

ORIGINAL

## The Application of Virtual Reality in Folk Dance Teaching in Shanxi

### La aplicación de la realidad virtual en la enseñanza de la danza folclórica en Shanxi

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#### ABSTRACT

**Introduction:** folk dance holds a vital place in the cultural heritage of Shanxi, reflecting deep-rooted traditions, regional diversity, and community identity. However, urbanization, changing lifestyles, and declining adolescent interest make it increasingly difficult to preserve and transmit this art form to future generations.

**Objective:** this research aims to investigate the effectiveness of virtual reality (VR) technology in enhancing the instruction and learning of Shanxi folk dance.

**Method:** a quasi-experimental design was employed involving 265 students from various educational institutions in Shanxi Province. Participants were randomly divided into two groups: the experimental group received VR-based folk-dance instruction, while the control group underwent traditional face-to-face teaching. A pre-test and post-test assessment framework evaluated dance performance, cultural knowledge retention, and learning engagement. Quantitative data were analyzed using statistical methods, including paired sample t-tests, chi-square tests, and ANOVA to compare mean differences between groups.

**Results:** the experimental group demonstrated a significant improvement in dance skill acquisition ( $M = 87,4$ ,  $SD = 5,9$ ) compared to the control group ( $p < 0,001$ ). Retention of cultural knowledge also improved more in the VR group ( $p=0,003$ ). A two-way ANOVA revealed a significant interaction between teaching method and student engagement levels ( $p=0,014$ ). Qualitative feedback indicated that VR learners experienced increased motivation, autonomy, and cultural appreciation.

**Conclusions:** VR-based instruction effectively enhances technical dance skills and fosters cultural immersion. The research recommends integrating VR tools into folk dance curricula to modernize heritage education and improve accessibility for younger generations.

**Keywords:** Virtual Reality (VR); Folk Dance Education; Shanxi Cultural Heritage; Dance Learning Systems; User Engagement.

#### RESUMEN

**Introducción:** la danza folclórica ocupa un lugar vital en el patrimonio cultural de Shanxi; refleja sus tradiciones profundamente arraigadas; la diversidad regional; y la identidad de la comunidad. Sin embargo, la urbanización, el cambio de estilos de vida y el menguante entusiasmo adolescente dificultan preservar y transmitir esta rica forma de arte a las generaciones futuras.

**Objetivo:** el estudio analiza la eficacia de la tecnología de realidad virtual (RV) para mejorar la enseñanza y el aprendizaje de la danza popular de Shanxi.

**Método:** se adoptó un diseño cuasi-experimental con 265 estudiantes de diversas instituciones educativas de la provincia de Shanxi. Los participantes se dividieron aleatoriamente en dos grupos: el grupo experimental

recibió instrucción de danza folclórica basada en RV; el grupo de control recibió enseñanza tradicional presencial. Se empleó un marco de evaluación de pre-prueba y post-prueba para medir el rendimiento en danza, la retención del conocimiento cultural y la participación en el aprendizaje. Los datos cuantitativos se analizaron mediante métodos estadísticos; incluyendo pruebas t de muestra pareada; chi-cuadrado; y ANOVA para comparar diferencias de medias entre los grupos.

**Resultados:** el grupo experimental mostró una mejoría estadísticamente significativa en la adquisición de habilidades de danza ( $M=87,4$ ;  $SD=5,9$ ) frente al grupo control ( $p<0,001$ ). La retención del conocimiento cultural también mejoró más en el grupo de RV ( $p=0,003$ ). Un ANOVA de dos vías reveló un efecto significativo de interacción entre el método de enseñanza y los niveles de compromiso estudiantil ( $p=0,014$ ). La retroalimentación cualitativa indicó mayor motivación, autonomía y apreciación cultural entre los estudiantes de RV.

**Conclusiones:** la instrucción basada en RV es efectiva para mejorar habilidades técnicas de danza y fomentar la inmersión cultural. Se recomienda integrar herramientas de RV en los programas de danza folclórica para modernizar la educación patrimonial y aumentar la accesibilidad entre las generaciones más jóvenes.

**Palabras clave:** Realidad Virtual (RV); Educación de Danza Popular; Patrimonio Cultural de Shanxi; Sistemas de Aprendizaje de Danza; Participación del Usuario.

## INTRODUCTION

Folk dance is a form of cultural expression that reflects the historical experiences, traditional practices, and social values of local communities. These dances tend to represent particular forms of cultural identity because they are always an inseparable part of many cultural heritages and are performed for commemorative ritual events, seasonal celebrations, and daily life.<sup>(1)</sup> Traditions are rooted in certain culturally defined familial and community contexts and are transmitted from one generation to the next, mostly through informal education. Folk dance is a formidable subject of culture and creative learning related to its artistic value and pedagogical approach. While folk dance, like several cultural productions, has cultural value, finding its transmission in the modern world is increasingly difficult. Modern structures have influenced younger generations of the modern world with the impact of urbanization, modern life, and digital entertainment. Live opportunities for embodied social engagement have been reduced, and exposure to cultural forms of dance is decreasing. As experienced folk dancers and teachers retire in many regions and localities, there is an increased risk of losing forms of dance in some communities.<sup>(2,3,4)</sup> Conventional folk-dance pedagogy typically relied on in-person practice, which involved imitation and observation from seasoned performers as the means to learn.<sup>(5)</sup> This type of emphasis on oral and practicing tradition typically happened in groups of students and entirely depended on the availability of qualified teachers, which could depend on the location or institution.<sup>(6,7)</sup> In addition, the needs of today's students and their preference for visual observation, participatory experiences, and self-guidance are traditionally neglected in teaching methods in folk dance, and there are no universally established materials to draw upon. The place of digital technology opens a new horizon. Virtual reality (VR) provides immersive learning environments for users that can provide realistic dance scenarios, multi-angle demonstrations, and cultural considerations embedded within the learning experience.<sup>(8,9,10)</sup>

The Identity and Sentiment-Centered Framework for Intangible Cultural Heritage (ISC-ICH) was used to examine audience identity and sentiment in four Eastern Sichuan ICH museums. It was designed to explore emotional engagement and digital issues. Results showed strong connections between cultural depth and audience identity.<sup>(11)</sup> The findings highlight the importance of cultural identity and emotional engagement, which VR-based folk-dance instruction can enhance.

A Deep Neural Network (DNN)-based classification approach was employed to improve folk dance image recognition and improve teaching strategies.<sup>(12)</sup> The model demonstrated improved accuracy, stability, and adaptability in identifying diverse dance styles and movements, even under challenging conditions such as lighting variation, perspective shifts, and noise. The findings highlight the importance of cultural identity and emotional engagement, which VR-based folk-dance instruction can enhance.

A feature vector matching method for dance posture analysis to enhance dance instruction through motion capture technology.<sup>(13)</sup> To evaluate how effectively the method enhanced learning outcomes and student engagement in educational settings. The results indicated improved teaching quality and accuracy of posture. Such findings indicate that technological tools can improve dance skill acquisition and engagement, similar to VR applications.

The research introduced a dance teaching system using data mining and Machine Learning (ML) to improve remote and local movement recognition.<sup>(14)</sup> It was designed to improve teaching effectiveness by analyzing

resources and identifying dance features. Results confirmed reliable performance and better teaching outcomes. A drawback was the system's dependence on high-quality input data for accurate identification. The research highlights the potential and limitations of advanced digital tools for enhancing dance instruction.

The mixed-methods approach to investigate how folk-dance education incorporates Intangible Cultural Heritage (ICH).<sup>(15)</sup> Its objective was to evaluate its effect on student involvement and knowledge. The findings indicated a rise in cultural pride and ICH awareness. Nevertheless, a disadvantage that limited uniform application across institutions was the need for instructor expertise. These outcomes underscore the role of educational strategies in promoting cultural awareness, which can be supported by VR-based instruction.

A descriptive-correlational method to assess students' perceptions of VR headsets in dance learning.<sup>(16)</sup> It focused on exploring the usefulness and influence of VR technology in enhancing dance performance. Results indicated significant correlations between familiarity, age, and perceived effectiveness. The findings support VR as an effective tool for enhancing dance learning and engagement.

Artificial Intelligence-based Motion Capture (AI-MoCap) in mathematical dance improved creativity in designing tasks for Science, Technology, Engineering, Art, and Mathematics (STEAM) education.<sup>(17)</sup> The outcomes showed pre-service teachers produced creative, conceptually rich tasks. The research illustrates the potential of AI and motion capture technologies to foster creativity and skill development in dance education.

A qualitative method using the SPRING online Flipped Learning (FL) model was applied to explore its impact on 21st-century skill development in college physical education.<sup>(18)</sup> The research demonstrates how innovative learning models can improve engagement and skill acquisition, supporting the integration of VR in dance education.

Research aims to explore the efficacy of VR-based instruction for Shanxi folk dance education. Hypothesize that, compared to traditional face-to-face learning, the VR intervention will lead to significantly greater improvement in dance movement accuracy, higher retention of cultural knowledge, and increased levels of student engagement, motivation, and learning autonomy.

### Research Questions

- How does VR-based instruction improve students' technical dance skills and cultural knowledge retention in Shanxi folk dance compared to traditional teaching methods?
- What is the effect of VR-based folk-dance instruction on learner engagement, motivation, and autonomy relative to conventional approaches?

Hypothesis: students receiving VR-based Shanxi folk dance instruction will demonstrate significantly higher improvements in technical dance skills and cultural knowledge retention compared to those receiving traditional face-to-face instruction.

### Research Gap

Recent research focused on digital heritage and dance instruction has examined audience identity, emotion, and engagement in creating meaning in the context of performance events.<sup>(12,13)</sup> Applied deep learning and motion capture to recognize dance and analyze postures in practices, and considered the use of machine learning and data mining to facilitate engagement and evaluate instructional approaches.<sup>(14)</sup> These methods can enhance technical precision and cultural understanding, but they often focus on a narrow aspect of dance education. The relationship between VR, skill acquisition, cultural identity, and learner engagement has been less explored as a way to integrate these issues more comprehensively. This justified the examination of VR's potential for revitalizing Shanxi folk dance instruction.

### METHOD

Quasi-experimental research was carried out in different schools in Shanxi Province, China, to compare VR-based folk-dance instruction to traditional pedagogy. The sample consisted of 265 students, who were recruited using stratified random sampling. The inclusion criteria were students enrolled in a dance program and students who had never participated in VRT before. The exclusion criteria were students with physical restrictions, and students withdrew from the research. Main variables were dance performance, retention of cultural knowledge, and engagement in learning; Secondary variables were motivation, autonomy, and appreciation of culture. Dance performance was measured using a validated rubric, cultural knowledge was measured using a piloted questionnaire (Cronbach's  $\alpha=0.87$ ), and user engagement was measured using UES. VR education with multi-angle demonstrations, guided practice sessions, and activities, while the control group received traditional, in-person interactive instruction. Pre- and post-tests provided quantitative data that was analyzed with paired t-tests, chi-square, and two-way ANOVA with effect sizes reported ( $\eta^2$ ), and feedback was qualitatively analyzed by themes. Figure 1 illustrates the methodology flow.

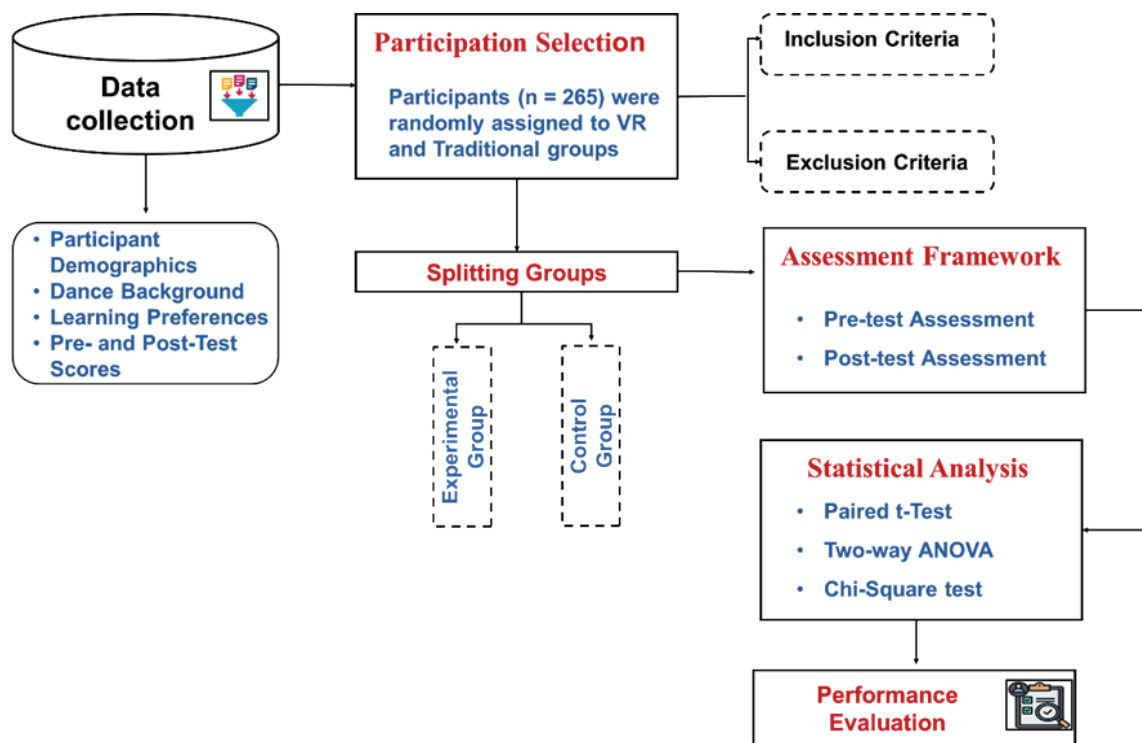


Figure 1. Research Methodology Framework of the Dance Instruction Study

### Data Collection

Data were collected from a total of 265 students who were randomly allocated to two groups: an experimental group ( $n = 132$ ) that received VR-based folk-dance instruction and a control group ( $n = 133$ ) that received traditional face-to-face instruction. A pre-test and post-test design for the research was used to analyze dance performance, cultural knowledge retention, and student engagement. All scoring was based on standardized rubrics and assessment criteria to reduce scoring subjectivity and variability. Qualitative data to supplement the statistical findings were collected through structured student reflections to analyze individual student learning, motivation, and attitudes toward the instructional approach. A mixed-method evaluation approach allowed for a full evaluation regarding the efficacy of VR in folk dance education.

### Inclusion Criteria

- Students aged 18 years or above enrolled in formal dance or related programs.
- Willingness to participate in both pre- and post-assessments.
- Basic familiarity with using digital devices.
- Availability throughout the study period.

### Exclusion Criteria

- Participants with diagnosed motion sickness or visual impairments affecting VR use.
- Students with prior specialized training in Shanxi folk dance.
- Individuals who failed to complete pre- or post-tests.
- Withdrawal of consent at any stage of the study.

### Splitting Groups

To assess the efficacy of traditional folk-dance training with VR-based teaching, participants were divided into two distinct categories at random. Stratified sampling was used to ensure that demographic parameters were distributed evenly.

### Group 1 (Experimental Group - VR-based learning, $n = 133$ ):

The VR instruction was implemented using a Meta Quest 2 VR headset with standard controllers and built-in motion tracking, which was adapted for use in the Folk-dance class. A white-label VR application was developed that provided immersive demonstrations of Shanxi folk-dance movement in 3D avatars, which allowed students to watch performances from multiple perspectives, slow down, and loop sequences to practice at their own pace. Participatory cultural inquiry was included in the VR instruction through interactive 3D models of artifacts and embedded pop-up informational texts in the VR experience. Participants engaged in ten sessions of 45

minutes with the instructor present to facilitate guided practice and provide feedback. While the instructor observed the students' performance in the VR experience, they practiced individually.

*Group 2 (Control Group - Traditional instruction, n = 132):*

The traditional, face-to-face delivery model incorporated partner work, instructor modeling, and group practice. The same instructor delivered every session to eliminate teacher bias for both conditions. Each session lasted approximately 45 minutes and included 15 minutes of modeling, 25 minutes of practice, and 5 minutes of feedback.

*Student Engagement Measurement:*

Engagement was evaluated with the validated Utrecht Work Engagement Scale-Student version (UWES-S), which measures vigor, dedication, and absorption towards learning activities. The reliability in the sample was Cronbach's  $\alpha = 0,89$ .

**Statistical Analysis**

It was performed using IBM SPSS version 26.0 to assess the effects of VR-based folk-dance instruction on various learning outcomes. All analyses were performed at the levels of significance of  $p < 0.05$  level, and effect sizes were also calculated to indicate the sizes of differences.

**Paired Sample t-Test:** the researchers conducted separate paired t-tests for each group (VR and traditional) to evaluate within-group improvements in dance performance, cultural knowledge retention, and learner engagement from pre-test to post-test. These t-tests helped the researchers determine if participants had improved significantly after the instructional intervention. For example, dance performance scores analyzed how much skill had been acquired, and cultural knowledge and engagement scores measured cognitive understanding and motivation as an outcome of instruction. Cohen's  $d$  was calculated to evaluate the size or magnitude of the change.

**Independent Samples t-Test:** the independent samples t-test compared post-test scores of dance technique, rhythm and timing, movement accuracy, cultural knowledge retention, engagement, motivation, and learning autonomy between VR and control groups, controlling for pre-test differences. This analysis determined whether VR-based instruction produced greater improvement than traditional methods. Cohen's  $d$  was reported for each variable to evaluate the magnitude of instructional effects.

**Two-Way ANOVA:** the two-way ANOVA examined the main and interaction effects of instructional type (VR vs. traditional) and student engagement level (high, moderate, low) on learning outcomes. It assessed whether VR's impact varied according to engagement levels, thereby indicating potential moderation. Partial eta-squared ( $\eta^2$ ) was calculated for each variable, providing a measure of both practical significance and effect strength.

**Chi-Square Test:** chi-square tests were implemented to examine categorical outcomes, such as students' involvement, satisfaction, and engagement with the culture, between students in the VR and traditional experiences. This explored the potential for instruction mode to affect qualitative facets of learning—attending to group interaction, perspectives on cultural aspects, and willingness to learn with technology.

**Assumptions:** parametric assumptions were verified for all relevant tests. Normality of continuous variables was confirmed using Shapiro-Wilk tests, and homogeneity of variance was confirmed with Levene's test. It allowed for a full assessment of VR-based instruction, examining quantitative improvements in performance and engagement and qualitative differences in participation and cultural appreciation, illustrating the educational impact of immersive technology in folkloric-dance instruction.

**RESULTS**

VR-based folk-dance instruction significantly improved students' dance performance, cultural knowledge, and engagement compared to traditional teaching. Higher engagement levels further enhanced the effectiveness of VR learning, demonstrating its potential for immersive cultural education. These tests were chosen to reflect the research aim of assessing the effectiveness of VR to enhance folk dance performance, cultural knowledge retention, and learner engagement with the conventional teaching approaches. Table 1 and figure 2 show the demographic outline of participants.

**Table 1. Demographic Characteristics of the Participants (N = 265)**

Variable	Category	Frequency (n)	Percentage (%)
Group	Experimental (VR-based)	133	50,2 %
	Control (Traditional)	132	49,8 %
Gender	Male	126	47,5 %
	Female	139	52,5 %



Age	18-20 years	102	38,5 %
	21-23 years	117	44,2 %
	24 years and above	46	17,3 %
Educational Level	Undergraduate	183	69,1 %
	Diploma	54	20,4 %
	Postgraduate	28	10,6 %
Prior Dance Experience	Yes	92	34,7 %
	No	173	65,3 %
Weekly Practice Time	<1 hour	94	35,5 %
	1-2 hours	108	40,8 %
	>2 hours	63	23,8 %
Urban/Rural Background	Urban	157	59,2 %
	Rural	108	40,8 %
Technology Familiarity Level	High	96	36,2 %
	Moderate	118	44,5 %
	Low	51	19,2 %
Cultural Knowledge Pre-test	Above average (>75 %)	74	27,9 %
	Average (50-75 %)	129	48,7 %
	Below average (<50 %)	62	23,4 %
Learning Engagement Level	High	101	38,1 %
	Moderate	117	44,2 %
	Low	47	17,7 %

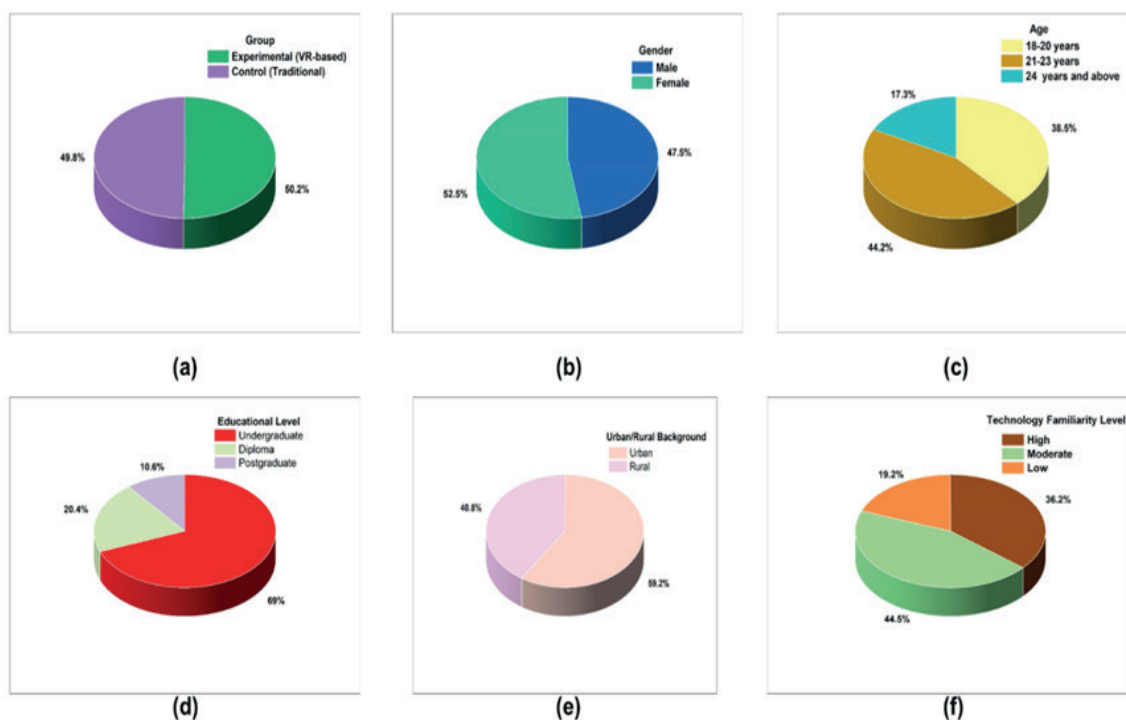


Figure 2. Demographic Characteristics of the Participants

(a) Group Distribution (b) Gender (c) Age Group (d) Educational Level (e) Urban/Rural Background (f) Technology Familiarity Level

Table 2 reports the results of paired sample t-tests used to evaluate the effectiveness of VR-based instruction in Shanxi folk dance education. Of the seven variables assessed, the experimental group exposed to VR-integrated instruction exhibited larger increases than the baseline standard teaching group, with activity level not yet reaching statistical evidence for improvement  $<0,001^{**}$ . The dance technique scores for the experimental group's mean difference (MD) score of 16,1 contrasted with a control group's MD of 7,3. This comparison shows

a significant improvement in dance technique scores from students given VR instruction. Additionally, the VR group's MD for rhythm and timing (94,6 - 80,2 = 14,4) and movement accuracy (84,1 - 70,3 = 13,8) were larger than the control group, which suggests that these VR students executed movements more accurately and their coordination increased from the use of VR. Evidence of VR's effectiveness to increase cultural knowledge makes this improvement in cultural knowledge retention noteworthy, as the VR-based group's (MD; 72,0 - 57,6 = 14,4 cultural knowledge gain was more than double the control gain of 6.8. Under the VR condition, affective characteristics like learning autonomy (MD = 15,8), motivation (MD = 15,8), and engagement (MD = 15,3) were also significantly enhanced. The statistical robustness of these results is further supported by the high t-values, which range from 15,37 to 18,25.

### Bottom of Form

**Table 2.** Paired t-Test Results for Pre- and Post-Test Scores in Experimental (VR) and Control (Traditional) Groups

Variable	Groups	Pre-test M (SD)	Post-test M (SD)	Mean Diff. (MD)	SD of Diff. (SDD)	t-value	p-value
Dance Technique Score	Experimental (VR)	71,3 (6,2)	87,4 (5,9)	16,1	4,3	18,25	<0,001 **
	Control (Traditional)	70,9 (5,8)	78,2 (6,1)	7,3	4,9	10,67	
Rhythm and Timing	Experimental (VR)	69,8 (6,5)	84,2 (5,7)	14,4	4,6	17,21	8,53
	Control (Traditional)	70,1 (6,1)	76,3 (6,0)	6,2	5,0	8,53	
Movement Accuracy	Experimental (VR)	68,5 (7,1)	82,3 (6,4)	13,8	5,4	15,37	7,92
	Control (Traditional)	67,9 (6,6)	74,8 (6,7)	6,9	5,6	7,92	
Cultural Knowledge Ret.	Experimental (VR)	68,7 (7,0)	83,1 (6,4)	14,4	5,1	16,42	7,58
	Control (Traditional)	68,1 (6,7)	74,5 (6,8)	6,4	5,3	7,58	
Engagement Level	Experimental (VR)	65,2 (6,4)	80,5 (6,0)	15,3	4,8	17,89	6,94
	Control (Traditional)	65,0 (6,3)	70,7 (6,5)	5,7	5,5	6,94	
Motivation	Experimental (VR)	66,8 (6,7)	82,6 (6,2)	15,8	4,9	18,12	6,47
	Control (Traditional)	66,5 (6,6)	72,1 (6,9)	5,6	5,2	6,47	
Learning Autonomy	Experimental (VR)	67,5 (6,8)	83,3 (6,1)	15,8	5,0	17,04	6,79
	Control (Traditional)	67,1 (6,5)	72,9 (6,6)	5,8	5,3	6,79	

Notes: p< 0,01 \*\* Very significant.

Table 3 presents paired sample t-test results for both experimental (VR) and control (traditional) groups, showing pre- and post-test differences across seven learning variables. The VR group consistently outperformed the traditional group in dance technique, rhythm and timing, and movement accuracy, with mean differences exceeding 13 points and highly significant t-values (all p< 0,001 \*\*). Cultural knowledge retention also improved more in the VR group (MD = 14,4) than in the control group (MD = 6,4), supporting VR's cultural learning benefits. Furthermore, affective outcomes, engagement, motivation, and autonomy showed nearly triple the improvement in the VR group. The use of two-way ANOVA further confirmed that higher student engagement amplified the effectiveness of VR instruction.

**Table 3.** Two-Way ANOVA Results for the Effects of Teaching Method and Engagement Level on Learning Outcomes in Shanxi Folk Dance Instruction

Source of Variation	SS	df	MS	F	p-value
Teaching Method (VR vs. Traditional)	1243,2	1	1243,2	32,84	<0,001***
Engagement Level (High vs. Low)	875,6	1	875,6	23,12	<0,001 ***
Teaching Method × Engagement Level	412,7	1	412,7	6,16	0,014 *
Error (Within Groups)	9543,8	252	37,9		
Total	12075,3	255			

Table 4 presents chi-square test outcomes comparing behavioral and attitudinal responses between the VR and traditional instruction groups. In terms of class participation, 101 VR students were active compared to only 67 in the traditional group, yielding a significant result ( $\chi^2 = 14,23$ , p< 0,001). Visual-spatial recall was rated as good by 97 VR participants versus 64 in the control group ( $\chi^2 = 12,87$ , p< 0,001), (104 satisfied) than in the traditional group (70 satisfied), with  $\chi^2 = 17,34$ , p< 0,001. For collaboration willingness, 95 VR learners showed high willingness compared to 60 traditional learners ( $\chi^2 = 13,02$ , p< 0,001). Technology acceptance was

significantly stronger in the VR group (100 accept vs. 33 resist) than in the traditional group (58 accept vs. 68 resist), with the highest  $\chi^2 = 20,15$ ,  $p < 0,001$ . emotional engagement was higher among VR learners ( $\chi^2 = 10,96$ ,  $p = 0,001$ ), suggesting a deeper emotional connection. Finally, cultural interest growth was reported by 99 VR learners, while only 61 in the control group showed similar improvement ( $\chi^2 = 15,22$ ,  $p < 0,001$ ). These results indicate that VR instruction significantly enhances participation, cognitive engagement, emotional connection, and cultural interest compared to traditional teaching. This supports the study's objective of integrating technology to promote more meaningful and immersive folk dance education experiences.

**Table 4.** Chi-Square Test Results Comparing Behavioral and Attitudinal Outcomes between VR and Traditional Instruction Groups

Variable	Category	VR Group (n)	Traditional Group (n)	$\chi^2$	df	p-value
Class Participation	Active / Passive	101 / 32	67 / 59	14,23	1	<0,001 ***
Visual-Spatial Recall	Good / Poor	97 / 36	64 / 62	12,87	1	<0,001 ***
Instruction Satisfaction	Satisfied / Unsatisfied	104 / 29	70 / 56	17,34	1	<0,001 ***
Collaboration Willingness	High / Low	95 / 38	60 / 66	13,02	1	<0,001 ***
Technology Acceptance	Accept / Resist	100 / 33	58 / 68	20,15	1	<0,001 ***
Emotional Engagement	High / Low	93 / 40	63 / 63	10,96	1	0,001 **
Cultural Interest Growth	Increased / Not Increased	99 / 34	61 / 65	15,22	1	<0,001 ***

## DISCUSSION

The effectiveness of VR-based instruction for Shanxi folk-dance education as compared to traditional teaching methods was examined. The findings show that VR instruction produced significantly larger improvements in dance performance, cultural knowledge recall, and engagement in learning. The VR students displayed a greater sense of motivation and autonomy, and our two-way ANOVA results indicated that engagement also moderated learning outcomes, as students who were highly engaged in learning were more affected by VR immersivity during the dancing instruction. The use of VR significantly enhanced all measured variables. Students in the VR group demonstrated improved dance technique, rhythm, and movement accuracy. VR also boosted cultural knowledge retention, motivation, engagement, and learning autonomy by providing immersive, interactive experiences. These factors collectively fostered deeper understanding and greater enthusiasm for folk dance. The control group's comparatively small improvements, on the contrary, show how inadequate traditional training is at producing comparable multidimensional growth. All things considered, the results support the educational benefit of using VR in folk dance instruction and point to its great potential for wider use in teaching cultural heritage.

### Interpretation of Findings:

The VR is providing an interactive, multi-sensory learning environment that not only helps the user acquire technical skills but also helps them understand the cultural contexts of the skills.<sup>(11)</sup> Unlike previous efforts, such as the ISC-ICH framework or feature vector motion capture.<sup>(13)</sup> that were limited to event-dependence or domain-specific skills, the intervention provided real-time feedback, multi-angle demonstrations, and adaptable practice opportunities. These benefits have contributed to the positive effects on the technical skills, technical movement errors, and cultural aspects, as the intervention supported self-paced learning, factoring in immediate correction of movements, and cultural contextualization during the interactive learning. The results contribute to previous studies that suggested the importance of immersive and participatory learning in cultural learning/education.<sup>(15,16,17)</sup> The current research illustrated that technology can be a vehicle to help overcome significant barriers that exist in traditional pedagogies.

### Implications:

The findings have valuable implications for educators, practitioners in cultural preservation, and researchers in the field. The use of VR to teach folk dancing can establish a model for scalable instruction of traditional arts practice, thus making cultural heritage more accessible for learners at large. VR can be a way to bring contemporary approaches to heritage education while maintaining traditional modes of practice through structured, self-directed, and more engaging learning opportunities. Institutions can consider these findings to integrate immersive technology into courses, the outcomes of which could enhance cultural pedagogy in a variety of educational settings.

### Limitations:

There are several limitations that should be recognized. The participants in this research were formally



enrolled dance students, limiting applicability to informal dancers and the public at large. Outcomes were assessed immediately after the intervention, not accounting for long-term retention of dance skills and cultural content knowledge. The virtual reality hardware represents a substantial monetary investment, which could impede acquisition in less well-resourced settings. Furthermore, the same instructor taught both groups, as a means to control for instructor bias, but future studies include multiple instructors to support findings and moderate potential bias from the instructor.

There is improvement in student relatedness, learning outcomes, and interest in, and appreciation of, the culture being portrayed in conventional folk dances with immersion in a VR environment in the folk-dance curriculum. Future research should monitor long-term retention of cultural knowledge, explore lower-cost or mobile VR options, and examine scalability in different educational scenarios. These areas will contribute to ensuring immersive technology continues to foster the preservation and dissemination of cultural heritage, help to expand access to traditional arts to a wider audience, and foster engagement in the traditional folk-dance curriculum.

## CONCLUSION

Virtual reality (VR) is a powerful tool for the instructional process of Shanxi folk dance. Compared to traditional pedagogical approaches, VR improved the acquisition of technical skills, retention of cultural knowledge, and increased student engagement. By offering an experiential, interactive, and sequential instructional environment, VR enabled students to practice independently and engage meaningfully in a cultural experience that addressed limitations of classroom instruction. The results of the research demonstrate how VR has the potential to modernize folk-dance education and support cultural heritage preservation. Although this research examined a regional form of dance and implemented a short-term intervention, this method serves as a scalable model that can be adapted to various educational settings. Future research should address long-term retention, other cultural applications, or relatively inexpensive or mobile VR systems to increase access and impact.

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The authors declare that there is no conflict of interest.

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