SCIENTIFIC CULTURE
www.sci-cult.com

SCIENTIFIC CULTURE, Vol. 12, No. 3, (2026), pp. 1-17
Open Access. Online & Print

DOI: 10.5281/zenodo. 18644160

# BRIDGING VIRTUAL REALITY AND CULTURAL HERITAGE EDUCATION: A MULTIMODAL APPROACH FOR ENHANCING COGNITIVE OUTCOMES IN VISUAL COMMUNICATION DESIGN

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*Received: 15/12/2026*
*Accepted: 02/02/206*

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## ABSTRACT

***The evolution of art and design education is intricately intertwined with societal advancement, as digital teaching methodologies reshape pedagogical paradigms. While emerging technologies have garnered significant attention in educational contexts, research on virtual reality (VR)-based intangible cultural heritage (ICH) instruction within design curricula remains underexplored, underscoring the necessity for innovative approaches. This study investigates the effective integration of VR into traditional culture education for art and design students. A curriculum framework was devised to incorporate ICH into professional courses, thereby enhancing design education while promoting cultural preservation. A total of 100 Visual Communication Design (VCD) students participated in this study, utilizing a self-developed VR Chinese Intangible Cultural Heritage (CICH) program embedded in coursework that encompassed theoretical instruction, collaborative learning, self-directed study, hands-on practice, and assessment. A mixed-methods approach was employed, combining quantitative analysis of performance changes with semi-structured interviews to capture subjective experiences. The findings indicate that a VR-based multimodal interactive framework significantly enhances students' CICH knowledge while optimizing learning through dynamic cognitive load regulation. Furthermore, the study validates VR's effectiveness in contextualized learning and cross-media knowledge transfer, offering an efficient technological pathway for the dissemination of digital cultural heritage. By encouraging a shift beyond theoretical constraints, this research provides valuable insights into reforming art education, fostering a deeper alignment with societal needs.***

**KEYWORDS:** Virtual Reality, Intangible Cultural Heritage, Immersive Learning Experience, Visual Communication Design, Educational Technology.

# 1. INTRODUCTION

## 1.1. Research background

Openness, inclusivity, and a commitment to innovation and reform are the three fundamental principles guiding design (Zhou, 2009). Design outcomes not only embody humanistic values but also serve as indicators of societal progress and development. Design can be regarded as a cultural window into a nation, an era, and its people (Li, 2020). Therefore, the essence of design lies in its cultural connotations. Design must harmonize with modernization trends while preserving the rich heritage of traditional culture spanning millennia. As an interdisciplinary field, VCD plays a pivotal role in nurturing innovative, cross-disciplinary, and applied talents. It also serves as a catalyst for the advancement and transformation of intelligent information technologies (Zhou & Duan, 2020). In recent years, the preservation efforts for CICH have entered a phase of deep integration (Ma & Zhang, 2022). The Chinese government has actively promoted the scientific incorporation of ICH knowledge into curricula at various educational levels, tailored to their respective contexts. By 2022, several Chinese universities had introduced ICH-related courses, signaling a transition from integrating ICH within existing programs to establishing it as an independent academic discipline. This development reflects China's advancement towards a more open and systematic academic ecosystem for ICH education (Guo & Zhang, 2024).

As a living cultural heritage, ICH carries the wisdom and creativity of human civilization, making its preservation and transmission vital to sustaining cultural continuity (Jagielska-Burduk et al., 2021). However, ICH transmission faces challenges—the number of traditional artisans is declining, younger generations face various constraints in inheritance, and modernization has further deteriorated the transmission environment. In this context, accelerating CICH dissemination and fostering cultural identity among younger generations has become an urgent task (Kong, 2019). VCD students are potential key players in the cultural and creative industries. Enhancing their understanding of ICH not only enriches the diversity of their design outputs but also contributes to the innovative pathways for cultural heritage preservation and transmission.

Although the preservation of intangible cultural heritage (ICH) has become the focus of increasing scholarly and policy attention, limited research on how a virtual reality (VR) could be incorporated successfully into design education to facilitate cultural knowledge transmission was located. The existing methods usually revolve around documentation and presentation without pedagogical concepts relating immersive technology to the cognitive and creative demands of design students. As a reaction to this gap, the current research paper explores the use of VR in the curriculum of Visual Communication Design (VCD) to boost the knowledge that students are learning about Chinese Intangible Cultural Heritage (CICH). The present study can bring the field of art and design pedagogy into a new stage by formulating and empirically validating a multimodal and project-based VR learning model and providing a viable prototype of a digital heritage education that combines technological innovation with cultural sustainability.

# 2. REVIEW AND DISCUSSION

## 2.1. Thematic Dissemination and Technological Development

Design education is continuously advancing, as traditional teaching methodologies and skill-based instruction alone are insufficient to address the increasing demand for digital and virtual solutions. The preservation of ICH is a global initiative that engages governments, public institutions, non-governmental organizations, and local communities (Jagielska-Burduk et al., 2021).

Sol Rogers, CEO of REWIND, a London-based company specializing in AR and VR solutions, examined this topic in his 2019 Forbes article titled "Meaningful Meetups: Is VR the Future of Social Connection?" He emphasized how VR facilitates more profound levels of interaction and shared experiences, enabling individuals to connect with friends globally and participate in activities that would otherwise be unfeasible in the physical world (Rogers, 2019). Rogers also noted that major technology companies, such as Facebook, have begun integrating VR into social platforms, stimulating discussions on its wider applications. As VR technology continues to evolve, its potential for enhancing social engagement and preserving cultural heritage is becoming increasingly apparent, presenting new opportunities for education and ICH protection in the digital age.

## 2.2. The Need for Disciplinary Development

Compared to other fields, design education research has lagged behind (Cash, 2018). To stay relevant, curriculum development must take a multifaceted approach, keeping pace with rapid advancements in science, technology, and art while addressing the evolving demands of knowledge dissemination.

Ulita and Hananto (2022) emphasized that aligning humanities education with industry needs and job market expectations significantly accelerates students' workplace adaptation. Graduates who receive such training are better positioned for career advancement. Numerous case studies reinforce the idea that forward-thinking and well-structured curricula (Ren, 2019) are key to developing highly skilled design professionals, equipping them with the knowledge and adaptability needed for a competitive job market (Zhou & Duan, 2020). This raises an important question: How can VR technology be effectively integrated into design education to enhance theoretical learning, boost student engagement, and foster self-directed learning?

Historically, visual representation has played a critical role in communication. The London Underground map, designed by Harry Beck, is a prime example of how graphic design improves everyday life (Guo & Wang, 2016). From a socio-semiotic perspective, historical representations hold significant meaning (Aiello & Van Leeuwen, 2023). However, vocational education in design faces three major challenges:

1. Slow theoretical updates regarding technology and practice;
2. Limited research methodologies;
3. Insufficient interdisciplinary collaboration (Wang, 2019)
4. Addressing these challenges is essential for advancing design education.

### 2.3. Market Transformations and Social Needs

The rapidly evolving market landscape has underscored the necessity for design education to transcend technical skills, placing greater emphasis on historical and cultural literacy. Leveraging VR technology as a gateway, this study investigates how integrating ICH into design education can foster innovation in both domains. Given that urbanization and globalization increasingly threaten the survival of ICH, preservation and transmission have become urgent priorities. ICH is shaped by cultural, geographical, historical, physical, and socio-economic factors (Fukuda et al., 2021), and its sustainability depends on keeping it relevant and accessible. CICH projects follow a tiered classification system, with thousands of cultural items under protection. However, many regions are facing the risk of cultural extinction due to a declining number of inheritors and excessive commercialization (Tan & He, 2021). Since the implementation of China's 13th Five-Year Cultural Plan in 2017, the government has systematically recorded, archived, and digitized ICH projects nationwide. However, it has become increasingly clear that documentation alone is not enough to preserve endangered cultural traditions. Many ICH practitioners face low education levels, financial instability, and aging populations, further complicating transmission efforts.

China is exploring innovative approaches to ICH preservation and transmission in alignment with UNESCO's framework, as part of the 14th Five-Year Cultural Development Plan. Current research on ICH primarily focuses on four key areas (Guo & Zhang, 2023):

- Developing a systematic and scientific classification mechanism to enhance preservation efforts;
- Investigating the relationship between ICH protection and regional cultural identity;
- Refining the approval and recognition process for ICH projects;
- Encouraging interdisciplinary collaboration to strengthen ICH-focused academic programs.

Since VCD curricula are designed in response to societal needs, they are inherently connected to contemporary production tools, acting as a medium for designers' values and objectives. VR technology offers three key attributes—imagination, interactivity, and immersion—that make it highly applicable to ICH education. Dewey (1916) emphasized the importance of learning through real-world experiences, arguing that active participation enhances educational outcomes. However, the regional specificity of CICH creates barriers to cross-regional learning. The development of VR technology has undergone multiple phases, dating back to Ivan Sutherland's 1965 paper, which described a computer-generated 3D immersive environment (Sutherland, 1965). Over time, VR has found applications in military training, gaming, and commercial industries, and has also proven effective for cognitive function assessment, particularly in attention, memory, and executive function evaluation (Ventura et al., 2019). A recent systematic review and meta-analysis by Jiawei & Mokmin (2023) examined VR applications in art education, particularly in VCD programs. Their findings suggest that VR enhances artistic creativity, learning outcomes, and students' technical and creative skills. Case studies further demonstrate that VR-based teaching methods successfully integrate traditional education with digital technology, leading to a novel educational model (Du, 2021).

Education, at its core, is fundamentally concerned with the transmission of knowledge. The integration of technology into educational settings should be assessed within a well-defined educational framework to ensure that VR applications are aligned with curriculum objectives. This study seeks to explore the optimal application of VR in ICH education, thereby maximizing its potential for both knowledge dissemination and cultural preservation.

## 3. THEORETICAL FRAMEWORK

This study integrates Social Constructivism and Project-Based Learning (PBL) to develop a framework for incorporating VR technology into CICH education. Social constructivism posits that knowledge is dynamically constructed through social interaction and situated learning (Vygotsky & Cole, 1978), with a primary emphasis on cultural tool mediation and the Zone of Proximal Development (ZPD). Within a VR environment, learners engage in multimodal interactions, such as virtual tool manipulation and collaborative tasks, thereby transforming abstract cultural symbols into embodied cognitive experiences. This process resonates with the concept of Legitimate Peripheral Participation (Lave & Wenger, 1991), where learners progressively internalize cultural norms within a virtual community of practice.

The PBL framework significantly enhances learning motivation and knowledge transfer by engaging students in authentic problem-solving activities and project-based outcomes (Chernobilsky et al., 2004). In the context of CICH education, PBL is exemplified through heritage preservation tasks that necessitate learners to collaborate within immersive VR environments to design, create, and critically reflect on their work. Research has shown that scaffolding strategies, such as stepwise task breakdown, can effectively reduce cognitive load during complex cultural knowledge acquisition (Balanescu, 2015), while immersive VR scenarios promote situated learning experiences.

By integrating these two perspectives, this study develops a "Context-Practice-Collaboration" three-dimensional framework. In the Context dimension, VR reconstructs cultural heritage settings, enabling learners to experience historical and social contexts through immersive environments. This approach aligns with the principles of Learning by Doing (Donnelly, 2010). In the Practice dimension, PBL guides learners to engage in design, experimentation, and iterative refinement within VR environments, promoting cognitive iteration (Barab & Squire, 2004). In the Collaboration dimension, Social Constructivism underscores the importance of community in knowledge construction. VR facilitates distributed collaboration, allowing learners to transition from passive consumers of culture to active creators, thereby fostering the transmission of living heritage.

### *3.1. Foundations of the Study*

#### *3.1.1. Research Questions*

This study aims to investigate the efficacy of the VR-CICH teaching approach in enhancing CICH knowledge levels among VCD students and to identify the contributing factors that facilitate this improvement. The research objectives are to answer the following questions:

- RQ1: How can the VR approach be effectively implemented to enhance CICH knowledge among VCD students?
- RQ2: What is the usability of the VR approach in this educational context?
- RQ3: Is there a statistically significant improvement in VCD students' CICH knowledge levels before and after the implementation of the VR approach?

#### *3.1.2. Research Hypotheses*

- Ho1: There is no significant difference in VCD students' intention to use VR for learning CICH before and after the implementation of VR-based teaching.
- Ho2: There is no significant difference in VCD students' learning motivation for CICH before and after the implementation of VR-based teaching.
- Ho3: There is no significant impact of VR-based teaching on VCD students' CICH knowledge levels before and after implementation.

#### *3.1.3. Research Significance*

1. **Exploring the innovative application of VR in CICH education** This study systematically investigates the potential role of VR in the construction of CICH knowledge among VCD students, highlighting its distinctive advantages as an educational tool for addressing gaps in ICH cognition and practice. Consequently, this approach aims to overcome the limitations inherent in traditional teaching methods.
2. **Developing a customized VR learning**

**framework** By designing and implementing immersive, scenario-based VR learning modules, this study proposes an innovative methodology for integrating VR learning experiences into VCD curricula. The research seeks to establish a comprehensive digital education framework that effectively bridges theoretical knowledge with practical application, thereby enhancing cross-media interpretation and creative transformation in the context of CICH.

3. **Evaluating the effectiveness of VR in deepening heritage understanding** This study employs a mixed-methods approach to critically evaluate the impact of VR on the internalization of CICH knowledge, cultural identity formation, and creative practices. By offering robust empirical evidence and theoretical insights, this research not only enhances our understanding of immersive learning strategies in heritage education but also fosters interdisciplinary innovation at the intersection of educational technology and cultural heritage studies.

### *3.2. VR Technology Program Design Framework*

#### *3.2.1. Participants and Measurement*

The study was conducted at a public vocational university in China, where a learning motivation survey was administered to 126 VCD students. To ensure adherence to ethical standards and maintain data integrity, all participants received a comprehensive explanation of the study's objectives, procedures, and confidentiality measures before participating in the questionnaire and interviews. Participants were explicitly informed that their personal information would be kept strictly confidential and that all collected data would be used exclusively for educational research purposes. Following data screening, 100 valid responses were retained, excluding cases that exhibited clear inattentiveness. The exclusion criteria comprised: 1) responses completed in less time than the minimum threshold established via a pilot study, and 2) response patterns suggestive of highly repetitive or mechanical answering. The final dataset achieved a valid response rate of 79.3%, thereby establishing a robust foundation for subsequent analysis.

This study examined cognitive transformations in learners engaged in VR-based instruction, utilizing a purposeful stratified sampling approach to align with the program's small-class teaching model and maintain ecological validity. A total of 50 representative students were selected for the experimental group, while an additional 50 students comprised the control group. All participants voluntarily enrolled and provided informed consent. To minimize extraneous variables, the experimental group underwent a structured pre-training session that included an overview of the project, a baseline proficiency assessment, and technical training on VR equipment operation. Rigorous data protection protocols were implemented to ensure the confidentiality of personal information and that all collected data were used solely for academic purposes. Moreover, intervention strategies were customized to accommodate the diverse learning backgrounds and disciplinary trajectories of the participants, thereby enhancing the relevance and applicability of the research findings. Participants' experiences and perceptions were evaluated through structured questionnaires and performance-based assessments administered before and after the VR learning sessions. The survey instruments were adapted from validated scales in educational technology research and modified to align with the CICH learning context.

#### *3.2.2. Script Iteration and Design*

Table 1 presents the development process script used in the design phase, drawing on case studies from multiple domains. It encompasses data acquisition, structuring, storage, organization, analysis, and visualization. The case-based development approach effectively identifies and rectifies errors, making it particularly suitable for addressing specific challenges while ensuring the accuracy and reliability of the program (Oluwagbemi et al., 2013).

***Table 1: Practical Examples Referenced in the Design of the Program.***

| Case references | Areas of use | Technical construction |
|---|---|---|
| (Cai et al., 2023) (Sun, 2023) | Folk art | Virtual environment construction<br>Human-computer interaction<br>Operation simulation<br>AI word frequency analysis<br>Dynamic capture |
| (Chen, 2022) (Wu, 2018) | Public resource space | 3D registration<br>Calibration technology<br>Application system development,<br>Real-time 3D formation<br>Dynamic environment modeling<br>System construction |
| (Theodoropoulos & Antoniou, 2022) (He et al., 2019) | Medical, Education, Gaming | Human-computer interaction,<br>Operation simulation<br>Online interaction<br>Dynamic capture<br>Virtual scene construction |

Figure 1 depicts the iterative process of VR program development, which predominantly adheres to a structured development methodology. This process is segmented into two primary stages: the Research Phase and the Development Phase, with review mechanisms instituted at critical junctures.

Research Phase: This phase elucidates the background, objectives, and significance of the study in response to societal needs. Subsequently, a comprehensive design and development plan is formulated, delineating the scope of the project. During the design input stage, core requirements are systematically collected and reviewed. If the requirements are rejected, necessary revisions are undertaken; if approved, the process proceeds to the design and development stage, wherein the technical architecture is established.

Development Phase: The design output phase produces deliverables including, but not limited to, the program architecture. Following this, a comprehensive design review is conducted. Should the initial review result in rejection, necessary modifications will be implemented, and subsequent reviews will determine if further adjustments are required. Upon successful approval, the design validation phase rigorously evaluates core functionalities. In the event of identified issues, targeted adjustments and re-evaluations will be carried out. After validation approval, the final confirmation stage ensures full compliance with established standards. Once all stages are completed and finalized, the development phase concludes with a comprehensive project summary.

This iterative review process guarantees scientific rigor, enhances developmental accuracy, and optimizes learning environments, user experiences, and educational efficacy.

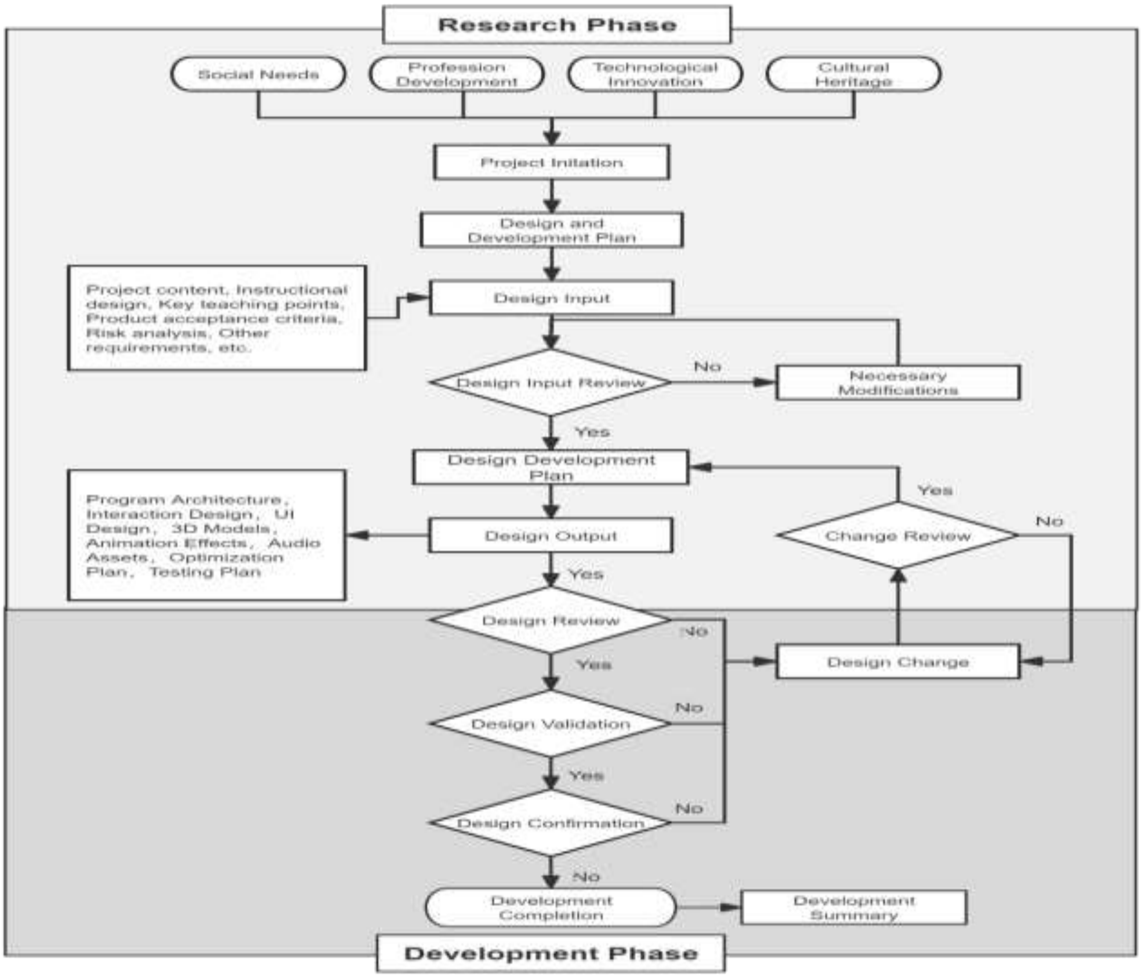


*Figure 1: Iterative Map of VR Programme Development.*

### *3.3. Development Tools and Implementation*

The development of the VR program involved multiple core tools across different stages Table 2, supporting the entire process from design to final adaptation:

- **Requirement Definition & Prototype Design:** Adobe Illustrator is utilized for visualizing UI frameworks and streamlining collaborative reviews. Adobe Photoshop optimizes visual elements and facilitates comparative analysis of various design options to ensure optimal presentation.
- **3D Modeling & Scene Construction**: Maya is utilized for managing fundamental model topology and skeletal rigging, ensuring the structural integrity of digital assets. ZBrush is employed for high-precision detail sculpting and iterative refinement, especially for complex and intricate features. Marmoset Toolbag facilitates normal map baking and validates rendering efficiency, ensuring consistent material presentation across various lighting conditions. Substance Painter enables the application of PBR (Physically Based Rendering) materials, significantly enhancing the realism and immersion of VR environments.
- **Program Development & Integration:** Unity 3D serves as the primary development engine, facilitating the construction of interactive logic and the integration of multi-module components. Microsoft Visual Studio supports C# scripting and debugging, thereby ensuring the stability and efficiency of the program.
- **Input/Output Device Adaptation:** The PICO 3 (Head-Mounted Display 'HMD' and Controller) offers interactive experiences and behavior-triggered events, enabling users to engage with the VR environment through head and hand movements. The Lenovo Thinkvision facilitates scene visualization and user behavior observation, thereby supporting multi-device testing.

By incorporating industry-standard tools into the development process, we achieved not only higher efficiency but also significantly enhanced VR immersion and interactivity, thereby substantially improving the overall learning experience.

***Table 2: The Role and Function of Development Tools.***

| Phases | Core tools | Functionality |
|---|---|---|
| Requirement Definition & Prototype Design | Adobe Illustrator | Visualizing UI frameworks and socialized reviews |
| | Adobe Photoshop | Optimizing visual elements and comparing multiple solutions |
| 3D Modeling & Scene Construction | Maya | Basic model topology and skeletal rigging |
| | Zbrush | High-precision detail sculpting and version iteration |
| | Marmoset Toolbag | Normal map baking and rendering efficiency validation |
| | Substance Painter | PBR material painting and enhanced physical realism |
| Program Development & Integration | Unity 3D | Scene logic configuration and multi-module integration |
| | Microsoft Visual Studio | C# script development and debugging |
| Input/Output Device Adaptation | PICO 3 (HMD/Controller) | Basic interactive experience and behavior event triggering |
| | Lenovo Thinkvision | Scene state visualization and behavior observation |

The development of the VR program was carried out on machines with Intel i7 processors or higher, running Windows 11. The development process encompassed three main stages. The first stage involved the creation of multimodal assets. Extensive preliminary research was conducted to collect a vast array of CICH images and 3D blueprints. The UI prototype design was carried out using Adobe Illustrator 24 (as shown in Fig. 2-a), adhering strictly to the principles of aesthetics and cognitive load balance to ensure the interface was both visually appealing and user-friendly. Core visual patterns and distinctive shapes were deeply extracted from the CICH elements to construct a symbol library, which provided a rich source of materials for subsequent design work. In terms of 3D model creation, ZBrush was utilized to finely sculpt masks with high design requirements (as seen in Fig. 2-b), followed by topology optimization to ensure they met real-time rendering demands, providing high-quality visual assets for the VR environment.

The second stage involved constructing the immersive learning environment. Unity, as the core development platform (Fig. 2-c1), was used to design the VR scenes, set animation effects, and develop interaction behaviors. Virtual environments were meticulously arranged to create an immersive experience for users, while animation effects were incorporated to enhance the liveliness and appeal of the scenes. A variety of interactive behaviors were designed to improve user engagement with the virtual environment. Subsequently, using integrated development environments such as Visual Studio and C# programming, critical functions such as logical control, data processing, and event triggers were implemented (as seen in Fig. 2-c2). The code provided the VR program with intelligence and interactivity, enabling users to interact naturally with the VR content. The close coordination between the various development stages resulted in a fully functional VR program with an excellent visual experience, effectively meeting user needs for immersive interaction.

*Figure 2: VR-CICH R&D Stage Demonstration for Pedagogical Applications.*

The VR-CICH program incorporates an immersive and interactive design (Figure 3), seamlessly integrating exhibitions, assessments, and gamified modules to create a robust and effective learning cycle. The Exhibition Hall presents CICH projects through an integration of textual descriptions, images, and 3D models, effectively minimizing cognitive load while facilitating self-directed exploration.

The Assessment Module employs a "Test-Read-Observe" iterative process, where students first identify knowledge gaps through initial testing, then address these gaps via targeted reading, and ultimately reinforce their understanding by interacting with 3D models.

The Shooting Game incorporates key CICH concepts, utilizing gamification techniques such as feedback and rewards to enhance learning motivation, attention, and retention. The Final Evaluation combines formative assessments with an achievement-based honor system, gradually shifting the focus from external incentives to intrinsic motivation, thereby fostering sustained engagement. The program is rooted in VR's "safe trial-and-error" principle, leveraging multisensory stimulation and progressively challenging tasks to transform traditional learning methods.

*Figure 3: VR-CICH Learning Experience Storyline.*

### 3.4. Course Implementation

The implementation of VR technology into the curriculum was grounded in social constructivism and PBL theory, progressing through four distinct phases Table 3: theoretical instruction, immersive learning, creative practice, and focus group interviews.

The theoretical instruction provides a solid foundation in CICH culture and design principles. The VR immersive learning experience significantly enhances student engagement and participation. During the creative practice phase, students apply CICH cultural concepts to creative design projects, thereby refining their professional skills. In the product realization and market application phase, students transform their designs into tangible products, optimizing them based on market feedback to cultivate commercial awareness. This unit adopts a comprehensive evaluation framework, rather than relying solely on teacher assessments, to evaluate the effectiveness of VR-based instruction.

The goal is to refine teaching methods and explore broader applications. To ensure a holistic assessment of the study’s impact, data collection incorporates both CICH proficiency tests and qualitative interviews.

***Table 3: Pedagogical Implementation Framework for VR Integration in Classroom Instruction.***

| Phase | Key Teaching Focus | Objectives |
|---|---|---|
| Theoretical instruction | History and cultural significance of CICH projects, theoretical foundations of specialized courses, cognitive application transformation | Establish a fundamental understanding of CICH culture, master CICH visual language, and gain initial knowledge of CICH application fields. |
| VR immersive learning | VR-based learning of CICH projects, knowledge Q&A, VR game-based learning | Enhance the learning experience of CICH through VR, improve teaching interactivity and knowledge retention, and increase engagement using games and technology. |
| CICH creative practice and product market | Based on CICH culture, creative tasks were designed to realize products, conduct market forecasting, and refine designs through user feedback. | *CICH Element Design*: Enhancing cultural knowledge and hands-on skills. *Market-Driven Design Optimization*: Refining products based on user feedback. *Adaptive Market Strategies*: Strengthening CICH cultural application and marketing awareness. |
| VR learning experience and impact assessment | Focus group interviews, CICH knowledge level testing and analysis | Evaluate the application value of VR in CICH courses, analyze the learning outcomes of the experimental and control groups, and reflect on and optimize teaching methods. |

## 4. RESEARCH MEASUREMENT

### *4.1. Demographics And Experimental Design*

This experiment was conducted among VCD students (n=50), a program that typically follows a small-class teaching model. This instructional format inherently constrains the potential sample size. A purposive sampling method was employed, selecting students from three academic levels (Level 1, Level 2, and Level 3) to ensure a representative sample. The gender ratio within the sample was 3:7 (male to female), consistent with the overall distribution of students in the program. Given that the primary objective of the experiment was to observe learners' operational behaviors and cognitive changes during the VR-based learning process, the study collected data from multiple sources, including technical feedback from VR participants, CICH knowledge test scores, post-course CICH project outcomes, experimental logs, and transcripts of group learning discussions. The small sample size facilitated comprehensive data collection, enabling a more nuanced understanding of individual learning processes—an aspect that is often challenging to capture in large-scale studies.

### *4.2. Measurement Tools*

Fig 4 illustrates the comprehensive implementation process of integrating VR technology into the curriculum. Specifically, the VR technology was incorporated into three core design courses: Composition Foundation, Packaging Design, and Brand Design. Based on the specific course structure, students engaged in VR learning sessions approximately five weeks after completing the theoretical component. The experiment was conducted under the direct supervision of the researcher and was divided into four distinct phases.

First, participants were provided with comprehensive information regarding the research objectives and data confidentiality protocols. After signing the informed consent forms, they commenced the experiment, retaining the right to withdraw at any time should discomfort arise. Next, students entered the VR learning environment where they engaged in self-directed exploration, knowledge assessments, and game-based learning activities for a duration of 15 to 30 minutes. Subsequently, participants completed a detailed technical feedback questionnaire to evaluate their VR experience. Thereafter, data were systematically collected and analyzed using SPSS 24 for descriptive statistics and regression analysis to test Ho1 and 2. Ultimately, a CICH knowledge proficiency assessment was conducted for both the experimental and control groups. Their post-test results were then compared with their respective pre-test scores to evaluate Ho3.

The overall learning outcomes were evaluated through a comprehensive approach, incorporating both instructor-designed test scores and real-world market feedback on student projects. Upon completion of the VR sessions, students participated in an online knowledge assessment, followed by a VR system usability survey and a course technology feedback questionnaire. The VR learning experience survey was adapted from Huang et al. (2010), which originally utilized a 7-point Likert scale. Two distinct questionnaires were administered: one immediately following the VR experience to evaluate system usability and learning engagement, and another at the conclusion of the course to assess students' perspectives on integrating VR into professional design education. Certain questionnaire items were modified to better align with the specific objectives of this study.

The VR learning experience questionnaire was based on Huang, Rauch, and Liaw (2010) and had 25 items rated against 7-point Likert scale. The statements contained in the sample items were as follows: the “VR system was not complex to use”, “I felt immersed in the learning environment”, and “when working with VR objects, I understood cultural heritage better”. Usability in the current research was operationalized as a composite variable which included both perceived performance of the system (responsiveness, stability and quality of visual rendering) and perceived ease of use (clarity of interaction mechanism, comfort and accessibility to learning). They measured these dimensions using items in five factors, which are interaction, imagination, immersion, collaborative learning, and technology usability, which are in line with the model of analysis recorded in the Results part.


*Figure 4: Implementation Process Of Instructional Research.*

The VR experimental session was conducted in a multimedia classroom (Fig.5) utfitted with PICO 3 HMDs and controllers to facilitate interaction. A Lenovo Thinkvision external display mirrored the participants' VR experiences, allowing researchers to monitor user interactions and behaviors in real time. Due to equipment constraints, only two participants could engage in the VR experience simultaneously. This configuration enabled researchers to provide immediate guidance and address participants' questions as needed, thereby maintaining a controlled and supportive experimental environment.


*Figure 5: Experimental Setup for VR Experience Testing.*

### 4.3. Results And Analyses

#### 4.3.1. Program Experience Feedback

Upon completion of the VR session, participants completed a feedback questionnaire evaluating their VR experience across five dimensions: system interaction, imagination, immersion, collaborative learning, and technology usability. The questionnaire consisted of 25 items rated on a 7-point Likert scale (1 = "strongly disagree," 7 = "strongly agree"). Reliability analysis revealed a Cronbach’s Alpha of 0.939, indicating high internal consistency and suitability for research purposes.

As illustrated in Table 4, the mean scores for all variables ranged from 6.18 to 6.656 ($M \geq 6$), indicating a generally positive evaluation of the VR system across all dimensions. The standard deviations varied between 0.601 and 0.802 ($SD \leq 0.8$), suggesting that participant responses demonstrated a relatively high level of consistency with minimal individual variability. From a mean-score perspective, the intention to use the system received the highest rating ($M = 6.656$, $SD = 0.601$), underscoring the cognitive embodiment advantages of VR technology. Furthermore, immersion ($M = 6.42$) and imagination ($M = 6.347$) exhibited strong correlations, indicating that the integration of 3D spatial visualization and scenario simulation effectively enhances both physical and psychological immersion. Although interaction ($M = 6.18$) was positively rated, it had the lowest mean score and a relatively higher standard deviation ($SD = 0.678$), suggesting potential limitations in operational fluency. Collaborative learning (M = 6.417, SD = 0.683) garnered robust feedback, reinforcing the idea that VR can transcend traditional barriers to collaborative learning.

*Table 4: Descriptive Participant Feedback on VR Application Experience.*

| Variable | M | SD |
|---|---|---|
| Interaction | 6.18 | 0.678 |
| Imagination | 6.347 | 0.698 |
| Immersion | 6.42 | 0.802 |
| Collaborative learning | 6.417 | 0.683 |
| Intention to use the system | 6.656 | 0.601 |

### 4.3.2. Integration of Technology into Course Feedback

At the conclusion of each course phase, an additional VR classroom integration feedback questionnaire was administered to gather comprehensive insights. This questionnaire specifically evaluated students' perceptions of incorporating VR technology into the curriculum, focusing on key dimensions such as immersion, interaction, imagination, motivation, and problem-solving capability. The 16-item scale, rated on a 7-point Likert scale, demonstrated high reliability for research purposes, as evidenced by a Cronbach's Alpha of 0.943.

As shown in Table 5, the mean scores across all dimensions ranged from 6.273 to 6.473, all exceeding the midpoint value of 4. This indicates generally favorable student perceptions regarding the integration of VR into professional courses. The standard deviations varied from 0.682 to 0.832, suggesting that individual differences were within an acceptable range. However, it is noteworthy that the dimensions of immersion and problem-solving capability exhibited slightly higher variance.

Regarding the specific findings, imagination achieved the highest mean score (M = 6.473), indicating that the contextual anchoring and boundary expansion mechanisms of VR significantly stimulated creative thinking. Interaction (M = 6.413) and motivation (M = 6.413) also received high scores, which suggests that VR's facilitation through both tool-based and social negotiation interactions effectively promoted knowledge internalization and cultural cognition reconstruction. Additionally, the incorporation of real-world problem scenarios further enhanced both extrinsic and intrinsic learning motivation. However, the scores for immersion (M = 6.273, SD = 0.832) and problem-solving capability (M = 6.295, SD = 0.819) were marginally lower. Although immersion received generally positive ratings, the relatively higher standard deviation indicates a wider variation in students' existing cultural cognition frameworks, which may have influenced their perceived level of immersion in VR environments. Similarly, while complex VR tasks can promote critical thinking, some students encountered challenges due to cognitive resource competition, particularly with respect to technical operational demands. This underscores the necessity for further refinement of collaborative problem-solving mechanisms within the VR system.

*Table 5: Descriptive Feedback on VR-Integrated Curriculum from Study Participants.*

| Variable | M | SD |
|---|---|---|
| Immersion | 6.273 | 0.832 |
| Interaction | 6.413 | 0.682 |
| Imagination | 6.473 | 0.722 |
| Motivation | 6.413 | 0.736 |
| Enhanced problem-solving capability | 6.295 | 0.819 |

## 4.4. Hypothesis Testing

To evaluate the impact of VR-based teaching on CICH learning, this study conducted statistical analyses to test the proposed hypotheses. Regression analysis was employed to examine H1 (intention to use VR for learning CICH) and H2 (learning motivation for CICH before and after VR-based instruction), while non-parametric tests were used to assess H3 (the effect of VR on CICH knowledge acquisition).

- Testing H1: Intention to Use VR for Learning CICH

To determine whether students' intention to use VR for learning CICH significantly changed following the VR intervention, a regression model was applied. The results (Table. 6) indicated an $R^2$ value of 0.359, suggesting that the model explained approximately 35.9% of the variance in students' intention to use VR. Among the predictor variables, imagination had a significant positive effect on intention to use VR ($\beta$ = 0.431, p = 0.029), while immersion ($\beta$ = 0.153, p = 0.885) and interaction ($\beta$ = 0.065, p = 0.717) were not statistically significant. These findings led to the rejection of H1, demonstrating that imagination plays a crucial role in shaping students' willingness to engage with VR for learning CICH. The results align with prior research indicating that higher levels of perceived imagination correlate with increased adoption of immersive learning tools.

- Testing H2: Learning Motivation Before and

After VR-Based Teaching

The second hypothesis, H2, posited that there would be no significant difference in students' motivation to learn CICH before and after experiencing VR-based instruction. However, the regression analysis revealed an $R^2$ value of 0.447, indicating that the model explained 44.7% of the variance in learning motivation. Notably, imagination emerged as the strongest predictor of motivation (β = 0.516, p = 0.004), while immersion (β = 0.027, p = 0.899) and interaction (β = 0.179, p = 0.334) did not yield statistically significant effects. Consequently, H2 was rejected, providing empirical support for the argument that VR enhances motivation by engaging learners' creative cognition and stimulating cultural curiosity. This finding is particularly pertinent in the context of CICH education, where fostering intrinsic motivation is crucial for sustained learning engagement.

***Table 6: Regression Outcomes for Hypotheses Validation.***

| H | Dependent variable | Independent variables | β | P | R²□ |
|---|---|---|---|---|---|
| H1 | Intention to use the system | Immersion | 0.153 | 0.885 | 0.359 |
| | | Interaction | 0.065 | 0.717 | |
| | | Imagination | 0.431 | 0.029* | |
| H2 | Motivation | Immersion | 0.027 | 0.899 | 0.447 |
| | | Interaction | 0.179 | 0.334 | |
| | | Imagination | 0.516 | 0.004** | |
| * p<0.05 ** p<0.01 | | | | | |

- Testing H3: Effect of VR-Based Teaching on CICH Knowledge Acquisition

To evaluate the impact of VR-based teaching on students' CICH knowledge levels, we analyzed pre- and post-test scores. Given that Shapiro-Wilk tests indicated non-normal distributions (pre-test: W = 0.92, p < 0.001; post-test: W = 0.95, p = 0.001), within-group comparisons were conducted using a Wilcoxon signed-rank test, while between-group comparisons utilized a Mann-Whitney U test.

The between-group comparison (Table.7) revealed no significant difference in pre-test scores between the experimental and control groups (U = 1177, p = 0.605, Mdn = 80, IQR = 75–85), indicating that both groups possessed comparable initial knowledge levels. However, in the post-test, the experimental group exhibited significantly higher scores compared to the control group (Mdn = 90 vs. 80, U = 271, p < 0.001), with a notable rightward shift in the score distribution (experimental group IQR = 85–95; control group IQR = 75–85). The calculated effect size (r = 0.69) further substantiates the substantial practical impact of the VR-based intervention.

***Table 7: Mann-Whitney U Intergroup Comparison on CICH Proficiency.***

| Non-parametric Test | | | | |
|---|---|---|---|---|
| | Group Median (P25, P75) | | Mann-Whitney Test (U) | p |
| | CG (n = 50) | EG (n = 50) | | |
| Post-test | 80.000 (75.0, 85.0) | 90.000 (85.0, 95.0) | 271 | 0.000** |
| Pre-Test | 80.000 (75.0, 85.0) | 80.000 (75.0, 85.0) | 1177 | 0.605 |
| * p < 0.05 ** p < 0.01 | | | | |

For the within-group comparison, the Wilcoxon signed-rank test (Table.8) indicated that 80% of students in the experimental group (40 out of 50) demonstrated significant post-test score improvements, with only 2 students scoring lower and 8 showing no change (Z = -5.495, p < 0.001, effect size r = 0.78). In contrast, the control group exhibited less substantial improvements, with 32% of students (16 out of 50) showing improvement, 10% scoring lower, and 58% remaining unchanged (Z = -2.449, p = 0.014, effect size r = 0.35). Although some improvement was observed in the control group, the smaller effect size suggests that these gains may be due to random variation rather than a systematic learning effect.

Based on these results, the H3 was rejected, confirming that VR-based instruction resulted in a statistically and practically significant enhancement in students' acquisition of CICH knowledge. These findings support the proposition that immersive learning environments facilitate the internalization of cultural knowledge by promoting deeper engagement and interactivity.

***Table 8: Wilcoxon Signed-Rank Intragroup Evaluation of Learning Gains.***

| H | Variables | Ranks | Mean | N | Sum | Z | p |
|---|---|---|---|---|---|---|---|
| H3 | Control group (Pre-Post test) | Negative | 16a | 11.16 | 178.5 | -2.449 | 0.014 |
| | | Positive | 5b | 10.5 | 52.5 | | |
| | | Ties | 29c | | | | |
| | Experimental group (Pre-Post test) | Negative | 40a | 22.2 | 888 | -5.495 | 0 |
| | | Positive | 2b | 7.5 | 15 | | |
| | | Ties | 8c | | | | |

### *4.5. Focus Group Interviews*

To gain deeper insights into the impact of VR-based learning on students' experiences, a focus group interview was conducted with five participants selected through stratified random sampling. These students, representing various academic levels, provided qualitative data that complemented the quantitative findings, thereby offering a more comprehensive understanding of the learning process. To ensure confidentiality and anonymity, each participant was assigned a unique code.

1. Immersive experience as a catalyst for cultural understanding

VR technology facilitated an immersive engagement with cultural heritage artifacts, thereby enhancing students' cognitive and emotional connections to the subject matter. As one student (WF) commented, "The Nuo mask module enabled me to meticulously examine the intricate details of the masks in a three-dimensional format, rendering the experience significantly more impactful than merely viewing images in textbooks." This observation aligns with existing research on embodied learning, which posits that sensory engagement improves information retention and cultural appreciation. Furthermore, the spatial storytelling capabilities of VR contributed to a heightened sense of identity and belonging. Another student (XCK) remarked, "I had never realized my hometown was renowned for calligraphy brush making—this discovery instilled in me a newfound pride in my cultural heritage." These findings support the argument that VR can serve as an Effective medium for fostering cultural identity through interactive learning environments.

2. Interactive design as a driver of learning motivation

The integration of gamified elements and task-based interactions markedly enhanced student engagement. Notably, the reverse-selection mechanism in the VR-based quiz game, which required students to eliminate incorrect answers rather than select correct ones, was especially well-received. As one participant (FJ) remarked, "The reverse-selection game compelled me to critically evaluate the components of CICH, thereby making the learning process significantly more engaging compared to passive lectures." This observation aligns with the PBL framework, which posits that active problem-solving promotes deeper knowledge internalization.

3. Multifaceted enhancements in the learning experience

Students perceived VR-based learning as an effective tool for enhancing comprehension and engagement. One participant (AYX) emphasized the sense of agency and autonomy provided by the VR environment, stating, "I appreciated the freedom to explore various aspects of CICH in depth at my own pace, rather than adhering to a rigid lecture format." Another student (XCK) remarked that the detailed rendering of brush-making techniques deepened their appreciation for traditional craftsmanship, noting, "I never fully grasped the intricacy of the process until I experienced each step in VR. It significantly enhanced my respect for the artistry involved." Similarly, AYX observed that VR-based instruction facilitated sustained attention, commenting, "I found it considerably easier to maintain focus in the VR classroom compared to a traditional lecture setting." Students also emphasized the advantages of incorporating gaming mechanics into the learning process. For instance, WF noted that the embedded assessment tasks served as efficacious tools for reinforcing knowledge, whereas LYY observed that gamification rendered the learning experience more engaging and memorable.

4. Challenges and Areas for Improvement

Despite the overwhelmingly positive feedback, students identified several areas for refinement in the implementation of VR learning. Physiological adaptation emerged as a key concern, with two participants (WF and FJ) reporting motion sickness after extended periods of headset use. This underscores the necessity of implementing shorter VR sessions or adaptive visual settings to mitigate such effects. Another significant challenge was operational fluidity; multiple students recommended incorporating gradual tutorial modes and more intuitive interaction mechanics to enhance user experience. Furthermore, there was a strong demand for greater depth in content presentation. For instance, WF expressed a desire for more interactive steps in the porcelain-making module, while LYY suggested including all 128 brush-making steps for a more comprehensive learning experience. These insights highlight the need for a dynamic balance between technological feasibility and content richness, ensuring that VR-based learning modules continue to evolve to meet student needs while preserving educational effectiveness.

### 4.6. Research Answers

This study systematically explored the impact of VR-based CICH education on VCD students' knowledge acquisition by integrating both quantitative and qualitative research methods. Through rigorous data analysis and focus group interviews, the study provides comprehensive answers to the research questions posed at the outset.

- RQ1: How can the VR approach be implemented to enhance CICH knowledge among VCD students?

The implementation of VR in CICH education adhered to a structured, phased methodology aimed at systematically enhancing students' knowledge and skills. Initially, traditional theoretical instruction was utilized to lay a robust foundation in CICH history, cultural significance, and visual representation. Subsequently, VR learning modules were progressively integrated at various stages, enabling students to engage in experiential, scenario-based interactions that reinforced their understanding through multisensory engagement.

To ensure the effectiveness of the VR learning experience, multiple instructional strategies were incorporated, including reading-based exploration, gamified assessments, and interactive design tasks. The combination of these strategies helped create a highly immersive learning environment, fostering active engagement and self-directed knowledge construction. In addition, task-based learning assessments were used to evaluate students' ability to apply their knowledge in practice, with performance measured based on accuracy, creativity, and execution quality.

- RQ2: What is the usability of the VR approach in this context?

The usability evaluation of the VR-based CICH learning system received overwhelmingly positive feedback from students, especially regarding its capacity to stimulate imagination, enhance interactivity, and boost learning motivation. Regression analysis indicated that VR's capability to evoke imagination was a pivotal factor in increasing students' willingness to utilize the technology for educational purposes. The incorporation of situated learning elements and principles of embodied cognition substantially contributed to students' perception of a more engaging and meaningful learning experience.

However, findings also highlighted usability challenges, particularly in motion adaptation and interaction fluidity. Some students reported mild motion sickness when wearing the VR headset for extended periods, while others found the operational mechanics slightly complex, suggesting a need for progressive tutorial designs and adaptive interface enhancements. Focus group interviews further reinforced these findings, emphasizing that VR's multimodal integration—incorporating visual, auditory, and haptic feedback—helped facilitate knowledge construction, but improvements in interface accessibility and content depth were necessary to optimize the learning process.

- RQ3: Is there a significant improvement in VCD students' CICH knowledge levels before and after the implementation of the VR approach?

The results of the CICH knowledge assessment demonstrated a statistically significant improvement in students' learning outcomes following the implementation of VR-based instruction. The experimental group exhibited a substantial increase in post-test scores compared to the control group ($\Delta Mdn = 10$, $p < 0.001$), indicating that VR-based learning was highly effective in enhancing CICH knowledge acquisition. Non-parametric testing further confirmed that 80% of students in the experimental group showed marked improvement, whereas the control group displayed only marginal gains.

These findings validate the hypothesis that VR's immersive and interactive learning environment facilitates deeper knowledge internalization and cultural understanding. The study further supports the argument that VR technology serves as a powerful tool for addressing the challenges of CICH education, providing an innovative solution for enhancing knowledge retention and student engagement.

## 5. CONCLUSION

Although this study was grounded in social constructivist theory, the research findings indicate that the influence of VR on CICH education transcends traditional constructivist learning paradigms. By incorporating PBL methodologies and immersive digital tools, the study has established a "Cultural Authenticity–Technological Interactivity" dual-track instructional model, offering novel perspectives on the role of emerging technologies in heritage education. The instructional design adhered to a structured three-phase PBL framework, encompassing VR experiential learning, collaborative discussions, and design materialization. A key extension of this PBL structure was the introduction of the creative marketplace model, which facilitated students in transforming CICH knowledge into tangible design products, thereby promoting both economic and social value creation. This pedagogical approach demonstrated significant efficacy, as reflected in students' enhanced comprehension of CICH's commercial potential. Moreover, the integration of VR-driven design processes significantly contributed to students' success in design competitions, further validating the impact of immersive learning on educational outcomes.

From a technological standpoint, this study underscored the critical role of adaptive rendering mechanisms and progressively increasing task complexity in VR-based learning environments. Going forward, future research should investigate how AI-driven adaptive learning algorithms can further tailor VR learning experiences to align with students' cognitive and behavioral profiles.

### *5.1. Future Research Directions*

This study suggests that VR has the potential to revolutionize CICH education, yet several key challenges remain unaddressed. Future research should focus on "3E":

1. Expanding the "VR+" Model – Investigating how AI, big data, and intelligent analytics can enhance personalized cultural education pathways, ensuring that VR-driven heritage education remains adaptive, scalable, and inclusive.
2. Enhancing Technical Stability and Usability Addressing motion sickness and interaction complexity through haptic feedback optimization and dynamic field-of-view adjustments, ensuring seamless usability across diverse learner demographics.
3. Exploring Cross-Cultural VR Applications – Examining how VR-driven CICH education can be adapted for global audiences, promoting cross-cultural knowledge exchange and international engagement in heritage preservation.

In conclusion, this study illustrates that VR technology functions as a revolutionary educational instrument for CICH learning, providing unparalleled opportunities for knowledge dissemination, cultural engagement, and creative expression. As VR technology advances, its significance in digital heritage education is expected to grow, thereby demanding further interdisciplinary research and pedagogical innovations.

**Acknowledgements:** The authors would like to extend their sincere appreciation to Zhang Zhen, Ding Lifang, He Xuelan, Liu Qun, Yang Ziyang, Li Xiaoya, and Bai Man for their substantial contributions to the implementation of the digital curriculum.

**Declarations Ethical approval**: In accordance with local academic legislation and institutional regulations, this study was exempt from ethical review. The data collection process did not entail the handling of any sensitive personal information, and all participants were adults. Prior to their involvement, all interviewees and participants were fully informed of the study's objectives and contents and provided written informed consent.

**Funding:** The authors received no financial support from any organization or individual for the conduct of this research.

**Competing interests:** All authors hereby confirm that they have no affiliations, financial interests, or involvements with any organization or entity related to the subject matter or materials discussed in this manuscript.

## REFERENCES

Aiello, G., & Van Leeuwen, T. (2023). Michel Pastoureau and the history of visual communication. Visual Communication, 22(1), 27–45. https://doi.org/10.1177/14703572221126517

Balanescu, R.-C. (2015). The Project-Based Learning in the Higher Education—Theoretical and Practical

Aspects. Scientific Research & Education in the Air Force - AFASES, 1, 159–164.

Barab, S., & Squire, K. (2004). Design-Based Research: Putting a Stake in the Ground. In Design-based Research. Psychology Press.

Cai, X., & Chen, Q. (2023). Design and Implementation of AI Co-created Traditional Chinese Poetry Culture VR Experience System. Publishing Journal, (31.04), 80-88. https://doi.org/10.13363/j.publishingjournal.20230712.004

Cash, P. (2018). Developing theory-driven design research. Design Studies, 56. https://doi.org/10.1016/j.destud.2018.03.002

Chen, T. (2022). Research on the Application of AR and VR Technology in Digital Museum. Digital Communication World, 04(81–83). https://doi.org/10.3969/J.ISSN.1672-7274.2022.04.026

Chernobilsky, E., DaCosta, M. C., & Hmelo-Silver, C. E. (2004). Learning to talk the educational psychology talk through a problem-based course. Instructional Science, 32(4), 319–356. https://doi.org/10.1023/B:TRUC.0000026552.14289.2c

Dewey, J. (1916). Nationalizing Education. Journal of Education, 84(16), 425–428. https://doi.org/10.1177/002205741608401602

Donnelly, R. (2010). Interaction analysis in a 'Learning by Doing' problem-based professional development context. Computers & Education, 55(3), 1357–1366. https://doi.org/10.1016/j.compedu.2010.06.010

Du, S. (2021). Application Analysis of Virtual Reality VR Technology in Art Design Teaching. Journal of Physics: Conference Series, 1881(2), 022056. https://doi.org/10.1088/1742-6596/1881/2/022056

Fukuda, A., Uekita, Y., Subroto, Y. W., & Zhao, R. (2021). Practice and Transmission of Batik in Wukirsari Village, Yogyakarta -Safeguarding Intangible Cultural Heritage in Indonesia-. Asian Culture and History, 13(1), 1–8.

Guo, H., & Wang, A. (2016). The Orientation of Visual Communication Design and the Construction of Curriculmn System. Zhuangshi, (07), 136-137. https://doi.org/10.16272/j.cnki.cn11-1392/j.2016.07.052

Guo, P., & Zhang, J. (2023). China Intangible Cultural Heritage Research Report 2022. Folk Culture Forum, 03, 92-101. https://doi.org/10.16814/j.cnki.1008-7214.2023.03.002

Guo, P., & Zhang, J. (2024). China Intangible Cultural Heritage Research Report 2023. Folk Culture Forum, (02), 58-68. https://doi.org/10.16814/j.cnki.1008-7214.2024.02.009

He, J., Huang, X., Han, G., Liang, Y., & He, X. (2019). Empirical Study on Influencing Factors of Learning Motivation in VR-based Educational Games. E-Education Research, 40(8), 70–77.

Huang, H.-M., Rauch, U., & Liaw, S.-S. (2010). Investigating learners' attitudes toward virtual reality learning environments: Based on a constructivist approach. Computers & Education, 55(3), 1171–1182.

Jagielska-Burduk, A., Pszczyński, M., & Stec, P. (2021). Cultural Heritage Education in UNESCO Cultural Conventions. Sustainability, 13(6), Article 6. https://doi.org/10.3390/su13063548

Jiawei, W., & Mokmin, N. a. m. (2023). Virtual reality technology in art education with visual communication design in higher education: A systematic literature review. Education and Information Technologies. https://doi.org/10.1007/s10639-023-11845-y

Kong, S. (2019). From Immersion to Flow Experience: A Ｒeconsideration of Immersive Communication. Journal of Capital Normal University( Social Sciences Edition), (4), 74-83. https://doi.org/CNKI:SUN:SDSD.0.2019-04-009.

Lave, J., & Wenger, E. (1991). Situated learning: Legitimate peripheral participation. Cambridge university press.

Li, Y. (2020). The Cultural and Historical Responsibility of Design - Li Yanzu on 'Design and Culture'. Design, (33.02), 42-46. https://doi.org/CNKI:SUN:SJTY.0.2020-02-006.

Ma, Q., & Zhang, Y. (2022). Inheritance and Protection of Intangible Cultural Heritage in the New Era — Interpretation of the 14th Five-Year Plan for Cultural Development. Research on Intangible Cultural Heritage, 4, 4–8.CNKI:SUN:FYCC.0.2022-04-001.

Oluwagbemi, O., Adewumi, A., Misra, S., Majekodunmi, F., & Fernandez, L. (2013). An Analysis of Scripting Languages for Research in Applied Computing. 2013 IEEE 16th International Conference on Computational Science and Engineering. https://www.academia.edu/5492685/An_Analysis_of_Scripting_Languages_for_Research_in_Applied_Computing

Ren, X. (2019). Change and Transformation: Rethinking the Talents Training Mode of Higher Vocational Education in the Age of Intelligence. Vocational and Technical Education, 40(28), 12–17.

Rogers, S. (2019). Meaningful Meet ups: Is VR The Future Of Social Connection? Forbes. https://www.forbes.com/sites/solrogers/2019/07/22/meaningful-meet-ups-is-vr-the-future-of-social-connection/

Sun, K. (2023). Protection and Dissemination Strategy of Pilu Temple Murals Based on "VR + Culture". Packaging Engineering, (44-6), 320-327. https://doi.org/10.19554/j.cnki.1001-3563.2023.06.035

Sutherland, I. E. (1965). The ultimate display. Proceedings of the IFIP Congress, 2(506–508), 506–508.

Tan, G., & He, Q. (2021). Research Status, Practical Dilemmas and Development Paths of Digital Communication of Intangible Cultural Heritage in China. Theory Monthly, 9, 87–94.

Theodoropoulos, A., & Antoniou, A. (2022). VR Games in Cultural Heritage: A Systematic Review of the Emerging Fields of Virtual Reality and Culture Games. Applied Sciences, 12(17), Article 17. https://doi.org/10.3390/app12178476

Ulita, N., & Hananto, B. A. (2022). Implementation of Design Thinking Method in Visual Communication Design. Eduvest: Journal Of Universal Studies, 2(8), 1458–1468. https://doi.org/10.36418/eduvest.v2i8.539

Ventura, S., Brivio, E., Riva, G., & Baños, R. M. (2019). Immersive Versus Non-immersive Experience: Exploring the Feasibility of Memory Assessment Through 360° Technology. Frontiers in Psychology, 10. https://www.frontiersin.org/articles/10.3389/fpsyg.2019.02509

Vygotsky, L. S., & Cole, M. (1978). Mind in society: Development of higher psychological processes. Harvard university press.

Wang, R. (2019). On Options for Creative Paths to Cultivate Talents Majoring in Art Design under Achievement Oriented Education Paradigm. Vocational and Technical Education, 32(40), 27–30. https://doi.org/CNKI:SUN:ZYJW.0.2019-32-007.

Wu, C. (2018). Research on the Use of VR/AR Technology in the Digital Museum of Bada Shanren [Master degree, Nanchang university].

Zhou, Y. (2009). The Design Philosophy of Peter Behrens and Related Analysis. Zhuangshi, (06), 139-140. https://doi.org/10.16272/j.cnki.cn11-1392/j.2009.06.039

Zhou, Y., & Duan, Z. (2020). Sustainable Development Strategy of Visual Communication Design Major underEra of Industry 4.0. Journal of Hubei Adult Education Institute, (26.04), 26-31. https://doi.org/10.16019/j.cnki.cn42-1578/g4.2020.04.005