates this transformation by creating new opportunities for developing cultural intelligence (CQ).

There have been a lot of definitions of cultural intelligence in recent years, as researchers and scholars have increasingly recognized its significance. The following articles and books significantly enrich the understanding of the complex nature of cultural intelligence and its crucial impact on intercultural communication including its role in efficient collaboration among members in the metaverse [2]; intercultural management in practice [3]; improving intercultural task performance [4]; promoting innovative work behavior [5]; key concepts of intercultural intelligence [6]; cultural intelligence as a construct [7; 8]; cultural awareness as a significant part of language teaching [9] and global cultural awareness [10].

In today's globally connected business world cultural intelligence is becoming a vital skill set, encompassing awareness, openness, and cultural adaptability [11]. In response to this need, there are a multitude of digital technologies to enhance cultural intelligence including collaborative work among employees from different cultural backgrounds [12]. These technologies incorporate simulation-based learning [13]; intercultural competence development [14]; virtual and augmented reality [15; 16]; the integration of cultural intelligence in commercial chatbots [17].

Virtual reality creates a simulated environment, offering experiences that range from fully immersive to semi-immersive, depending on the equipment and design. VR in education can provide realistic, interactive, and engaging learning experiences that are not achievable through traditional methods [18]. As VR technology advances, its application in education expands, making it a powerful tool for simulating environments otherwise inaccessible [19].

Virtual reality has been successfully implemented across various educational fields, demonstrating improvements in learning outcomes, engagement, and retention. For instance, VR simulations in medical training have shown significant benefits in skill acquisition and decision-making [20]. In history education, virtual reality has enabled students to virtually visit historical sites, providing contextual learning that enhances retention [21]. Language learning studies have used virtual reality to create immersive environments for practicing conversational skills, showing improved fluency and confidence [22].

Immersive VR experiences allow learners to virtually participate in cultural activities, navigate diverse cultural landscapes, and interact with various cultural scenarios [23]. Several studies have explored VR's potential in cultural education. Tafazoli, for instance, discusses the integration of virtual reality into teaching culture, highlighting its role in enhancing cultural immersion and simulating authentic experiences crucial for developing CQ among EFL learners [24]. This integration aligns with findings from Shadieva et al., who demonstrated that VR environments, especially through 360-degree video technology, significantly enhance cross-cultural understanding and emotional intelligence among Chinese and Uzbekistani students [25].

Studies focusing on VR's application in intercultural sensitivity further emphasize its effectiveness in educational contexts. Li et al. conducted research with Hong Kong youth, using VR scenarios to address cultural topics and enhance participants' intercultural sensitivity [26]. They believe that virtual reality can be an effective means of delivering meaningful intercultural education within classrooms.

The application of virtual reality continues to develop in the field of cultural heritage communication, where it engages younger audiences in immersive learning experiences. Research by Škola et al. and Ch'ng et al. reveals significant user acceptance and engagement in VR-based cultural heritage exploration, underscoring its potential to convey historical information through interactive and compelling virtual environments [27; 28].

Another research presented a systematic review on VR applications in cultural heritage, categorizing 290 articles into coherent taxonomy schemes such as case studies, systems design, and evaluation studies [29]. This review highlights the motivations for using virtual reality in this domain, including the enhancement of immersion through multimedia content and the creation of compelling user experiences that effectively convey historical and cultural information.

Beyond cultural education, virtual reality enhances language learning practices by fostering creativity and intrinsic motivation among EFL learners. Lin and Wang explored VR's impact on learners' creative self-efficacy and its role in reducing anxiety and offering a refreshing platform for language learning through creative projects [30]. This approach corresponds to broader conceptualizations of language learning as a transformative process that incorporates cultural immersion and empathy-building activities [31].

Conceptualizing language as a reflection of cultural norms enriches the theoretical foundations of VR integration in language education [32]. This perspective supports the practical application of virtual reality to enhance cross-cultural awareness in EFL classrooms, bridge cultural gaps and promote effective communication skills among learners. Such integration not only transforms traditional educational practices but also contributes to broader discussions about cultural competence and global citizenship in contemporary education.

A large number of literature highlights the significance of cultural intelligence, global cultural awareness, openness, and cultural adaptability. Many researchers have noted the particular impact and immersiveness of virtual reality as the latest educational tool. However, the extent to which virtual reality can effectively enhance cultural intelligence has not been thoroughly explored.

The aim of this study is to assess the effects of VR immersion on cultural intelligence, global cultural awareness, openness, and cultural adaptability among students. The innovative use of virtual reality seeks to deepen participants' understanding of diverse cultural contexts.

MATERIALS AND METHODS

This study was conducted in three phases to comprehensively evaluate the impact of virtual reality immersion on cultural intelligence, global cultural awareness, openness, and cultural adaptability. In the first phase, we focused on assessing the effects of VR immersion on changes in cultural knowledge and measuring cultural intelligence. The participants engaged in VR experiences centered on the cultural landscapes of Jerusalem. The results from this phase provided valuable insights into the immediate impact of virtual reality on cultural knowledge acquisition and the development of cultural intelligence. The second phase aimed to broaden the scope of the study by assessing the impact of VR immersion on changes in cultural knowledge in a different cultural background of Tokyo city and measuring awareness of global cultural diversity, openness, and cultural adaptability. This phase intended to capture nuanced shifts in participants' perceptions and adaptability to a broader range of cultural scenarios. In the next stage of our research, a separate group of new participants was included in the study without the immersive VR experience. The control group was used to compare with those who were exposed to virtual reality. During this stage, two questionnaires were completed by the participants without the VR videos. The aim of this stage was to isolate the impact of VR immersion on cultural understanding. The overall goal of the study was to compare the results from the first two phases to understand the cumulative effects of VR experiences on cultural intelligence. Additionally, correlation analyses explored potential relationships between cultural intelligence and global cultural awareness, openness, and cultural adaptability.

We hypothesized a positive correlation between cultural intelligence scores and scores related to global cultural awareness, openness, and cultural adaptability after VR experience. We expected that high cultural intelligence would align with a heightened awareness and adaptability. Our second hypothesis was that the participants who underwent VR immersion would demonstrate higher cultural intelligence scores and increased levels of global cultural awareness, openness, and cultural adaptability compared to those who were not exposed to virtual reality.

The participants of the experiment were students of the Financial University under the Government of the Russian Federation (127 people at stage 1 and 2, 77 – at stage 3). They represented a diverse group of EFL learners with different academic backgrounds, including majors in political studies, information technologies, sociology, advertising and public relations, with English levels ranging from B1 to B2, and with 1 to 3 years of study. English for Specific Purposes (ESP) was a part of their curriculum, and a balanced representation was guaranteed by thoroughly selection criteria. The participants were randomly assigned to either the experimental group, where they engaged in VR cultural immersion, or the control group. The recruitment process emphasized informed consent, and the students were made aware of the study's objectives, procedures, and potential impacts. Ethical considerations and the privacy of the participants were of utmost importance throughout both the recruitment and data collection phases.

The experiment was carried out in a VR laboratory CyberHub of the Financial University (<http://www.fa.ru/org/div/cyberhub/Pages/Home.aspx>) which provided a controlled and standardized environment for the VR classes, thus increasing the consistency of the study conditions across the participants. The participants used Oculus 2 VR headsets and explored virtual reality content in the form of 360° VR videos, which were accessible through YouTube VR. This immersive approach allowed the participants to explore the surroundings as if they were physically present. The videos showcased the cultural diversity of Jerusalem and Tokyo, and were chosen for their detailed cultural context and to represent significantly different cultures with little in common. Jerusalem represented historical and religious significance, while Tokyo reflected modern urban life mixed with tradition.

To evaluate the impact of VR immersion on cultural intelligence, global cultural awareness, openness and cultural adaptability the participants underwent pre-test assessments before experiencing the VR content and post-test assessments immediately after the VR session. These assessments included language proficiency tests specific to the EFL curriculum and a cultural indicators measurement. The pre-test established the level of EL knowledge and cultural awareness before the experiment, while the post-test was to evaluate any changes in linguistic and cultural competencies.

To supplement the quantitative data, the participants were given questionnaires in order to provide qualitative analyses of their experiences. The selected questionnaires were based on the established validity and reliability in assessing cultural intelligence and related constructs. The qualitative component, derived from open-ended responses, provided compelling message about participants' experiences with VR immersion and a clearer vision of how virtual reality contributes to cultural education.

Quantitative data collected from the tests and questionnaires were subjected to rigorous statistical analysis. There was a comparative approach to assess the disparities in language proficiency and cultural intelligence levels between the experimental group (before and after experiment) and control group. Descriptive statistics, such as means, medians, standard deviations, and dispersions, were calculated for both the VR and non-VR groups, providing a comprehensive overview of the data. Pearson correlation coefficients were used to investigate the relationship between scores of cultural intelligence and global cultural aspects, providing insight into possible connections. Independent samples t-tests were conducted to compare the VR and non-VR groups for Questionnaires 1 and 2. The degrees of freedom were taken into consideration, and Cohen's d effect sizes were calculated to evaluate the magnitude of differences. Responses from questionnaires, presented as percentages, were analyzed to identify notable patterns and trends within the VR and non-VR groups. Recurring themes and participant experiences were extracted from open-ended responses, providing valuable qualitative findings.

FINDINGS

The pre-test scores were collected before the participants watched each VR video, with post-test scores taken after they had finished watching. Initially, the students explored Jerusalem, and then in three months they visited virtual Tokyo. Tables 1 and 2 present the summary statistics which gives a comprehensive snapshot of the participants' performance during first two stages of the experiment.

Table 1

VR video Jerusalem pre-test and post-test results

Test	Minimum	Maximum	Mean	Median	Standard Deviation	Dispersion
Pre-test	0	7	3.54	4	1.57	2.47
Post-test	0	10	5.15	5	2.07	4.28

Table 2

VR video Tokyo pre-test and post-test results

Test	Minimum	Maximum	Mean	Median	Standard Deviation	Dispersion
Pre-test	0	8	2.71	2	1.68	2.83
Post-test	1	10	4.04	4	2.20	4.83

The research findings indicate that participants demonstrated a notable improvement in their mean scores from the pre-test (3.54) to the post-test (5.15) after answering questions about the culture of Jerusalem. A similar increase in mean scores can be seen after the exposure to the Tokyo VR video, where they grew from 2.71 to 4.04. The t-test result of $t=6.98$, $p<0.001$ for Jerusalem and $t=5.97$, $p<0.001$ for Tokyo confirmed this statistically significant improvement, indicating the substantial impact of virtual reality on cultural learning outcomes. The post-test scores exhibited greater variability for both phases of the experiment which is reflected in a larger standard deviation scores. These diverse responses can be affected by a unique nature of the virtual immersion, which was a new experience for many participants.

The bar charts presented in Figure 1 and 2 visually illustrate a positive trend in scores from the pre-test to the post-test following the VR sessions. Scores ranged from 1 to 10, with a notable concentration of higher scores in the post-test. Thus, we may assume that VR experience improved students' understanding of Jerusalem's and Tokyo's cultural aspects.

In order to examine potential correlations between participants' scores before and after both VR experiences, Pearson correlation coefficients were calculated. While comparing pre-test scores of Jerusalem and Tokyo we got 0.14, and for the post-test scores, it was 0.23. This analysis revealed a weak positive correlation for two sets.

Table 3 demonstrates an overview of the summary statistics for two questionnaires which were given both to students who had VR immersion with culture-related videos (VR group) and those who did not watch them (non-VR group). The first questionnaire evaluated participants' cultural intelligence, while the second – global cultural awareness, openness, and cultural adaptability. These findings are crucial for further analysis and will enable us to compare the scores between VR and non-VR groups.

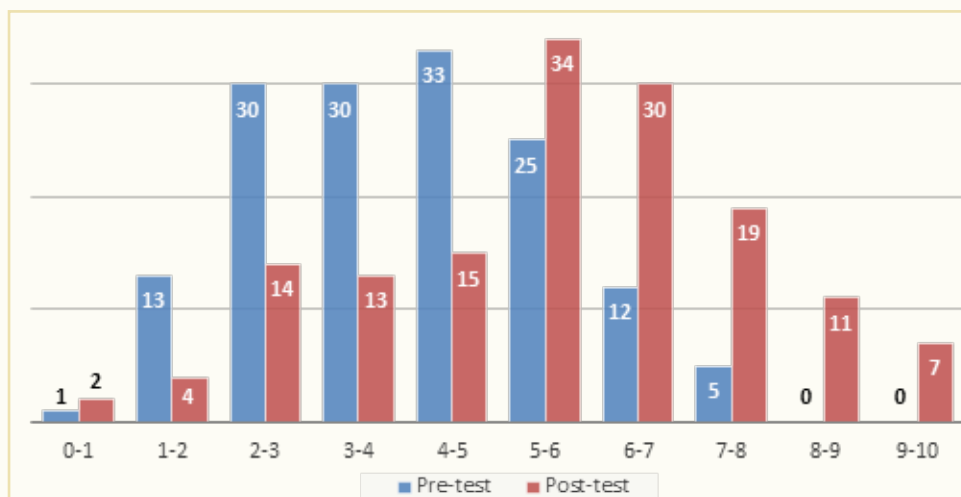


Figure 1 Pre and post-test comparison for Jerusalem VR video

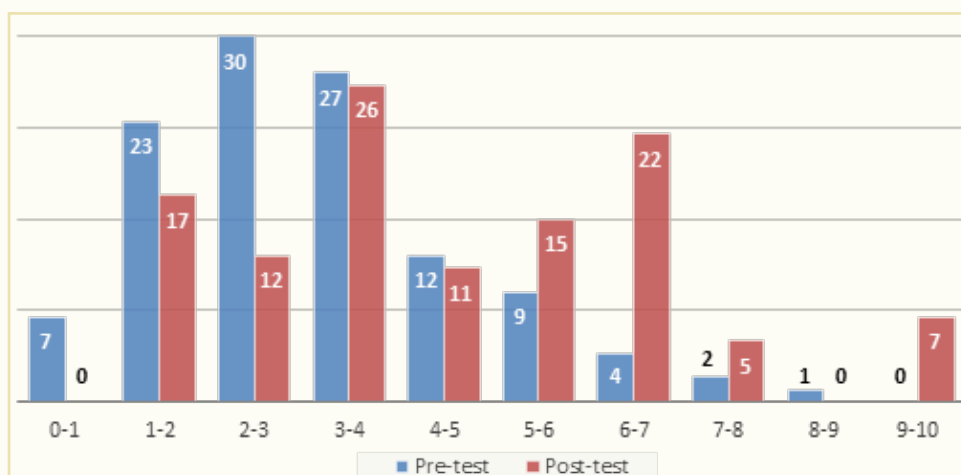


Figure 2 Pre and post-test comparison for Tokyo VR video

Table 3

Questionnaires Results for VR and Non-VR Groups

Type of Questionnaire	Minimum		Maximum		Mean		Median		Standard Deviation		Dispersion	
	VR group	Non-VR group	VR group	Non-VR group	VR group	Non-VR group	VR group	Non-VR group	VR group	Non-VR group	VR group	Non-VR group
Questionnaire 1	27	24	50	48	39.9	37.3	40	38	5.1	5.6	25.7	31.3
Questionnaire 2	34	26	49	50	40.6	38.9	40	39	4.7	5.4	22.6	29.7

Next, the findings in Tables 4 and 5 contain the evidence which can help us gain a comprehensive understanding of participants' perspectives on various cultural dimensions. The responses are presented as percentages, allowing us to track the attitudes distribution within each group.

A brief overview shows that both groups have a positive attitude towards cultural intelligence and global cultural aspects, which aligns with the intended goals of the study. However, some participants may have had difficulties interpreting certain items in the questionnaires, as they found some questions difficult to answer.

Table 4
Cultural Intelligence Questionnaire Results (VR and Non-VR)

	Strongly agree		More likely to agree		Difficult to answer		Rather disagree		Strongly disagree	
	VR group	Non VR group	VR group	Non VR group	VR group	Non VR group	VR group	Non VR group	VR group	Non VR group
1. I know how to best communicate with people from different cultures.	18,9%	15,6%	54,3%	59,7%	21,3%	10,4%	4,7%	14,3%	0,8%	0,0%
2. I am able to recognize what words and gestures may offend people from other cultures.	13,4%	10,4%	53,5%	46,7%	21,3%	22,1%	11,0%	18,2%	0,8%	2,6%
3. I know what traditions and customs are respected in different cultures.	13,4%	5,2%	59,8%	55,8%	18,1%	24,7%	8,7%	10,4%	0,0%	3,9%
4. I often use knowledge of other cultures to better understand my colleagues and friends.	17,3%	11,7%	37,8%	41,6%	18,9%	19,5%	21,3%	22,1%	4,7%	5,2%
5. I am ready to work in a team with people from different cultures.	64,6%	53,2%	29,9%	31,2%	2,4%	10,4%	1,6%	2,6%	1,6%	2,6%
6. I adapt quickly to unfamiliar cultural environments.	23,6%	19,5%	46,5%	46,7%	18,9%	22,1%	10,2%	11,7%	0,8%	0,0%
7. I respect cultural differences and try not to judge people by stereotypes.	60,6%	42,9%	33,9%	46,7%	3,1%	3,9%	2,4%	2,6%	0,0%	3,9%
8. I know what questions to ask to learn more about another person's culture.	22,8%	19,5%	43,3%	41,6%	25,2%	23,4%	8,7%	15,6%	0,0%	0,0%
9. I often feel empathy towards people of a different culture.	26,0%	13,0%	32,3%	46,7%	27,6%	26,0%	9,4%	13,0%	4,7%	1,3%
10. I recognize the emotions of people from other cultures.	19,7%	24,7%	43,3%	41,6%	29,9%	24,7%	5,5%	7,8%	1,6%	1,3%

Table 5
Global Cultural Awareness, Openness, and Cultural Adaptability Questionnaire Results (VR and Non-VR)

	Strongly agree		More likely to agree		Difficult to answer		Rather disagree		Strongly disagree	
	VR group	Non VR group	VR group	Non VR group	VR group	Non VR group	VR group	Non VR group	VR group	Non VR group
1. I am open to accepting new cultural experiences, even if they are unfamiliar to me.	47,2%	45,4%	47,2%	42,9%	0,8%	7,8%	0,8%	3,9%	3,9%	0,0%
2. I can easily adapt my communication style and behaviour to better interact with people from different cultures.	37,8%	27,3%	48,0%	51,9%	10,2%	18,2%	3,9%	1,3%	0,0%	1,3%
3. I am willing to learn and accept cultural practices and traditions different from my own.	26,0%	28,6%	46,5%	39,0%	20,5%	22,1%	7,1%	9,1%	0,0%	1,3%
4. I easily navigate and adapt to new cultural environments.	22,8%	23,4%	44,9%	41,6%	29,1%	20,8%	3,1%	14,3%	0,0%	0,0%

5. I am open to accepting new ideas and practices from other cultural traditions.	38,6%	31,2%	38,6%	50,6%	13,4%	13,0%	9,4%	5,2%	0,0%	0,0%
6. I believe that learning about different cultural perspectives is important.	55,9%	48,1%	33,9%	36,4%	10,2%	9,1%	0,0%	3,9%	0,0%	2,6%
7. I actively seek opportunities to broaden my understanding of different cultures.	22,0%	16,9%	38,6%	33,8%	29,9%	20,8%	8,7%	24,7%	0,8%	3,9%
8. I am aware of cultural practices and traditions from around the world.	18,1%	11,7%	54,3%	55,8%	18,1%	18,2%	9,4%	14,3%	0,0%	0,0%
9. I am aware of the importance of recognizing and respecting cultural differences globally.	56,7%	50,6%	22,0%	36,4%	14,2%	7,8%	7,1%	3,9%	0,0%	1,3%
10. I try to keep up with cultural events and changes in the world.	31,5%	27,3%	41,7%	29,9%	17,3%	18,2%	9,4%	16,9%	0,0%	7,8%

Another correlation analysis was conducted to explore the potential relationships and dependencies between the two key aspects of cultural understanding in Questionnaire 1 and 2 within the VR group. The calculated Pearson correlation coefficient was approximately 0.39, which points to a moderate positive correlation and indicates a connection between participants' cultural intelligence and their awareness of global cultural aspects. The statistical significance of this correlation was validated by a significance test ($\alpha = 0.05$), which value showed that the correlation was deemed statistically significant.

The aim of our next step was to identify any significant differences due to virtual reality exposure. To reveal this we conducted independent samples t-tests and compared the mean scores from Questionnaire 1 and Questionnaire 2 between the VR and non-VR groups. These detailed findings can be found in Table 6.

Table 6

Independent samples t-tests results

Questionnaire 1	Questionnaire 2
$t_1 = 3.4673$	$t_2 = 2.3562$
p-value = 0.0006423	p-value = 0.01942
$df_1 = 148.44$	$df_2 = 143.74$
Effect size (Cohen's d) = 0.49472131	Effect size (Cohen's d) = 0.33450732

The t-tests indicated significant differences and showed a moderate effect size (Cohen's $d \approx 0.49$) for Questionnaire 1 and a smaller effect size (Cohen's $d \approx 0.33$) for Questionnaire 2. These findings suggest that VR exposure meaningfully impacted cultural intelligence and global cultural aspects scores.

The other part of our study was devoted to the analysis of two open-ended questions about virtual reality experience:

1. How has virtual reality helped you understand different cultures? Does it have advantages over traditional methods (such as reading, watching videos or attending lectures) in understanding and appreciating different cultures?

2. How has virtual reality affected your openness and tolerance of other cultures?

The participants of the VR group expressed different ideas but mostly appreciated the immersive experience and felt that it provided a unique and detailed understanding of cultural aspects.

Nevertheless, some participants mentioned that while virtual reality is beneficial, it should complement, not replace, traditional methods. A few participants also highlighted some challenges, such as dizziness or difficulty perceiving audio information, which highlighted potential limitations of VR technology.

DISCUSSION

The first key pattern of our research is a pre-test to post-test increase in mean values for both VR sessions. These results may indicate that VR immersion has the potential to improve cultural knowledge and understanding, providing support for a number of studies that advocate for VR's use in education as a more effective and motivating learning method than traditional techniques [22; 29]. The interactive nature of virtual reality and the effect of presence allowed participants to explore cultural contexts in a more engaging way, which is likely to have contributed to these significant improvements. The immersive environment offered sensory-rich simulations that promoted active learning and it helped participants assimilate and retain cultural information more effectively as it was demonstrated in some studies on innovative technologies such as simulation-based learning [13]; virtual and augmented reality [15; 16] and commercial chatbots [17].

Another finding under discussion is the wider standard deviation in post-test scores (Jerusalem=2.07, Tokyo=2.20). These values suggest that the participants had diverse responses to the immersive experience. The variability here can be attributed to several factors. Firstly, prior experience with VR technology plays a crucial role. Participants with previous VR exposure may have adapted more quickly to the immersive environment, which allowed them to focus more on the cultural content rather than the novelty of the technology. In contrast, participants who were new to virtual reality may have needed more time to adapt, which could negatively affect their learning outcomes.

Secondly, participants' individual cognitive processing styles could be different and influenced the way they interacted with the VR content. Some participants might have been visual learners and benefited from the rich visual stimuli provided by VR technology, while others might have preferred traditional learning methods, and this lead to the differences in engagement and knowledge retention. These findings challenge some theoretical assumptions [18; 19], indicating the need for further exploration or for a longer period of adaptation to VR technology for participants to fully experience the effects of VR-based learning on cultural intelligence.

Emotional responses to the VR content can be the third reason that contributed to the observed variability. The ability of virtual reality to evoke strong emotional reactions is known to improve memory retention and comprehension. If participants felt emotionally connected to the exposed VR video, they might have been engaged more deeply. But, those who experienced discomfort, such as dizziness or disorientation, might have been distracted, and this negatively impacted their performance.

Moreover, the content and context of the VR videos themselves may have influenced the wider standard deviation. The simulations of Jerusalem and Tokyo portrayed different cultural elements and levels of complexity, which might have resonated differently with participants based on their background knowledge, personal interests, and cultural familiarity. For example, participants with prior knowledge or a strong interest in the cultural aspects of Jewish culture may have found this VR experience more enriching, while those more interested in Japanese culture may have responded better to the video about Tokyo.

All in all, pre-test and post-test results clearly demonstrate the ability of virtual reality to enhance cultural education. However, they also reveal the complexity of individual responses to the immersive environment.

Data from Table 3 indicate higher mean scores in both Questionnaire 1 (39.9 vs. 37.3) and Questionnaire 2 (40.6 vs. 38.9) for the VR group compared to the non-VR group. This again advocates for virtual reality potential to enhance cognitive aspects related to cultural intelligence

and other cultural dimensions but this time in comparison with traditional non-technological methods. VR group was more deeply engaged with cultural content due to vivid and interactive experience that facilitated better understanding and retention of cultural norms, behaviors, and values. Virtual reality helped students connect with and appreciate diverse cultural perspectives more effectively than traditional methods.

Next, we need to compare dispersion values which differ a lot in the VR and non-VR group. The non-VR group exhibited a larger dispersion value which suggests they had more varied reactions to the cultural content. We suppose that traditional methods might not engage all participants equally, leading to a broader range of outcomes. Conversely, the scores of the VR group were more closely clustered around the mean, indicating a more consistent pattern of responses among the participants immersed in VR sessions. This indicates that new technological approach to cultural education may provide a more balanced and equitable learning experience. This lower variability within the VR group implies that virtual reality may allow participants from a variety of backgrounds and learning styles to achieve a similar level of cultural understanding and awareness.

A moderate positive correlation ($r = 0.39$) between the scores obtained in Questionnaire 1 and 2 indicates a meaningful relationship between these constructs. Specifically, as participants' cultural intelligence increases, so do their scores on global cultural issues. This indicates a concurrent improvement in their ability to navigate and adapt to diverse cultural environments.

The significance test ($p < 0.05$) confirms that this correlation is statistically significant and proves confidence that the observed relationship between cultural intelligence and global cultural awareness, openness, and adaptability is genuine and not due to random chance. This result enhances the credibility of our hypothesis, affirming that the association we found is meaningful and likely to hold true in broader contexts beyond our sample. It becomes evident that individuals with higher CQ scores tend to be more aware of, open to, and adaptable to diverse cultures. These people are likely to have a deeper understanding of cultural nuances and demonstrate a greater ability to appreciate and integrate into various cultural settings.

Our findings demonstrate that CQ is not an isolated trait but is connected to various global cultural aspects as previously proposed by other researchers [11; 32]. This comprehensive association highlights the multifaceted nature of cultural competence and shows that improvements in one aspect (e.g. cultural intelligence) often lead to improvements in related areas (e.g. global awareness and adaptability).

The most valuable insight from responses to the questionnaires, presented as percentages in Tables 4 and 5 is that both VR and non-VR groups displayed a high level of agreement on the importance of effective communication with people from diverse cultures. Participants from both groups acknowledged that adapting communication styles for better interaction with culturally diverse backgrounds is crucial. This consensus suggests a broad understanding and appreciation of the need for flexibility in communication to foster effective cross-cultural interactions.

Another idea expressed by the majority of participants is positive attitudes toward learning and accepting cultural customs and traditions different from their own. Both groups shared a common belief in the significance of recognizing and respecting global cultural differences. This reflects a growing appreciation of the value of intercultural competence in a globalized world and underlines a willingness to embrace cultural diversity.

However, a more nuanced difference emerged when examining the ability to adapt quickly to unfamiliar cultural environments. The VR group had a higher percentage of participants who reported feeling more capable of adapting to new cultural environments compared to the non-VR group. Additionally, the VR group showed a stronger ability to recognize the emotions of people from other cultures and a higher awareness of global cultural practices and traditions. This finding suggests that immersive VR experiences may increase participants' confidence and adaptability in unfamiliar cultural contexts and may facilitate a deeper emotional and connection with cultural content.

Our analysis of independent samples t-tests, assessing differences between the VR group and the non-VR group across Questionnaires 1 and 2, yielded important findings, revealing substantial

distinctions in scores between the two groups. The significant differences in the VR group with notably higher scores and moderate effect sizes observed in the t-tests highlight the practical advantages of virtual reality in cultural education. The degrees of freedom provided a more accurate and reliable basis for statistical inference. By considering both sample sizes, the degrees of freedom helped enhance the precision of the t-test results and ensured that the conclusions drawn from the analysis were robust and dependable. These findings suggest that virtual reality can become a valuable addition to educational strategies aimed at fostering intercultural competence.

The insights from open-ended responses enriched our understanding of participants' experiences with virtual reality. Many respondents found virtual reality to be more engaging and enjoyable than traditional methods such as reading, videos, or lectures. This qualitative feedback was backed up by quantitative data showing significant improvements in cultural intelligence scores after VR immersion. Participants noted that the virtual immersion allowed for a deeper exploration of different cultural perspectives, making learning more memorable. This enjoyment likely enhanced motivation and willingness to work with the material, contributing to the observed improvements in cultural competence. The VR visual component was seen by students as crucial in enhancing cultural understanding. This aligns with cognitive theories suggesting that visual and experiential learning can significantly enhance memory retention and comprehension compared to text-based methods. The ability to virtually "visit" different cultural settings allows learners to experience cultural nuances first-hand. The feedback also underscored a positive influence of virtual reality on participants' openness and tolerance towards various cultures. The use of VR headsets received positive feedback overall, but some participants reported feeling dizzy or uncomfortable during their VR sessions. This note shows the need for ongoing technological improvements to enhance physical comfort during VR sessions. Issues like motion sickness can affect the learning experience and may limit the duration or frequency of lessons in virtual reality settings.

As the study progressed, we rigorously evaluated the proposed hypotheses to determine how well our findings aligned with our initial expectations. Our correlation analyses confirmed this hypothesis 1, demonstrating a statistically significant positive correlation between the scores from the cultural intelligence questionnaire (Questionnaire 1) and the global cultural awareness, openness, and adaptability questionnaire (Questionnaire 2). This significant correlation suggests that participants who exhibited higher levels of cultural intelligence also scored higher in global cultural awareness and adaptability. Independent samples t-tests provided robust support for hypothesis 2 which suggested that participants undergoing VR immersion into the cultures of Jerusalem and Tokyo would achieve higher scores in cultural intelligence, global cultural awareness, openness, and cultural adaptability compared to those not exposed to 360° VR videos.

One of the primary limitations of this study was the focus on Jewish and Japanese cultural contexts, which restricts the generalizability of the findings across a broader spectrum of global cultures. While this focus helped us understand these specific cultures, it does not account for the diverse cultural experiences that could have different effects on the study's outcomes. In the future, research should aim to include a wider variety of cultural contexts, such as African, Latin American, and Southeast Asian cultures, in order to ensure that the findings are relevant to a broader array of global perspectives.

Additionally, the effectiveness of the VR experiences was influenced by technological constraints, such as visual quality issues and participant discomfort. Addressing these issues requires advancements in technology, such as better resolution displays, lighter and more comfortable headsets, and improved motion tracking to reduce discomfort and enhance the realism and immersion.

Another limitation lies in external factors which may have influenced the study results. People with prior VR experience might have found the simulations less novel and easier to use, while those without experience might have faced more difficulties, which affected their engagement and performance. Future studies should take into account this issue by categorizing participants based on their VR familiarity.

While the study design is strong, it could be improved by including more diverse methodological approaches. Longitudinal studies tracking participants over extended periods could offer deeper

insights into the long-term impact of VR on cultural education. Comparative studies directly contrasting VR-based learning with traditional educational methods (such as reading or watching traditional videos) would help to isolate the unique benefits and potential limitations of virtual reality in a more controlled manner. Collaboration across such disciplines as psychology, education and technology can enrich interdisciplinary perspectives and foster innovative research methodologies.

CONCLUSION

The implications of this research are profound for the advancement of cultural education through innovative technologies. Virtual reality is emerging as a transformative tool that can significantly enhance cultural understanding by providing learners with immersive experiences that traditional methods cannot match. Practical applications include integrating virtual reality into academic curricula to enrich students' intercultural communication skills, cultural sensitivity, and adaptability to diverse environments.

By simulating real-world cultural contexts, virtual reality enables students to engage directly with different cultural practices and perspectives, fostering a deeper and more empathetic comprehension of global diversity. This immersive approach can lead to more effective educational experiences, offering learners a chance to develop practical skills and knowledge in a simulated yet realistic environment.

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