Facilitating Daily Practice in Intangible Cultural Heritage through Virtual Reality: A Case Study of Traditional Chinese Flower Arrangement

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Figure 1: Traditional Chinese flower arrangement (TCFA) is one intangible cultural heritage that requires daily practice to refine skills and learn related culture. We designed FloraJing, a VR application that addresses the challenges in TCFA daily practice by providing rich cultural environments and accessible materials and tools. (a) In FloraJing, a user arranges flowers with natural hand gestures in a Chinese tea room. (b) The user saves the TCFA work and captures it. (c) In mixed reality mode, the user interacts with the digital TCFA within the physical environment.

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Abstract

The essence of intangible cultural heritage (ICH) lies in the living knowledge and skills passed down through generations. Daily

practice plays a vital role in revitalizing ICH by fostering continuous learning and improvement. However, limited resources and accessibility pose significant challenges to sustaining such practice. Virtual reality (VR) has shown promise in supporting extensive skill training. Unlike technical skill training, ICH daily practice prioritizes cultivating a deeper understanding of cultural meanings and values. This study explores VR's potential in facilitating ICH daily practice through a case study of Traditional Chinese Flower Arrangement (TCFA). By investigating TCFA learners' challenges and expectations, we designed and evaluated FloraJing, a VR system enriched with cultural elements to support sustained TCFA practice. Findings reveal that FloraJing promotes progressive reflection, and continuous enhances technical improvement and cultural understanding. We further propose design implications for VR applications aimed at fostering ICH daily practice in both knowledge and skills.

CCS Concepts

• **Human-centered computing → Empirical studies in HCI**.

Keywords

Virtual Reality, Intangible Cultural Heritage, Daily Practice, Traditional Chinese Flower Arrangement

1 INTRODUCTION

Intangible cultural heritage (ICH) includes the traditions and living expressions passed down from our ancestors to future generations, represented in five domains, such as traditional craftsmanship, performing arts, and knowledge and practices concerning nature and the universe [76]. ICH serves as a bridge connecting past, present, and future, playing a vital role in the preservation of cultural diversity amid growing globalization [41, 58, 76]. Its significance lies not in the cultural forms themselves, but in the living knowledge and skills transmitted through these forms across generations [30, 76, 78]. ICH knowledge and skills are inseparable: skills objectify knowledge, while knowledge provides skills with their value. ICH knowledge is acquired and understood through long-term, accumulated experience gained via embodied, hands-on skill practice [3, 30, 73].

However, traditional *ICH knowledge* and *skill transmission* methods, such as apprenticeships, face challenges due to being labor-intensive, time-consuming over extended periods, and constrained by geographical limitations [92]. These factors often lead younger generations to lose interest or discontinue their learning [77]. While local residents can participate in ICH workshops, challenges such as limited financial support and irregular scheduling hinder sustained practice [69]. ICH practices were once an integral part of daily life routines [39], and reviving them through daily practices in contemporary life presents a promising prospect. However, societal

changes, including the limited availability of local resources and rising production costs [77], have made sustaining ICH daily practice increasingly difficult. While prior HCI research has explored various digital technology solutions (e.g., motion capture, interactive digital storytelling, and integrating digital tools with traditional crafts production) for ICH preservation [46, 59, 67], much of this work has focused on singular experiences rather than fostering continuous daily practice to revitalize ICH. This highlights the need to explore the challenges ICH learners face in sustaining their daily practice and develop innovative solutions that seamlessly integrate ICH practice into daily life.

Previous studies on virtual reality (VR) have demonstrated its potential to support continuous and extensive skill practice by providing virtual environments and interactions that closely simulate real-world conditions. Its effectiveness has been proven in fields where real-world constraints limit regular practice, such as surgical skills [22, 87], motor skills [18, 28], and personal safety skills [9]. In these areas, trainees are expected to perform behaviors that closely align with the demonstrated or desired standards. However, compared to technical skill training, ICH practice places greater emphasis on fostering interest, understanding, and creativity within the concerned communities [5]. Achieving this goal requires reflecting on concrete ICH practices, using methods such as active imagination to abstract cultural meanings from specific technical rules [1], and continuing to actively participate in ICH practices. Given the distinctive nature of ICH, it is crucial to explore how to design VR experiences that effectively facilitate ICH daily practice.

In this study, we take Traditional Chinese Flower Arrangement (TCFA) as a case study, aiming to explore design strategies that leverage VR's potential to support and enhance ICH daily practice. TCFA is a craft-based ICH deeply rooted in Chinese philosophy and literature [84]. These cultural influences are reflected in its styles, principles, and techniques [8, 80], such as the Confucian idea of *benevolence*, which is expressed in TCFA through the practice of cherishing flowers and decorating them minimally [84]. Another key example is TCFA's pursuit of yijing, an essential aesthetic in China's poetic traditions, which blends emotions and scenery to create a lasting, poetic appeal, often through techniques like liubai (intentional blank spaces) [29, 81]. TCFA was once one of *the Four Arts of Living* practiced by Chinese for physical and mental well-being [42], but declined since the Qing Dynasty (1636–1912) due to invasions and economic recessions [8], nearly disappearing from folk traditions [80]. Today, TCFA is experiencing a resurgence, especially among younger generations drawn to traditional culture and an aesthetically enriched lifestyle [90]. As a form of plastic art, TCFA demands continuous practice for learners to master materials, tools, aesthetic principles, and underlying cultural knowledge and philosophical reflections [8]. However, the high cost and limited availability of essential materials (e.g., woody plants and Chinese-style vases) hinder its daily practice [90].

Our research flow is shown in Fig. 2. In this study, to address **RQ1**: What specific challenges do TCFA learners face in their daily practice, and what technological solutions do they envision?, we conducted three workshops, which included a TCFA practice session and a focus group discussion. We open-coded the results and identified key barriers to daily TCFA practice, such as the lack of a cultural atmosphere in physical environments and the inability to
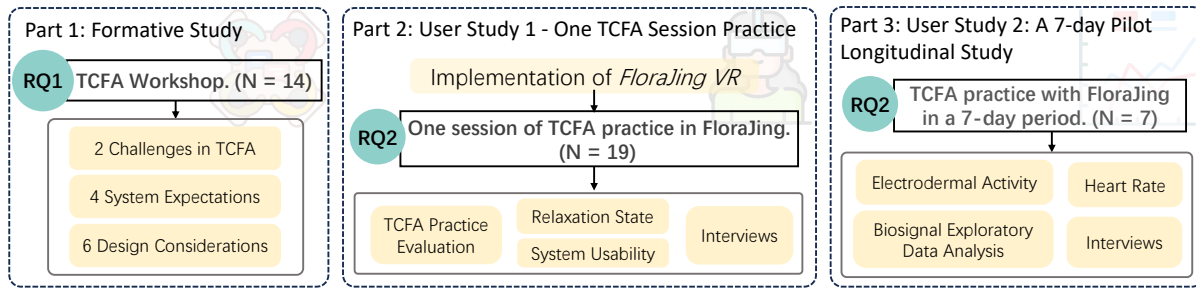
Figure 2: Part 1 investigates the current challenges in TCFA learners' daily practice and derives design considerations; Part 2 focuses on evaluating whether the VR system can support learners' daily practice; Part 3 is a 7-day pilot longitude study for assessing whether and how FloraJing could sustain daily practice over time.

revisit and reflect on practice outcomes. From these findings, we derived six design considerations (DCs). Based on these DCs, we designed and implemented FloraJing, a hand-interactive VR system aimed at supporting TCFA learners' daily practice. To address **RQ2**: How effectively do our VR designs support and sustain TCFA daily practice, and what improvements can be made in the future?, we conducted an evaluation study with learners of varying levels of TCFA expertise. This included a TCFA practice session to assess whether FloraJing could support learners' daily practice. Following this, we carried out a pilot 7-day longitudinal study to evaluate its effectiveness in sustaining TCFA daily practice over time. Key findings indicate that FloraJing supports and sustains TCFA daily practice by (1) facilitating progressive reflection and improvement based on previous TCFA work records, (2) enabling virtual creative experiences that can be transferred to real-life TCFA practice, and (3) enhancing understanding of TCFA within an immersive, culturally enriched environment.

We make two primary contributions: (1) We design and develop a VR application to support TCFA learners in their daily practice, both in cultural knowledge and skill, offering a novel approach to help preserve ICH, (2) We propose design implications for future researchers to develop effective VR applications to support ICH daily practice.

2 RELATED WORK

2.1 ICH Preservation with Digital Technologies in the HCI Community

A growing body of work in the HCI community has focused on digital innovations aimed at preserving ICH. The digital preservation lifecycle of ICH resources can broadly be divided into three key stages: recording, representing, and reviving [30]. In the recording phase, techniques similar to those used in tangible heritage (TH) preservation, such as photography, 3D scanning, and modeling, are employed to archive ICH objects and artifacts [33]. However, unlike TH, which is centered around physical objects, the cultural expressions of ICH are defined through tacit reliances and embodied practices [30]. Therefore, motion capture systems and computer vision methods are employed for movement acquisition, recognition, and reproduction within ICH, such as the sequence trajectories

of traditional folk dances [59] or the manufacturing process in traditional craftsmanship [57].

For ICH representing, HCI researchers primarily use VR-based [48, 66, 91] or AR-based [53, 83] systems to create authentic and immersive experiences. These immersive systems often integrate interactive digital storytelling [48, 67, 88] and game-based learning [56] approaches to raise awareness and enhance public engagement with ICH. For example, Liu et al. developed an interactive VR system to engage audiences with the traditional oral performance of Hua'er, which improved users' understanding of its cultural significance through participatory performance and knowledge-based gameplay [48]. These interactive systems have also been shown to strengthen family ties [13] and foster intercultural exchange [61]. These works primarily focus on providing short-term, single experiences rather than long-term integration into daily life.

Reviving ICH through technology primarily focuses on creatively integrating digital tools with traditional crafts [24, 32, 45]. For instance, Jacobs and Zoran worked with a hunter-gatherer community, combining digital tools with ostrich eggshell jewelry crafting to incorporate modern design into ancient practices, enriching communal life and sustaining cultural practices [32]. Research on supporting practice within ICH has been less explored but is essential for reviving ICH in modern contexts. For example, Yu et al. developed a mixed reality learning environment for Guqin, a traditional Chinese musical instrument, which significantly lowered the entry barriers for learners and enhanced their practice performance [89]. This study illustrates how technology can empower ICH practices and aid in the preservation of ICH traditions at risk of fading away.

Much of the digital preservation research on ICH in the HCI community has focused on the recording and representing stages, with fewer studies addressing the challenges of reviving ICH. Reviving requires the continuous adaptation and creative practice of ICH in contemporary contexts [46]. Daily practice, a key aspect of reviving ICH, integrates ICH into the everyday lives of practitioners, keeping these traditions alive and dynamic. However, factors like diminishing apprenticeships, and globalization have negatively impacted ICH daily practices [77], making it crucial to explore how digital technologies can support the daily practice of ICH in modern life.

2.2 VR for Supporting Skill Practice

VR has increasingly emerged as a high-fidelity simulation modality for skill practice and acquisition, particularly in fields where real-world resource constraints hinder regular training. Its effectiveness in supporting skill development and maintenance has been demonstrated across diverse fields requiring continuous, intensive training, such as surgical skills [22, 87], motor skills [18, 28], and mindfulness practice [20, 64].

Virtual reality offers several technical advantages for skill practice and development. First, 3D visual representation in VR offer richer information that closely approximates real-world environments, enhancing skill practice by allowing users to view scenarios from multiple angles [51]. For example, in surgical training, computer-generated 3D models in VR enabled medical students to better locate abnormalities and plan surgeries with greater precision compared to 2D methods [36, 87]. Additionally, compared to other skill practice methods, VR provides a learner-centered, embodied experience that promotes independent practice. Feinberg et al. developed a learner-centered VR application to support progressive meditation practice, showing significant improvements in both mindfulness and self-reported meditation abilities [20]. The embodied affordances of VR, such as gesture-based interactions within a 3D space, have been found to positively influence real-world learning outcomes by reinforcing physical actions performed in virtual environments [34]. Moreover, VR with multisensory integration, such as haptic feedback, can guide users to avoid unnecessary actions and ultimately reduce their cognitive load, as demonstrated in the training of dental anesthesia technical skills [15, 75].

However, most VR applications for skill training largely prioritize technical skill development, requiring trainees to replicate behaviors that align with predefined standards. Outcomes in such contexts are typically quantified through objective metrics like accuracy or speed. In contrast, ICH practice emphasizes deepening understanding, and cultivating interest and creativity within the communities [5]. While VR has been found to enhance enthusiasm, creativity, and emotional engagement in art practice [70, 82], further exploration is needed to understand how VR can be leveraged not only for training the practical skills of ICH but also for fostering the rich cultural and communal knowledge embedded within these practices. In this study, we take TCFA as a case study to investigate strategies for maximizing VR's potential in supporting ICH daily practices.

2.3 VR for Cultural Heritage Preservation

In recent years, VR has emerged as a valuable tool for both cultural heritage (CH) and ICH preservation by improving accessibility and offering realistic, immersive, and interactive experiences. Various immersive forms, such as Cave Automatic Virtual Environment (CAVE) [14], 360° videos [65, 91], VR headsets [43, 68], or their combinations, have been employed for this purpose.

VR's immersive capabilities have been utilized to create holistically immersive environments for showcasing digitized ICH works, such as 3D animations derived from recorded dance movements [2, 57]. Additionally, the embodied affordances of VR enable participants to take on roles within CH scenarios, allowing them to engage in storytelling and practices from a first-person perspective.

This interactive approach sparks interest in traditional events and encourages users to transition from passive observers to active learners [43, 68]. Non-playable characters (NPCs) in VR can serve as realistic agents for guidance and knowledge dissemination, significantly boosting users' engagement and interest in CH [48, 79]. Moreover, integrating VR with multimodal feedback significantly heightens the sense of presence while enriching the experience with additional CH information [91]. For example, Sun et al. incorporated olfactory and wind feedback to convey invisible cues. These multisensory elements also served as task annotations, provided spatial hints, and helped users gain a deeper understanding of the virtual CH environment [74]. These findings demonstrate that VR can promote active participation and cultural exploration in CH preservation. These insights inform our system design to support TCFA learners in their daily practice effectively using VR.

3 FORMATIVE STUDY

We conducted three workshops with 14 participants of varying TCFA expertise to identify specific challenges and expectations related to daily TCFA practice (RQ1), which inform our design of a supportive system. All user studies followed the standard ethical procedures of the research institute.

3.1 Workshop

To better understand TCFA before conducting the workshops, two authors read TCFA related books [42, 80] and attended courses to gain a foundational understanding of TCFA. Every workshop included a TCFA practice session and a focus group discussion. The practice session was designed to help participants recall more detailed aspects of their daily TCFA practice and to foster connections among participants. The focus group discussion aimed to understand the detailed challenges. In total, we held three workshops, each lasting between 1 to 1.5 hours.

We received support from three TCFA instructors throughout the workshops. They assisted in participant recruitment by sharing the recruitment poster, provided guidance and support on venue setup and material preparation for TCFA practice sessions, and also joined the workshops as participants, offering valuable insights during the focus group discussions.

3.1.1 Participants. We shared a recruitment poster on social media platforms and TCFA online communities to recruit participants with diverse daily practice habits and varying levels of expertise in TCFA. The poster included a questionnaire to gather details on participants' daily practice routines and skill levels. In total, we recruited 14 participants (see Table 1).

3.1.2 Procedure.

1) *Introduction.* We first asked each participant for informed consent. This consent included audio recordings and picture shots during the workshop. We then gave a short introduction describing the objectives of the study, and workshop procedures. Two researchers facilitated the workshops, one responsible for coordinating the session and the other for documenting the process.

2) *TCFA Pratice Session.* Participants took part in a free-form TCFA practice session. To ensure convenience, we consulted TCFA instructors and participants to identify essential materials for daily

Table 1: Information of Participants in TCFA Workshop. The table provides participants' demographics and their relevant experience in TCFA. *Years of Experience* **refers to the duration from when a participant began learning TCFA until the experiment.** *Total Time Spent* **refers to cumulative amount of time dedicated to practicing TCFA.**

∗ notes that P1, P5 and P10 are TCFA instructors who helped us during the workshop and joined the workshop as participants.

ID	Age	Sex	Prior TCFA Experience			Practice Frequency
			Skill Level	Years of Experience	Total Time Spent	
Group 1						
P1∗	29	F	Expert	7 years	>200 hours	Every week
P2	26	F	Beginner	3 months	10 hours	Every month
P3	27	M	Beginner	1 month	<5 hours	Every month
P4	22	F	Competent	2 year	40 hours	Every 2 months
Group 2						
P5∗	35	F	Expert	7 years	>200 hours	Every week
P6	24	F	Beginner	2 months	5 hours	Every month
P7	26	F	Competent	4 months	60 hours	Every week
P8	28	M	Competent	7 months	50 hours	Every 2 weeks
P9	20	M	Proficient	1 years	120 hours	Every week
Group 3						
P10∗	37	M	Expert	5 years	>200 hours	Every week
P11	33	F	Beginner	1 year	15 hours	Every month
P12	27	F	Beginner	2 years	15 hours	Every two months
P13	28	M	Competent	1 year	70 hours	Every two weeks
P14	32	F	Proficient	5 years	100 hours	Every month

practice and reserved a spacious tea room based on their recommendations (shown in Fig.3(a)). We provided tools like pruning scissors, floral pin holders, traditional Chinese vases, and seasonal classic materials, including lotus flowers, and leaves (see Fig. 3(b)). This session aimed to help participants immerse themselves in the practice of TCFA, encouraging them to reflect on their daily routines and experiences.

3) *Focus Group Discussion.* After practice, the focus group discussion took place beside the flower arrangement table, enabling participants to interact with the tools and refer to their work to better express themselves. Since the *TCFA Practice Session* has functioned as an icebreaker, the focus group discussion was divided into two main parts. The first part (25 minutes) focused on challenges in daily TCFA practice. Participants were asked questions such as: *What challenges do you face when practicing TCFA in your daily life?* and *How do these challenges affect your daily practice?* The second part focused on a discussion of desired technological solutions (20 minutes). Questions included *What features or tools would you like to see in a technological solution that supports your TCFA daily practice?* and *What aspects of the TCFA experience are most important to you that should be preserved or enhanced?*

3.2 Data Analysis

The data analysis aims to identify challenges and expectations of current TCFA practice, and inform the key features that better support this process. Our data consisted of observational note and audio recordings from the workshop. The audio recordings were transcribed into a text script from the workshop. To analyze the data, we followed the thematic analysis [54] method. Initially, four researchers thoroughly reviewed the script to gain a comprehensive understanding of the content. Subsequently, two authors conducted

Figure 3: (a) One of the TCFA workshop scenes in our study. (b) Difficulties in preparing the TCFA's material. (c) Frustration related to shape stability. Gravity or wilting makes it challenging to maintain flower and leaf arrangements, often requiring wires or poles for support. (d) Anxiety of irreversible pruning decisions. (e) Burden of post-practice cleanup.

the open-coding process independently after familiarizing themselves with the data. During weekly meetings, all members deliberated on the interpretations of the data, and reached a consensus on the final coding results.

3.3 Findings

3.3.1 Challenges in the TCFA Daily Practice.

Physical Environmental Constraints on Cultural Immersion. Participants (N=7) indicated that limited physical environments, such as cramped and noisy spaces, significantly affect their emotion and cultural experience of daily practice. All instructors expressed a preference for selecting venues aligned with Chinese

aesthetics (e.g., Chinese temples, Zen-inspired tearooms) for their classes to better convey the abstract sense of Chinese beauty to their students. Other participants also recognized how cultural immersion through environmental settings enhances the experience and helps materialize otherwise abstract aesthetic concepts and philosophical reflections. As P11 mentioned, *"I believe the beauty of TCFA is not limited to the act itself. The beauty of the environment is also important for understanding, especially to sense the yijing, which heavily relies on the entire setting."* However, everyday environments often fail to provide sufficient cultural immersion, which can affect learners' mood and diminish their interest in daily practice. As P4 mentioned, *"I currently live in a rented place with a small and cluttered space, so I don't feel the same sense of being immersed and relaxed as I do in class, which makes me less inclined to practice flower arrangement at home."* - **Design Consideration (DC)1: The prototype should incorporate elements that create a culturally immersive environment, even in physically constrained spaces.**

Peripheral Tasks External to the Creative Process. Participants reported that tasks outside the core flower arrangement session, such as acquiring materials (N=14) and post-practice cleanup (N=8), posed significant challenges to maintaining regular daily practice (shown in Fig. 3(b)&(e)). These tasks diminished enthusiasm, with some participants opting for classes as a complete substitute for daily training (N=5). For material acquisition, TCFA often requires ligneous plants with distinctive lines to convey energy and rhythm, which are scarce in flower markets. As P8 explained, *"Sometimes I stop by after work to buy flowers, but I mostly see flowers like roses. It's rare to come across traditional TCFA flowers like lotus or asparagus fern."* Regarding cleanup, participants reported spending between 20 minutes to over an hour on the task, significantly extending the overall activity duration. This was particularly challenging for those with busy schedules. - **DC2: The prototype should reduce the burden of peripheral tasks to maintain learners' enthusiasm and accessibility for TCFA daily practice.**

3.3.2 System Expectations.

Enabling Progressive Revisions of TCFA Works. All participants expressed regret that their previous TCFA works could not be revisited or revised. They hope for a system that could preserve their arrangements in a three-dimensional form, enabling them to freely view and modify their works from different perspectives. In real-life practices, flower arrangements inevitably wilt and fade, leaving participants with only photos to document their creations. This reliance on static images makes it difficult to refine previous works when new inspirations or ideas arise, hindering continuous reflection and improvement. As P13 mentioned, *"Tracking practice progress is very important for my learning. When I work on my next TCFA arrangement, I often review my past creations. When I have new ideas, I really wish I could revise them, but it's just not possible."* - **DC3: The system should enable users to save their TCFA works in a modifiable, three-dimensional format, to support continuous reflection, improvement, and creative exploration.**

Embodied Interaction for Authenticity. All participants expressed a desire for the prototype system to involve physical behaviors, mainly hand gestures, to conduct TCFA in a more intuitive and natural way. As P1 (TCFA instructor) shared her experience in learning TCFA, *"At first, I felt clumsy and could not create what I envisioned. But through continuous practice, I reached a state where my hands moved in harmony with my mind, achieving a seamless integration of body and spirit."* - **DC4: The prototype should incorporate natural and intuitive interaction methods that closely mimic the real-life experience of TCFA.**

Connect the Virtual Work with Reality. Most participants (N=9) expressed a desire for their TCFA creations to have a connection with their real lives, fostering a stronger emotional bond. As P6 noted, *"When I played a flower arrangement game, I created a beautiful piece, but it could only stay on the computer. I wished I could see it on my table at home—then it would feel truly special, and my effort would have more meaning."* - **DC5: The system should bridge the virtual and physical worlds to connect the virtual TCFA works with reality.**

Transcending Real-World Physical Limitations. Participants (N=9) expressed a desire for the system to offer features that go beyond real-world limitations to enhance their creative processes. Two primary challenges were identified as obstacles to their creative expression. First, the influence of gravity and the instability of long-stemmed plants commonly used in TCFA made maintaining the desired stability and shape particularly difficult (shown in Fig.3(c)), leading to frustration and reduced interest. Second, the irreversible nature of pruning created a fear of making mistakes, which could potentially ruin the arrangement or waste flowers (shown in Fig.3(d)). - **DC6: The system should bridge the virtual and physical worlds to connect the virtual TCFA works with reality.**

4 PROTOTYPE DESIGN AND IMPLEMENTATION

Based on the formative study findings and the derived DCs, we proposed FloraJing, a VR-based prototype designed to support daily practice for learners of TCFA. The name *FloraJing* was chosen to reflect the pursuit of yijing in TCFA, emphasizing the deep aesthetic and cultural experience that the system aims to facilitate. In this section, we detail the design and implementation of FloraJing, including its core features, user interface, and interaction mechanisms, as well as how these elements align with the needs and preferences of TCFA learners identified in our formative study.

4.1 System Design and Implementation

We developed FloraJing with Unity3D (2022.3.15f1-LTS)[1] and implemented it with an Oculus Quest 3[2] VR headset on a desktop computer with AMD 3500X, 16GB RAM and RTX3090 GPU. Meta XR All-in-One SDK[3] ver.66 was included to provided VR features.

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[1]Unity: https://unity.com/releases/2022-lts
[2]Meta Quest 3: https://www.meta.com/quest/quest-3/
[3]Meta XR All-in-One SDK: https://assetstore.unity.com/packages/tools/integration/meta-xr-all-in-one-sdk-269657
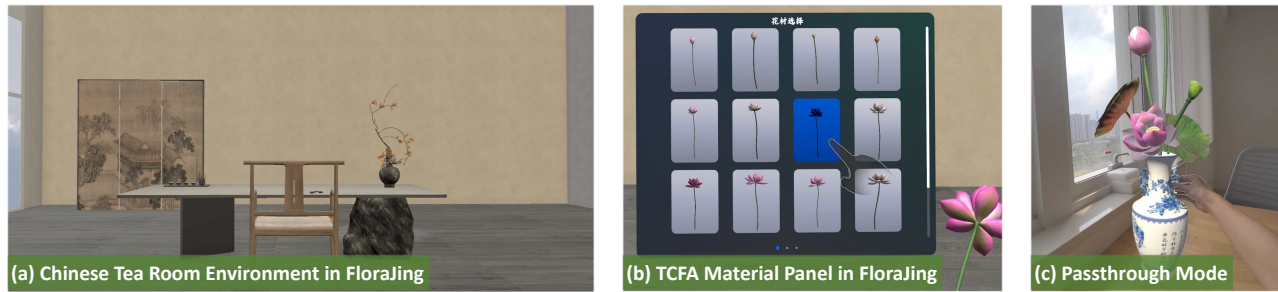
Figure 4: (a) A representative TCFA environment, specifically a tea room, was utilized as the VR scene in FloraJing. (b) Material selection panels in FloraJing, including *Flower Panel - 14 lotus models, Leaf Panel - 16 lotus leaf models* and *Vessel Panel - 12 Chinese vessel models* . (c) Mixed reality passthrough mode in FloraJing.

TCFA Theme Selection. The selection of a theme for FloraJing was guided by the principles and traditions of TCFA. TCFA emphasizes harmony with nature, the symbolism of flowers, and the reflection of seasonal changes, often referred to as "timely flower arrangement" [80]. In ancient China, arranging lotus flowers was a traditional summer practice, considered a way to stay cool during the hot months. The lotus, in Chinese symbolism, represents purity and noble character, as it is said to "emerge unstained from the mud". Since our experiment was conducted in the summer, we chose the lotus as the practice theme.

Virtual Tea Room Design. According to **DC1**, we utilized a virtual tea room environment with traditional Chinese-style decoration to create a culturally immersive TCFA environment (shown in Fig. 4(a)).

Gesture Interaction and Pruning Features. To achieve natural and intuitive interaction (**DC4**), we applied hand gesture interaction in FloraJing and attached VR grabbable modules to all TCFA materials, allowing users to perform natural gestures to freely grab, rotate and release the materials as they would in the real world. For the Pruning Feature, we used a hand gesture recorder in Unity to capture different hand gestures associated with scissor use, enabling a realistic simulation of the pruning process (**DC4**). Fig. 5(a) showcases the recording of various hand gestures for grabbing and using scissors, designed to adapt to different users' usage patterns.

Material Selection and Cleaning Features. According to **DC2**, We used categorized lists to allow users easy access to different TCFA materials, including vessels, lotus flowers, and lotus leaves, as shown in Fig. 4(b). We provided a variety of models in different styles, colors, and shapes to give participants more creative freedom. In line with **DC6**, each time a material icon on the panel is clicked, a corresponding virtual object is generated for repetitive pruning. We also designed the unwanted parts disappear after being trimmed, as shown in Fig. 5(b). Additionally, when users press the clean button on the control panel in Fig. 5(c), plant models that are in contact with the chosen vessel's collider will remain, while others will be removed, as shown in Fig. 5(d).

Artwork Saving, Photo Capture, and Mixed Reality Features. In line with **DC3**, we designed the save, and photo capture features to allow users to preserve and revise their TCFA artworks in both 3D or 2D format. When users click the save button, the prototype generates prefabs for the selected vessel and the plant

models that are in contact with the vessel's collider. This ensures that the relevant model data is saved and can be reloaded later. FloraJing also allows users to their TCFA works in reality (**DC5**) using the Quest 3's passthrough mode, as shown in Fig. 4(c).

Considerations and Trade-offs of the Gravity System. In the design of the FloraJing, we chose not to implement a gravity system and instead opted for kinematic interactions with TCFA virtual materials. This decision was primarily driven by the feedback from users regarding the challenges they face in maintaining the stability of flower arrangements in real life (**DC6**).

5 USER STUDY

The user study consisted of two parts. First, we recruited 19 TCFA learners with diverse expertise to participate in a one-session TCFA practice, assessing whether the system could support TCFA practice. Then, we conducted a 7-day pilot study to evaluate whether and how FloraJing could sustain daily practice over time (RQ2). All user studies were conducted in the same studio environment, with a floor space measuring $2.9m \times 3.9m$. The space is clearly separated from other areas to avoid disturbances, ensuring that user experiments are conducted in a relatively quiet and safe environment. A set of Meta Quest 3 128GB was used to provide VR experience.

5.1 User Study 1: One TCFA Session Practice

5.1.1 Participants. Participants were recruited through social media, snowball sampling, and online communities. To gain a comprehensive understanding of their backgrounds and expertise in TCFA, we administered an online recruitment survey before the study. In the survey, we collected participants' self-reported learning levels (classified into five levels: Novice, Beginner, Competent, Proficient, and Expert) and their daily practice frequency. Based on their responses, we recruited 19 participants (10 male, 9 female, average age = 29.4, SD = 7.48) with diverse backgrounds, as detailed in Table 2.

5.1.2 Questionnaire. The questionnaires are divided into three parts, assessing learners' practice outcomes, system usability, and relaxation state. Practice outcomes includes both skill training and cultural knowledge acquisition. Relaxation state was included as a dimension of the user experience evaluation due to feedback from workshop participants, who noted that practicing TCFA in real life

(a) Pruning Gesture Design **(b) Pruning Effect Design** **(c) Control Panel** **(d) Cleaning Function**
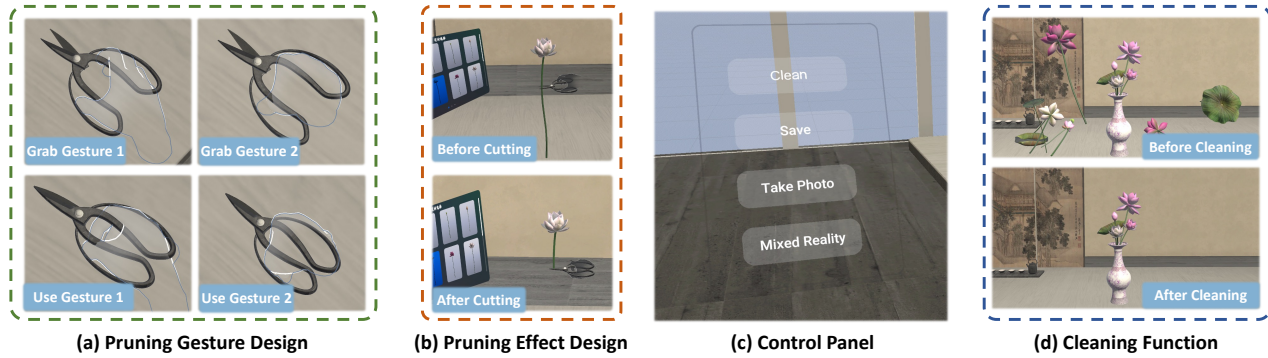
Figure 5: (a) Pruning gesture design, featuring two accommodating grab gestures and two use gestures. (b) Pruning effect design allows users to grasp the scissors to prune materials, with trimmed parts disappearing automatically. (c) FloraJing control panel enables users to clean the scene, save work, take photos, and activate mixed reality mode. (d) The cleaning function removes unwanted materials that do not collide with the vessel when the clean button is clicked.

Table 2: This table presents the demographics and relevant experience of participants, including prior experience with TCFA, and previous VR experience. ∗ indicates participants who took part in both User Study 1 and User Study 2.

ID	Age	Sex	Prior TCFA Experience			Practice Frequency	Previous VR Experience
			Skill Level	Years of Experience	Total Time Spent		
P1∗	28	M	Beginner	4 months	5 hours	Every 2 months	Yes
P2	26	F	Beginner	3 months	10 hours	Every 2 weeks	Yes
P3	23	M	Beginner	1 month	<5 hours	Every month	Yes
P4	22	F	Beginner	1 year	15 hours	Every 2 months	Yes
P5	20	F	Beginner	3 months	5 hours	Every 2 months	No
P6∗	42	F	Beginner	2 months	<5 hours	Every month	Yes
P7	25	M	Competent	3 months	40 hours	Every week	Yes
P8	28	M	Competent	6 months	50 hours	Every 2 weeks	Yes
P9	20	M	Competent	8 months	50 hours	Every week	No
P10∗	26	F	Competent	2 years	70 hours	Every month	Yes
P11∗	37	F	Proficient	10 years	200 hours	Every 2 months	No
P12∗	28	F	Proficient	2 years	150 hours	Every two weeks	No
P13	20	M	Proficient	1 year	120 hours	Every month	Yes
P14	38	M	Proficient	2.5 year	150 hours	Every month	No
P15∗	26	F	Expert	10 years	>200 hours	Every week	Yes
P16∗	37	M	Expert	5 years	>200 hours	Every 2 day	No
P17	33	M	Expert	4 years	>200 hours	Every 2 day	No
P18	41	F	Expert	7 years	>200 hours	Every week	No
P19	39	M	Expert	9 years	>200 hours	Every week	Yes

provides a relaxing effect - a sentiment echoed by the two authors who are also TCFA learners. Historically, TCFA was practiced by ancient Chinese people as a way to relax and restore [42]. Moreover, modern research on flowers and flower arrangement has demonstrated their ability to enhance relaxation and calmness [47, 85], reduce fatigue [19], and alleviate emotional stress [40, 50]. Therefore, assessing participants' relaxation state before and after using FloraJing serves as a metric for evaluating the system's capability to support TCFA practice.

TCFA Practice Questionnaire. To assess FloraJing's effectiveness in supporting TCFA practice, we selected *Overall Practice Evaluation* alongside two key TCFA skills: *Composition* and *Color Allocation* [8, 80], as well as two aspects of cultural knowledge: *Philosophical Aesthetics* and *Cultural Context* [80, 84], to form a

TCFA Practice Scale (Likert 5-point scale). For the complete list of questions, please refer to Appendix Table 2.

Relaxation State Questionnaire. To measure the user's relaxation state, we referenced the State Trait Anxiety Inventory (STAI) [71], the Discrete Emotions Questionnaire (DEQ) [26] and the Relaxation State Questionnaire (RSQ) [72] and ultimately selected the following eight emotions to capture participants' emotional responses (Likert 7-point scale): *Excited*, *Tired*, *Pleasant*, *Nervous*, *Relaxed*, *Tense*, *Calm* and *Bored*.

System Usability Questionnaires. Based on previous research on evaluating VR system usability [17, 31, 49], we adopted System Usability Scale (SUS, Likert 5-point scale) [6] and NASA Task Load Index (NASA-TLX, Likert 5-point scale) [27] to jointly assess FloraJing VR's usability, as shown in Appendix Table 1. SUS was used

to measure the system's overall ease of use and user satisfaction, while NASA-TLX was employed to evaluate the perceived workload and stress experienced by users during interaction with the system.

5.1.3 Procedure. The session comprised five parts, as shown in Fig. 6, and lasted approximately one hour. Each participant received 100 RMB as compensation upon completing all tasks.

1) ***Introduction and Pre-Relaxation State Record.*** Before starting, the participants were first briefed on the project and signed an informed consent form, which included permission for photos, screen, and audio recordings. Next, the participants filled out the NASA-TLX questionnaire (**Daily-NASA-TLX**) to assess their perceived workload during the conventional daily practice of TCFA. Following this, they completed a pre-experiment relaxation state questionnaire (**Pre-Relax**), as described in Section 5.1.2, to gauge their relaxation state before using the FloraJing.

2) ***System Familiarization.*** Once the participants finished the emotion record, they were exposed to a prerecorded two-minute video clip illustrating the basic operations of FloraJing, which included interacting with the menu using pinch and poke gestures, selecting and grabbing plants, and using virtual scissors to cut materials. Participants were given ample time to navigate the virtual environment until they self-reported having mastered the controls and interactions. Once they expressed confidence in their ability to operate the system, they removed the Quest 3 headset and took a three-minute break.

3) ***FloraJing Experience.*** After the break, participants began completing a TCFA practice session within FloraJing. They were provided ample time to work on their arrangements, allowing them to practice and refine their creations multiple times until they were fully satisfied. At the conclusion of the experience, participants saved their final creations. The TCFA works created by the 19 participants in our user study are shown in Fig.7.

4) ***Post-Relaxation State Record and System Evaluation.*** After completing the experience session, participants were first asked to fill out a post-experiment relaxation state questionnaire (**post-Relax**) after engaging with FloraJing. Following this, they completed the **SUS**, a second NASA-TLX questionnaire (**VR-NASA-TLX**) to assess their perceived workload in the virtual environment, and a **TCFA Practice Questionnaire** to evaluate the system's effectiveness in supporting their TCFA practice.

5) ***Semi-Structured Interview.*** Finally, participants engaged in semi-structured interviews (lasting approximately 30 minutes) to discuss their overall experience with FloraJing, the system's usability, the effectiveness of the skill practice features, and their suggestions or expectations for system improvement.

5.2 User Study 2: A 7-day Pilot Longitudinal Study

5.2.1 Participants. To ensure continuity in the research and obtain in-depth feedback on TCFA practices, we recruited participants from User Study 1 to participate in User Study 2. Due to device limitations, the 7-day Pilot Longitudinal Study was conducted in the same lab space as User Study 1 on campus. To approximate a daily practice context, we recruited participants living on campus. Seven participants took part in User Study 2 over the 7-day period, as indicated by ∗ in Table 2.

5.2.2 Procedure. The positive results regarding the subjective relaxation effects from participants in User Study 1 motivated us to incorporate biofeedback in User Study 2 to empirically asses the relaxation effects of FloraJing. The procedure of the User Study 2 is shown in the lower part of the Fig.6. We collected Electrodermal Activity (EDA) and Heart Rate (HR) which are well-established physiological measures used to assess emotional and stress responses in previous studies [10, 21]. EDA reflects changes in skin conductance associated with sweat gland activity, which is often influenced by emotional arousal and relaxation states. HR, on the other hand, is indicative of autonomic nervous system activity, with lower rates typically associated with relaxation and higher rates linked to stress [4, 11].

1) Introduction. Participants were initially provided with an introduction and informed consent for physiological data collection, including video recording. To align with the general daily practice of TCFA, we informed participants that the experimental space would be available with researcher assistance from 6:00 AM to 11:00 PM daily. The study operated on a drop-in basis, allowing participants to join freely at their convenience.

2) Daily Practice Session. During each session, participants wore the Empatica E4 wristband[4] to continuously record EDA and HR, with data streamed in real-time for monitoring by the experimenters. Participants wore the Empatica E4 wristband on their non-dominant hands, which were all left hands in this study. E4's EDA sampling rate is 4 Hz, while the HR sampling rate is 1 Hz. Once the EDA and HR data stabilized, the formal daily practice session commenced. Both the beginning and end of the TCFA practice were marked with event tags. Each TCFA practice session was recorded through video and screen capture. Each daily practice session lasted approximately 30 to 50 minutes. Participants engaged in daily sessions between 2 to 4 times during the 7-day period. Specifically, among the seven users, three (P6, P11, P12) participated in two daily practice sessions over the seven days, three (P1, P10, P16) participated in three sessions, and one (P15) participated in four sessions. Overall, there were a total of 19 daily practice sessions.

3) Overall Semi-structure Interview. At the end of User Study 2, participants engaged in a semi-structured interview. Based on our observations, participants demonstrated reflective thinking on previous TCFA practices, abstracted cultural meanings from TCFA skills and specific virtual objects, and continued to actively engage in TCFA daily practice during the 7-day period. This aligns with Kolb's experiential learning model, which emphasizes learning through a cycle of Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation [38]. Therefore, our interview questions were designed based on Kolb's experiential learning model and observations of physiological data and screen recordings. The questions covered four dimensions: 1) Whether and how FloraJing helped improve their skills. 2) Whether participants engaged in reflection during VR practice and how this reflection occurred. 3) How VR practice deepened their understanding of TCFA culture, and in what ways. 4) Whether they practiced TCFA in real life after VR sessions, and if so, how VR practice influenced their real-life practice. For the complete list of questions, please refer to Appendix Table 3.

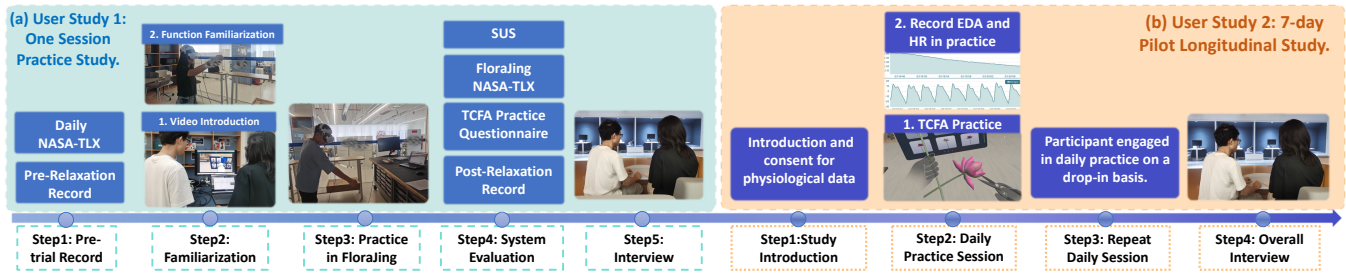[4]Empatica E4 wristband: www.empatica.com/en-int/research/e4/

Figure 6: The Study Procedure of One TCFA Session Practice and 7-day Pilot Longitude Study.

6 FINDINGS

6.1 Overall Experience.

Overall, all participants indicated that the experience of practicing TCFA in FloraJing was novel, interesting, immersive, convenient and low-cost. Every participant reported experiencing the same flow state [16] in VR as they did during real-life TCFA practice. They felt that their skills and cultural understanding of TCFA were enhanced through the practice in FloraJing, and they expressed a willingness to use it for daily TCFA practice in their lives in the future.

6.2 FloraJing's Usability

The participants' feedback on the prototype's usability was gathered from the data collected in User Study 1, including the *SUS*, *Daily-NASA-TLX*, and *VR-NASA-TLX* questionnaires, as well as the time spent by users on system familiarization and practice complexation.

Reduction in Time and Physical Load. Compared to the time participants reported spending on daily TCFA practice (Daily: $M = 82.5min$, $Max = 210min$, $Min = 42min$), all participants expressed that FloraJing (VR: $M = 15.6min$, $Max = 35min$, $Min = 9min$) significantly saved time by eliminating the need to purchase flowers, stabilize arrangements, and clean up the environment. We also compared the *Daily-NASA-TLX* and *VR-NASA-TLX* scores (as shown in Fig. 8(b)). A Shapiro-Wilk test on these two NASA-TLX scores indicated that the data is not normally distributed ($p < 0.05$). Therefore, Mann-Whitney U tests were performed. The results show that, compared to real-life practice, practicing TCFA in FloraJing significantly reduced physical, mental, and temporal demands (each $p < 0.001$).

Ease of Use. The *SUS* score analysis [6] indicates that FloraJing's various functions are well-integrated, easy to learn ($M = 4.7, SD = 0.71$), easy to operate ($M = 4.2, SD = 0.76$), and smooth in use ($M = 3.8, SD = 0.82$). The short time participants spent during the system familiarization phase ($M = 6min, Max = 9min, Min = 4min$) further suggests that the system is intuitive and easy to learn.

6.3 Effectiveness of FloraJing supporting TCFA Daily practice

Participants from *User Study 1* recognized FloraJing's contribution to enhancing their overall TCFA skills ($M = 4.2, SD = 0.52$). Beginners, in particular, found the learning benefits significant ($M = 4.4, SD = 0.51$), though no substantial difference was observed between participants of varying skill levels (p > 0.05). Most
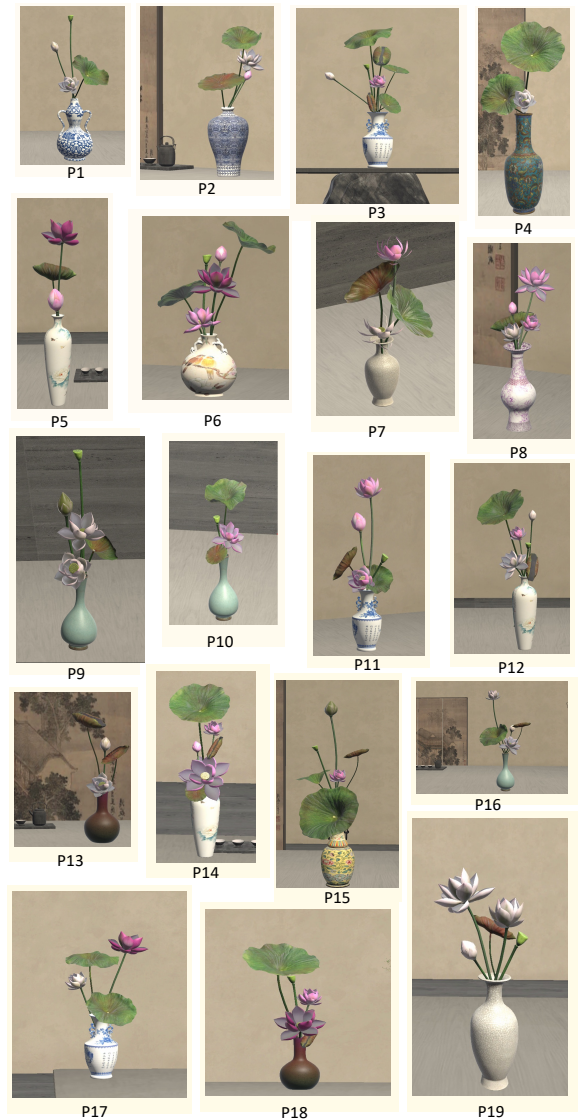

Figure 7: The TCFA works created by the 19 participants in our user study 1.
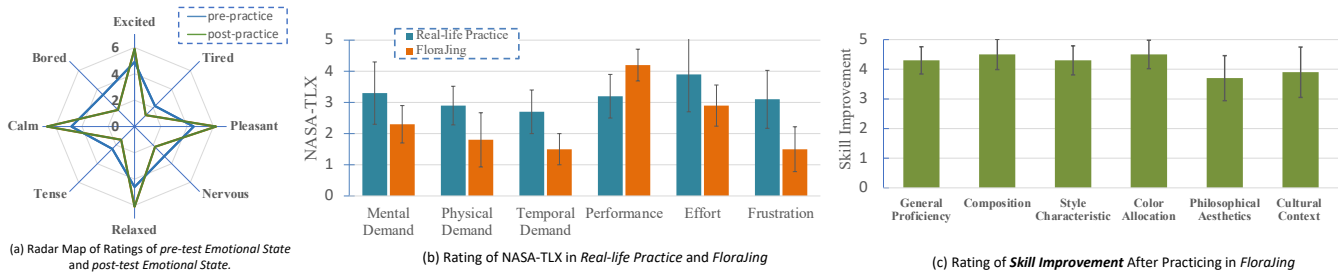
(a) Radar Map of Ratings of *pre-test Emotional State* and *post-test Emotional State*.

(b) Rating of NASA-TLX in *Real-life Practice* and *FloraJing*

(c) Rating of **Skill Improvement** After Practicing in *FloraJing*

Figure 8: Results of the questionnaires in user study. (a) Radar Map of Ratings of *pre-practice Relaxation State* and *post-practice Relaxation State*. (b) Bar Chart of Scores of NASA-TLX in *Real-life Practice* and *FloraJing*. (c) Bar Chart of Scores of *Skill Improvement* After Practicing in FloraJing.

participants (N=12) appreciated the diverse selection of virtual materials, which offered them greater creative freedom.

6.3.1 Facilitate Progressive Reflection and Improvement Based on Previous TCFA Work Records. Participants from the 7-day pilot study indicated that the ability to view and modify previous TCFA works in FloraJing significantly facilitated their reflection and improvement. This benefit was evident in their exploration of different styles, refinement of past works, and motivation to learn more about TCFA knowledge and skills. We observed that all participants began their practice in FloraJing by reviewing their previous works, as shown in Fig. 9(a). Having these as references inspired them to experiment with varying styles, such as alternative color allocation and composition, to challenge themselves. P15, for instance, frequently revisited her earlier creations while selecting vases and flowers.

After completing their arrangements, most participants (N=5) laid out all their works on the table for extended observation and contemplation. P6, after completing her third practice, believed that the third work had the most harmonious proportions. In contrast, she identified issues in her earlier creations, *"The first was top-heavy with a crowded base, lacking the beauty of blank space in TCFA, and the second suffered from disharmony between the flowers and the vase proportions."* Using insights from her comparative observation, she revisited and refined her earlier works, as shown in Fig. 9(b). P12, on the other hand, was surprised by how her aesthetic preferences limited her creative output. After her fourth practice, through comparative observation, she realized that despite attempting to create something entirely different, the resulting structures across her works were similar, with only the colors changing. Reflecting on this, P12 remarked, *"I might like this style, but it also shows my lack of learning. I need to explore more works and different expressions to enrich myself. "*

6.3.2 Transfer Virtual Creative Experience to Real-Life TCFA Practice. Four participants from 7-day pilot study practiced TCFA in real life. They indicated that their practice in FloraJing motivated them to conduct TCFA practice in real life, and acknowledged that VR practice contributed to their real-life training by helping them better conceptualize their arrangements and enhancing their confidence and boldness in real-life creations. Participants noted that their virtual creations in FloraJing served as references for real-life arrangements. When encountering similar flowers, vases, or styles,

they would recall their VR creations to aid in pre-arrangement conceptualization, achieving an effect similar to that of practicing with real flowers. For instance, P11 utilized her VR TCFA work as inspiration, adapting it with different materials to replicate similar structures and colors in a real-life arrangement, as shown in Fig. 9(a). Additionally, participants mentioned that the shorter VR practice sessions allowed them to produce a larger variety of samples for future reference. They also expressed that practicing in FloraJing boosted their confidence in real-life TCFA practice. They became more willing to experiment with a broader range of materials and attempt more complex compositions and color combinations.

6.3.3 Increase understanding of TCFA within immersive cultural-enriched Environment. Participants indicated that the combination of traditional Chinese-style sound and visuals helped create a culturally immersive atmosphere, which deepened their understanding of the *Philosophical Aesthetics* ($M = 3.9, SD = 0.73$) and *Cultural Context* ($M = 3.9, SD = 0.84$) of TCFA. All participants expressed that their work was influenced by the environment, leading them to adjust their creations to achieve aesthetic harmony with the setting. For example, P13 mentioned being inspired by the virtual Zen-style tea room, she decided to leave more blank spaces to create a sense of breathability and potential. P11, on the other hand, noted that the background music (he recognized it as *High Mountains Flowing Water*) and the traditional Chinese landscape painting screen inspired him to showcase the natural growth and blossoming of the lotus flowers. The TCFA materials also led participants to associate their creations with related literary works (N=4). For instance, P1 recalled the classical Chinese poetry that praises lotus flowers, *Ode to the Lotus*, which inspired them to emphasize the noble qualities of the lotus in his arrangement. Their TCFA works created by participants from User Study 1 are shown in Fig. 7.

6.4 Relaxation State Changes

6.4.1 Subjective Relaxation Effect. The radar chart Fig. 8(a) illustrates participants' subjective relaxation state before and after using the system. A Shapiro-Wilk test indicated that the data of the *Relaxation State Questionnaire* is normally distributed (p > 0.05). Given the pre- and post-test design within subjects, we performed paired t-tests to assess significant differences in emotional ratings. The analysis revealed significant effects on all dimensions. All participants expressed that while arranging flowers in FloraJing VR, the
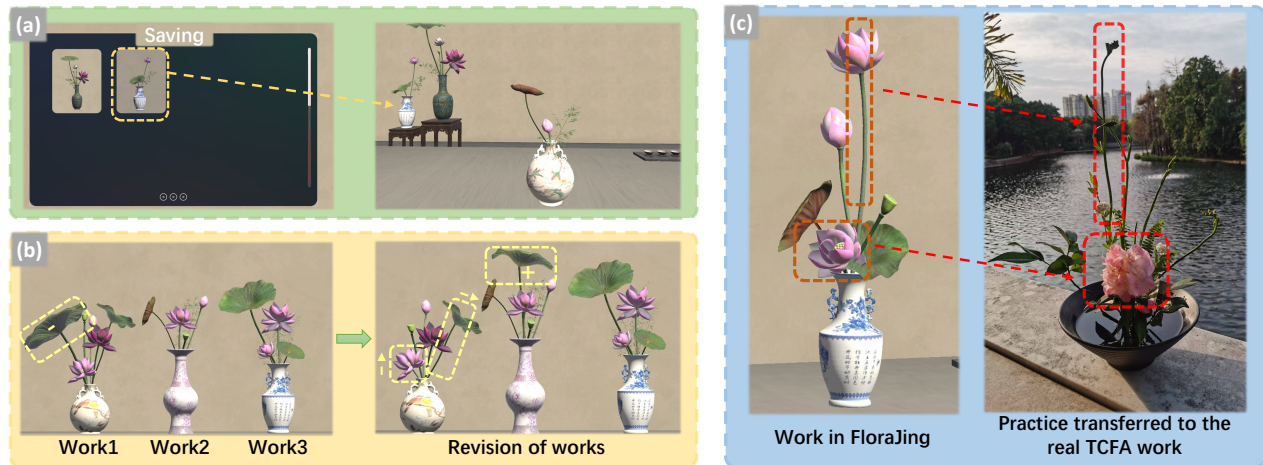
Figure 9: (a) In User Study 2, participants can save their work and review it while creating new TCFA. (b) The series of works by P6 in User Study 2, where she reflected on and adjusted previous creations during the 7-day practice, is highlighted with yellow borders. (c) A participant transferred their creations from VR to real-life TCFA, using similar techniques, as shown with red borders.

natural, realistic, and coherent interactions allowed them to enter a flow state similar to that of real-life flower arrangement. Due to the immersive nature of VR, which isolates external distractions and creates a cultural atmosphere through audiovisual elements, some participants (N=7) indicated that practicing flower arrangement in VR provided a greater relaxation effect than real-life practice. P13 shared, *"Although I had sweat on my head after taking off the HMD, I didn't feel any fatigue. I could clearly feel that my mind and body were in a joyful state, and this feeling was even stronger than when arranging flowers in real life. I actually worked a night shift yesterday and then an early shift today, so I was a bit tired. But after doing this today, I felt relaxed and awake. It's quite amazing."*

6.4.2 EDA Data Indicates Relaxation Effect. We utilized relative change to assess both EDA and heart rate (HR) during the TCFA practice[23, 44]. We calculated the difference between the average EDA and HR values during the activity and their respective baseline values. Each participant's EDA and HR were measured during the one minute prior to the start of each TCFA practice session to establish the baseline. The average EDA and HR throughout the entire floral arrangement activity were then computed. For the EDA data, a relaxation state is defined as a relative decrease exceeding 10%, while for the HR data, it is defined as a decrease exceeding 5%.

For the results, based on EDA data, seven users entered a relaxation state after the daily practice, while according to HR data, five users reached a relaxation state post-practice. Regarding the 19 independent daily practice sessions conducted by the seven participants, as mentioned in Section 5.2, the EDA data indicated that users entered a relaxation state in 15 sessions (78.9%), whereas the HR data showed that users reached relaxation in 8 sessions (42.1%).

6.5 Expectations for Improvement

6.5.1 Enhancing Cultural Immersion through Olfactory Simulation of Traditional Chinese Incense. While participants appreciated the

visual and auditory simulations in FloraJing, they pointed out the absence of olfactory enhancement. Interestingly, even though floral scents are integral to the flower arrangement experience in reality, most participants (5 out of 7 who mentioned the lack of olfactory input) expressed a preference for the simulation of traditional Chinese incense rather than floral scents. They also expect this incense to be accompanied by visual effects, such as the rising of smoke. When further asked why they preferred Chinese incense over floral scents, participants explained that rather than pursuing sensory realism, they more valued a multisensory experience that enhances the cultural atmosphere and immersion. As P6 said, *"No, I didn't think of flower scents. Because it's Chinese flower arrangement, I'd prefer a deeper immersion in Chinese aesthetics."*

6.5.2 Personalized Feedback on TCFA Artwork. Participants had differing opinions and needs regarding whether they should receive feedback on their flower arrangements after practicing in FloraJing. Most participants (N=10) expressed a desire to receive feedback from others, mainly from instructors, while others preferred not to receive any external feedback because they viewed daily practice as a means of self-relaxation and self-expression. They were concerned that receiving feedback might turn daily practice into an assignment, making it feel more stressful rather than enjoyable. While also expressed concern that the teacher's feedback might affect their sense of relaxation, P4 and P3 proposed having an AI TCFA instructor as a way to reduce the psychological burden.

For those who wanted feedback, their preferences regarding the type and level of feedback varied. Some (N=4) wished to see the entire process from a first-person perspective of how the teacher freely modified their arrangement, along with the final result. Some (N=3) hoped the teacher would use the same materials they had used to make modifications, believing that restricting the materials would result in more focused and tailored advice. P13 and P6, on the other hand, preferred to see only the final result, choosing to reflect on and appreciate the changes independently.

6.5.3 Different Requirements for System Realism. Participants expressed varying requirements for system realism, primarily concerning the realism of tactile feedback and the mechanical systems in the virtual environment, with differing opinions and suggestions for improvements. Regarding the realism of the mechanical system, all beginners and most competent participants (N=9) reported that the absence of gravity made the process more enjoyable, allowing them to focus more on the arrangement without the constraints of real-world physics. However, for those with higher tactile expectations (N=4), mainly experts, They felt that the lack of haptic feedback during the virtual arrangement process in FloraJing made the experience fall short of the standards for creative expression. Despite this, they also acknowledged the system's value for training in color coordination and layout techniques.

As for the feedback related to real-world tactile sensations, there was no clear distinction based on TCFA skill level, but different purposes drove their preferences. Some participants (N=6) simply wanted a stick-like tool for supporting their hand during the arrangement, simulating the suspended position in real-life flower arranging. On the other hand, others (N=4) desired dynamic feedback matching the virtual model to better replicate the physical experience of flower arranging.

7 DISCUSSION AND FUTURE WORK

Informed by a formative study with TCFA learners of varied expertise, we identified six DCs and developed FloraJing, a VR application that provides rich cultural environments and accessible materials and tools. We then conducted a one-session TCFA practice with FloraJing to assess the system's support for TCFA practice, followed by a 7-day pilot longitudinal study to evaluate its effectiveness in sustaining TCFA daily practice. The results demonstrated that FloraJing facilitates TCFA learners' progressive reflection, skill improvement and enhances cultural understanding of TCFA. Participants also expressed diverse needs regarding the system's realism and the types of feedback they received on their creations. In this section, we discuss how our findings inform the design of systems that support daily practice for ICH with VR.

7.1 Supporting ICH Daily Skill Practice through VR

In this section, we refer to Kolb's experiential learning model [38], which aligns with the learning patterns of participant' practices, to propose design implications for future research.

7.1.1 Enhancing Concrete Creative Experience by Reducing Peripheral Tasks in ICH Practice. In Kolb's experiential learning model, the Concrete Experience phase refers to learners engaging directly with a related hands-on experience [38]. Our findings indicate that preparatory activities such as gathering materials and organizing the workspace, which are external to the creative process, significantly hinder ICH learners from maintaining regular daily practice and greatly impact their creative experience. Studies have demonstrated that having a well-organized and prepared environment reduces cognitive load for creators, while disruptions in these stages can slow down the creative process and lead to frustration or reduced creative satisfaction [7, 12]. In this study, participants noted

that the abundant variety of high-fidelity TCFA materials and convenient cleaning features in FloraJing allowed them to focus more deeply on the concrete TCFA creative process, enhancing their immersion and enabling them to direct their full attention to the artistic aspects of the practice. This also shortened the time required for daily practice, making it more flexible and convenient to schedule.

VR can help unlock creative potential by reducing the need for physical resources [70, 82]. To maximize the benefits of VR in making daily practice more flexible for ICH learners, we propose **Design Implication 1: Enabling ICH learners to focus more on their artistic expression by reducing peripheral activities and disruptions in their daily practice.**

7.1.2 Using Multimodal Co-creation of ICH Cultural Atmosphere to Enhance Understanding of Abstract Aesthetic Concepts. The Abstract Conceptualization phase with Kolb's experiential learning model involves learners forming deeper insights and frameworks by interpreting experiences. Participants' feedback in our study indicated that the visual elements (e.g., the tea room and TCFA flowers) and auditory simulations (e.g., traditional Chinese music) together shaped a cultural atmosphere that helped them conceptualize TCFA's aesthetic principles, such as *intended blank* and the *harmony between humans and nature*, and facilitated associations with related literary knowledge.

When participants expressed a desire for enhanced sensory experiences, they preferred the simulation of traditional Chinese incense over floral fragrances, even though floral scents are naturally part of real-world flower arranging. While sensory realism is often emphasized in many VR skill practice systems in pursuit of better skill training outcomes [18, 28, 35, 87], our results show that, instead of pursuing sensory fidelity, ICH learners in daily practice favor a richer cultural atmosphere and immersion. This approach helps them better understand and engage in the ICH aesthetic experience. To create a more culturally immersive experience in VR systems for ICH learners' daily practice, we propose **Design Implication 2: Enable ICH learners to better understand and immerse themselves in the cultural atmosphere of ICH through multimodal co-creation aligned with its cultural essence.**

7.1.3 Reflective Observation with Progressive ICH work Records. In Kolb's experiential learning model, the Reflective Observation phase involves learners contemplating their experiences and drawing insights to guide future actions [38]. Our findings suggest that the ability to review and modify previous TCFA works in FloraJing significantly supported learners' reflection and improvement during their practice. Participants in the 7-day pilot study emphasized that revisiting and adjusting their past works was crucial for personal growth, helping them identify strengths and weaknesses in their arrangements and make adjustments accordingly.

Research on creative skill improvement, particularly in art and design education, indicates that keeping records of past works can substantially impact skill development in creative practices [55, 62]. Reviewing and reflecting on these works fosters a deeper understanding of one's progress and encourages continuous refinement. Based on these insights, we propose **Design Implication 3: Facilitating progressive reflection and skill improvement by enabling learners to revisit and modify previous ICH works**

in virtual systems, enhancing their learning through continuous observation and refinement.

7.2 Enhancing Emotional Well-being in ICH Pratices Through VR

Studies indicate that engaging with ICH activities in VR can help ICH learners relaxed. The immersive involvement in ICH activities (e.g., traditional crafts) fosters a sense of connection with local people and culture, and the aesthetic experience, satisfaction, or achievement from creating ICH works leads to increased well-being, stress relief, and personal happiness [25, 52, 63, 86]. However, in real-life scenarios, environmental distractions and peripheral tasks related to creation (e.g., material preparation) often interrupt the immersive experience of ICH [7, 12]. These distractions can limit the emotional benefits and flow experiences that come from sustained attention and mindfulness in practice.

Our findings suggest that VR can help users overcome these challenges by immersing themselves more easily in a culturally rich virtual environment. In VR-based ICH practices, users can quickly immerse themselves, achieving or even surpassing the flow experiences found in real-life ICH practices. They feel both relaxed and energized, deeply focused yet not fatigued, and even experience a sense of self restoration [37] . VR has been shown to improve users' focus by isolating them from external distractions, inducing a flow state, and enhancing concentration [60]. This benefit is particularly valuable for activities that demand sustained attention or mindfulness [20, 64], like ICH practices. This benefit is particularly valuable for activities that demand sustained attention or mindfulness [20, 64], like ICH practices. In the context of ICH, we advocate for future research to explore the potential of enhancing emotional well-being in ICH practices through VR, given its capacity to create immersive, culturally enriched environments that foster deeper emotional engagement.

7.3 Limitation and Future Work

7.3.1 Lab-based Longitudinal Study. Influenced by the constraints of available equipment, our 7-day Pilot Longitudinal Study is the setting in a campus lab environment. Although we selected participants who lived on campus and extended the available time as much as possible, The controlled lab environment might not fully capture the diversity of real-life settings. Future work could deploy the study in participants' homes for a longer period.

7.3.2 Small Sample Size in TCFA Workshop. One limitation of this study is the small sample size in the initial workshop, which might affect the generalizability of the findings regarding the challenges faced by TCFA learners. While the small sample allowed us to gain valuable insights into the specific difficulties encountered by a diverse group of TCFA learners, we recognize that a larger sample size could provide more comprehensive data and a better understanding of these challenges across various skill levels.

7.3.3 Control Group for Comparison. This study does not include a control group, as the primary goal of this exploratory research was to investigate how VR features could facilitate ICH daily practice, focusing on the design process and rationale. However, future work could compare the effectiveness of VR with other technologies (e.g.,

AR) in supporting ICH daily practice to gain different insights into the creative practice of ICH in a contemporary technological era.

7.3.4 Possibility of Expert Involvement. A limitation of this study is that two of the researchers were still in the learning phase of TCFA. While expert participants provided valuable support through their professional knowledge and guidance on venue setup, their level of involvement was not fully integrated into the research process, such as informing the data interpretation.

In future work, we suggest involving ICH experts more deeply, potentially as co-authors. Their active participation might provide more critical insights into system design and ensure a more nuanced interpretation of the data, offering a more accurate representation of TCFA practices and learner experiences.

8 CONCLUSION

This study highlights the potential of VR as an effective tool for facilitating ICH daily practice through a case study of TCFA. We conducted three workshops to identify specific challenges TCFA learners encounter and derived six design considerations (DCs). Based on these considerations, we proposed FloraJing, a VR application that provides rich cultural environments and accessible materials and tools for the daily practice of TCFA. We conducted a one-session TCFA practice with FloraJing to assess the system's support for TCFA practice, followed by a 7-day pilot longitudinal study to evaluate its effectiveness in sustaining TCFA daily practice. The results demonstrated that FloraJing facilitates TCFA learners' progressive reflection, skill improvement, and enhances cultural understanding of TCFA. Our work provides a foundation for future research in this field, highlighting the potential of VR applications designed for ICH daily practice, both in knowledge and skills.

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A Appendix

Table 1: The questionnaires used in the One Session Practice User Study to assess FloraJing's system usability.

	I. System Usability Scale (SUS)
1	I think that I would like to use FloraJing frequently.
2	I found FloraJing unnecessarily complex.
3	I thought FloraJing was easy to use.
4	I think that I would need the support of a technical person to be able to use FloraJing.
5	I found the various functions in FloraJing were well integrated.
6	I thought there was too much inconsistency in FloraJing.
7	I imagine that most people would learn to use FloraJing very quickly.
8	I found FloraJing very awkward to use.
9	I felt very confident using FloraJing.
10	I needed to learn a lot of things before I could get going with FloraJing.
	II. NASA Task Load Index (NASA-TLX)
1	How mentally demanding was it to complete the TCFA practice in FloraJing?
2	How physically demanding was it to complete the TCFA practice in FloraJing?
3	How hurried or rushed was the pace of the TCFA practice in FloraJing?
4	How successful were you in accomplishing the TCFA practice in FloraJing?
5	How hard did you have to work to accomplish your level of performance?
6	How insecure, discouraged, irritated, stressed, and annoyed were you?

Table 2: The questionnaires used in the One Session Practice User Study to assess FloraJing's TCFA practice effect.

	TCFA Practice Scale
	I. Overall Practice Evaluation
1.	I feel that my overall skills in Chinese flower arrangement have improved.
	II. Composition
2.	I feel that my composition skills in Chinese flower arrangement have improved.
3.	I feel that my shape-designing skills in Chinese flower arrangement have improved.
4.	I think that my proportion skills in Chinese flower arrangement have improved.
5.	I think my work has improved in terms of balance and contrast.
	III. Color Allocation
6.	I feel that my color allocation skills in Chinese flower arrangement have improved.
7.	I think my skill in the overall harmony of colors in my work has improved.
8.	I think my skill to express the depth and variation of colors has improved.
	IV. Philosophical Aesthetics
9.	I believe I have gained a deeper understanding of the philosophical aesthetics of TCFA
10.	I believe I have gained a deeper understanding of the Chinese philosophy of the unity between nature and humanity.
11.	I think I have a deeper understanding of the philosophical concept of Yin-Yang balance
12.	I think my understanding of yijing has deepened.
13.	I think I have a deeper understanding of the aesthetics of the pursuit of intended blank space.
	V. Cultural Context
11.	I believe I have gained a deeper understanding of the cultural context of TCFA
12.	I think I have a deeper understanding of the symbolic meanings attributed to flowers in Chinese literature.
13.	I have gained a deeper understanding of expressing emotions through flowers in Chinese culture.

Table 3: The outline of semi-structured interview according to Kolb's experiential earning model for the 7-day Pilot Longitudinal Study.

	I. Concrete Experience
1	Can you describe your overall experience using the FloraJing VR system for TCFA?
2	What specific features of FloraJing did you find most beneficial in enhancing your TCFA skills?
	II. Reflective Observation
3	During your practice sessions, did you engage in any reflection about your skills or techniques? If so, how did this reflection manifest?
4	What challenges did you encounter while practicing your TCFA skills in FloraJing, and how did you address them?
	III. Abstract Conceptualization
5	In what ways did your VR practice deepen your understanding of TCFA culture and its significance?
6	How did the interactive features of FloraJing contribute to your learning about floral design techniques and cultural practices?
	IV. Active Experimentation
7	Have you practiced TCFA in real life after using FloraJing? If so, how did your VR experience influence your real-life floral arrangements?
8	How do you plan to apply the skills you learned in FloraJing to real-life TCFA or other creative activities?
	V. General Feedback
9	What aspects of the FloraJing most effectively supported your skill development? Were there any features you felt could be improved?
10	Is there anything else you would like to share about your experience with FloraJing?