LanternOperAR: A Hybrid Cultural Gift for Quality Education and Family Well-being*

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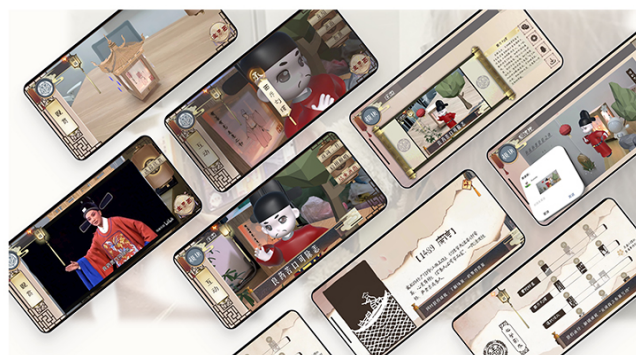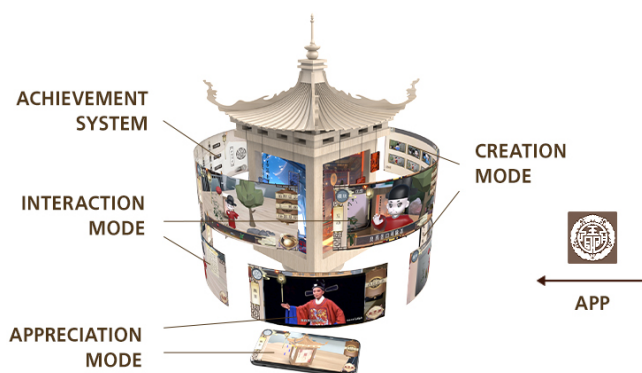ningning.xu@zwu.edu.cn

Figure 1: Overview of LanternOperAR.

ABSTRACT

Quality education and well-being have always been the focus of sustainable development as social concerns, with an increasing demand for enriched cultural activities. Shared experiences, especially in family setting, bring about a better understanding of culture and foster public interest. In this context, our research endeavors to promote the philosophies and historical insights of Yangmingism while concurrently seeking to uplift family well-being through the immersive cultural exposure offered by Yue Opera, a national opera in China. To intertwine the cultural content for a consistent and continued experience, we design LanternOperAR, a hybrid gift for cultural appreciation, learning and recreation. We fully consider and respect user interests and requirements among different target groups to provide playful interaction in cultural activity, thereby promoting cultural inheritance and strengthening family ties.

CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**; **Mixed / augmented reality**; **User centered design**.

KEYWORDS

Augmented Reality, Yue Opera, Quality Education, Cultural Heritage, Sustainable Development

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1 INTRODUCTION

Guided by the 2030 Agenda set by the United Nations in 2015, the preservation of cultural heritage has become an integral part of the Sustainable Development Goals (SDGs). Yue Opera, recognized for its unique sing-song storytelling style, is regarded as an intangible cultural heritage. Its performances delve into narratives, and character relationships, serving as a bridge for

conveying the abundant Chinese cultural ideologies and historical depth [7]. For decades, Chinese institutions have been devoted to promoting cultural inheritance. Digital resources like text, images, and videos have been used as a valuable medium for preserving local opera and its hidden cultural thoughts.

In line with these efforts, we see the promotion of Yue Opera *'Wang Yangming'*, which centers on the life and teachings of the influential Chinese philosopher of the same name. His philosophy, Yangmingism, has a major influence on society and culture, linking to the Chinese civilization and the world [13]. The play reproduces historical events and development tracks of these philosophies. It translates abstract theories into art, bringing history and cultural thought to life. Nevertheless, this passive watch mode may not effectively engage the general public. Consequently, it's essential to delve into a new dissemination paradigm to present Yue Opera performances in a more immersive way. An emerging trend is the use of augmented reality (AR) for shared experience in cultural narratives, since its strengths in scenario creation [14], interactive storytelling [3], and active exploration [15]. Past studies have presented the use of tangible AR interfaces to foster embodied interaction with multi-sensory experience [9, 14], which greatly enhances the learning motivation, experience and outcome in cultural heritage. Therefore, we would like to design a hybrid cultural gift as a carrier in a shared space to provide active cultural activities.

In this paper, we propose LanternOperAR, an hybrid cultural gift based on the Yue Opera *Wang Yangming* to promote quality education and family well-being. We present our research procedure based on the cultural product design model [10] as depicted in Fig. 2, and further discuss the contributions to the SDGs and design considerations for future development.

2 REQUIREMENT GATHERING

2.1 Background Research

To better understand the culture of Yue Opera, we first conduct the ethnographic study of Yue Opera in *Shijia'ao* village located in Shenzhou and extend to interviews with professional actors and audiences. Their interpretations of performance and relevant insight contribute to comprehending the culture of Yue Opera.

We first investigated an ancient local opera stage at *Liangchen Temple*. (see Fig.3a). Some traditional Chinese architectural features such as dragon carving with stone columns, along with the Hipped Roof, are incorporated into the stage construction. The main performing area is spacious enough, providing ample space for the opera actors to present their movements and choreography. Apart from that, the stage construction incorporates traditional Chinese architectural features such as stone columns with dragon carvings, along with a Hipped Roof. The background of the upstage is typically adorned with patterns, reflecting the narrative theme during the performance. Some details of the stage decor are not merely aesthetics, but also regarded as subtle cues to uncover the narrative in plot [8].

Next, we went on fieldwork in a town named after Yue Opera. For most children and young adults, Yue Opera, along with numerous other traditional Chinese opera forms, often appears antiquated. We see the residents who come to watch the performances are generally above the age of 50, and notice most of them can sing some clips. Uncle Zhang is a loyal audience who would rarely miss any of the Yue Opera. He expressed, *'Yue Opera is a traditional Chinese art treasure, I hope more people find fascination in it, even global audiences can come to my hometown to experience it'*.

With the invitation of *Shijia'ao* female opera troupe, we finally experienced the costumes of Yue Opera (see Fig.3b). From the conversations, we got three key points about the costume art: (1) based on story content, that is, the costume should match characters' identities and statuses; (2) fully consider the movements of actors, since they serve as fundamental conduits of emotional expression; (3) keep the balance between historic and modern aesthetic, integrated daily costume elements into the stage costume design, but fitting the overall narrative.

As we summarized from fieldwork, the stage set and opera costumes contribute to the plot, dialogue and characterization that unfolds the historical narrative. It focuses on how the plot develops and highlights what characters' actions and conflicts. However, previous drama studies have noted that certain sequences and scenarios have already been artistically polished, which might not align with the known historical context [11]. To address this gap in cultural interpretation and appreciation, we then refer to the digital archives, specifically Yue Opera *Wang Yangming* and the history literature of Yangmingism to distinguish between fact and fiction, and better convey the hidden cultural value. The workflow of data processing with documenting, analyzing, and visualizing is given in section 3.

2.2 Expert Interview

To develop a deeper understanding of the opportunities and challenges towards our design and fill the gaps in academic research, semi-structured interviews were conducted one-on-one via Tencent Meeting or onsite. The study involved four domain experts, two males and two females (M = 48.25, SD = 7.46), who have professional experience in Yue Opera (E1), Yangmingism (E2), innovative product design (E3), and AR application development (E4), respectively. Each interview lasted approximately 80 minutes, including questions about the meaning of cultural popularization in Yue Opera and Yangmingism, user intention in cultural activities, the interactive design and technology to extend the cultural experience, and the design consideration of cultural gifts.

We summarize a set of messages after analysis of responses. First, all experts are aligned with the necessity of cultural education and cultural inheritance, and further confirmed about using the Yue Opera *Wang Yangming* to popularize Yangmingism to comprehend the cultural concepts with historical narratives. Furthermore, E3 emphasized the essential role of the interaction, practice, and application scenarios to illustrate the formation and development of culture, forming the personal cultural interpretation. However, they also expressed concerns regarding the cultural transformation. For example, E1 noted, *'younger people may find it hard to understand the content due to regional dialect and literary language use'*. In addition, some suggestions indicated that shared experience with family is a proper way to engage in cultural activity. As E4 mentioned, *'observations revealed that the elder was more likely to perform online cultural experience aided by younger generations'*. E1 and E3 also
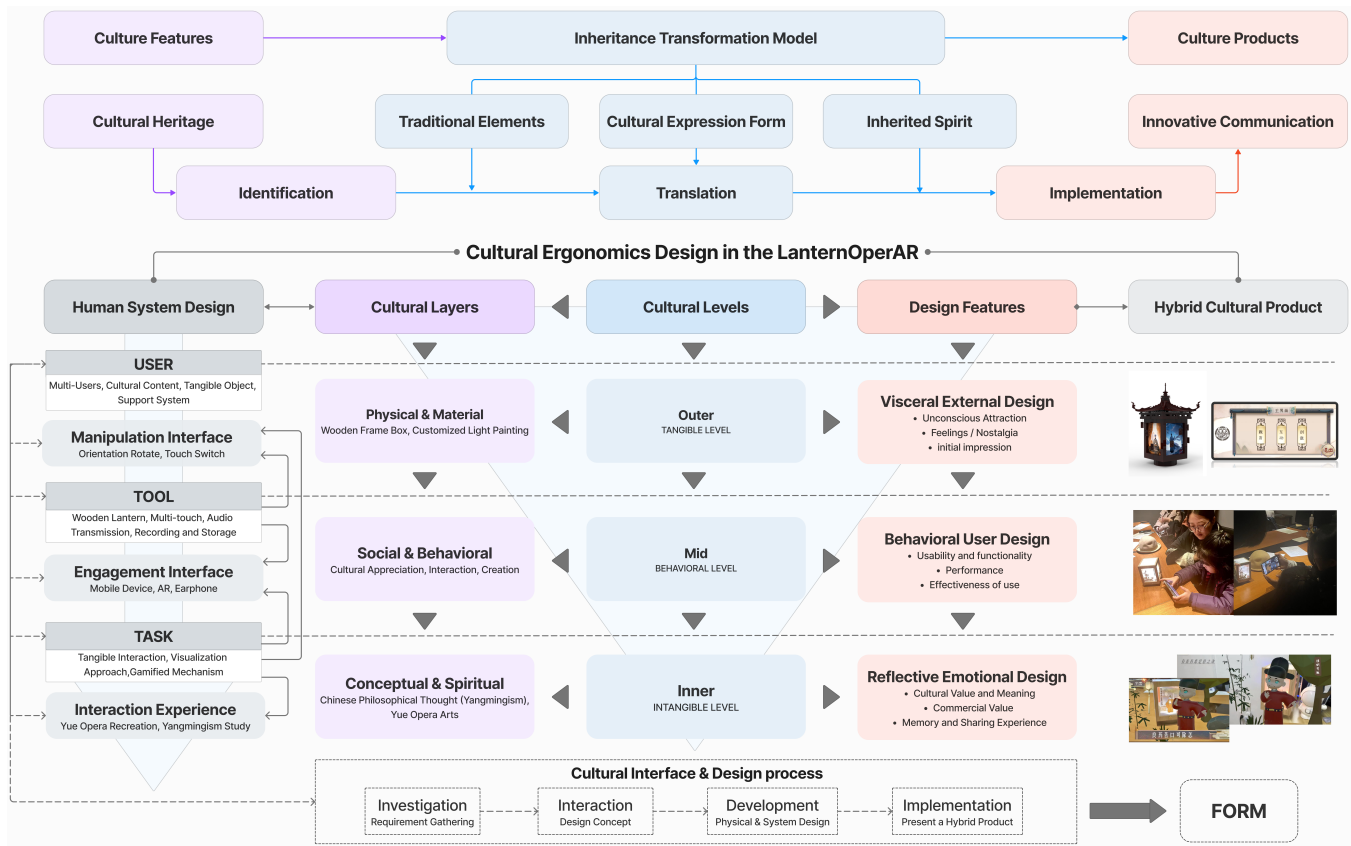
Figure 2: Cultural product and inheritance model of LanternOperAR adapted by Lin et al.'s research [10].

pointed out some actions that always exist in cultural tours, such as collecting memorabilia like ticket stubs, taking photographs, and sharing their personal feelings. These social behaviors are vital to reinforce emotional connection and well-being. Third, Experts upheld a positive view of AR technology in presenting cultural content. They highlighted the importance of enriching sensory experiences to engage audiences. E4 suggested combining gamification and tangible interaction with AR technology to provide immersive cultural experiences. Moreover, E3 pointed out, *'the fast pace of life leaves many people no time for long-time entertainment, some plots need be clipped to present essence to catch audiences'*. Ultimately, for cultural gifts, experts commented that

Figure 3: Fieldwork about Yue Opera. (a) Visiting the opera stage in *Liangchen Temple*; (b) experiencing the Yue Opera costume.

some factors would affect audiences' choices. Functionality, as E3 mentioned, *'it should have an actual function for daily use'*. They also noted the cultural value in gift design, such as *'reflect the historical background of Yangmingism'*. Additionally, attributes such as appearance, novelty, collectability, and cost were regarded as common primary factors that could determine the purchase intention.

2.3 Online Survey

We conducted an online survey to investigate the public's attitude and feelings about emerging techniques, cultural experience and learning, and their expectation of cultural gifts. Participants took 5 minutes on average to answer 24 questions, some of them based on 5 Likert scales. The data was analyzed using SPSS 23.0, as the results depicted in Fig.4.

Among the 109 valid responses (52 males, 57 females) aged 19 to 81 (M = 37.60, SD = 15.37), most of them (84%) have been to the Zhejiang Province, the birthplace of Yue Opera and Yangmingism. The majority of respondents (67%) hold a bachelor's degree or above, and the distribution of social identity responses generally aligns with the demographic makeup of society.

The survey results identified that (1) young people are more familiar with emerging techniques and digital devices, meanwhile, we see a high willingness among the elderly to accept new things for
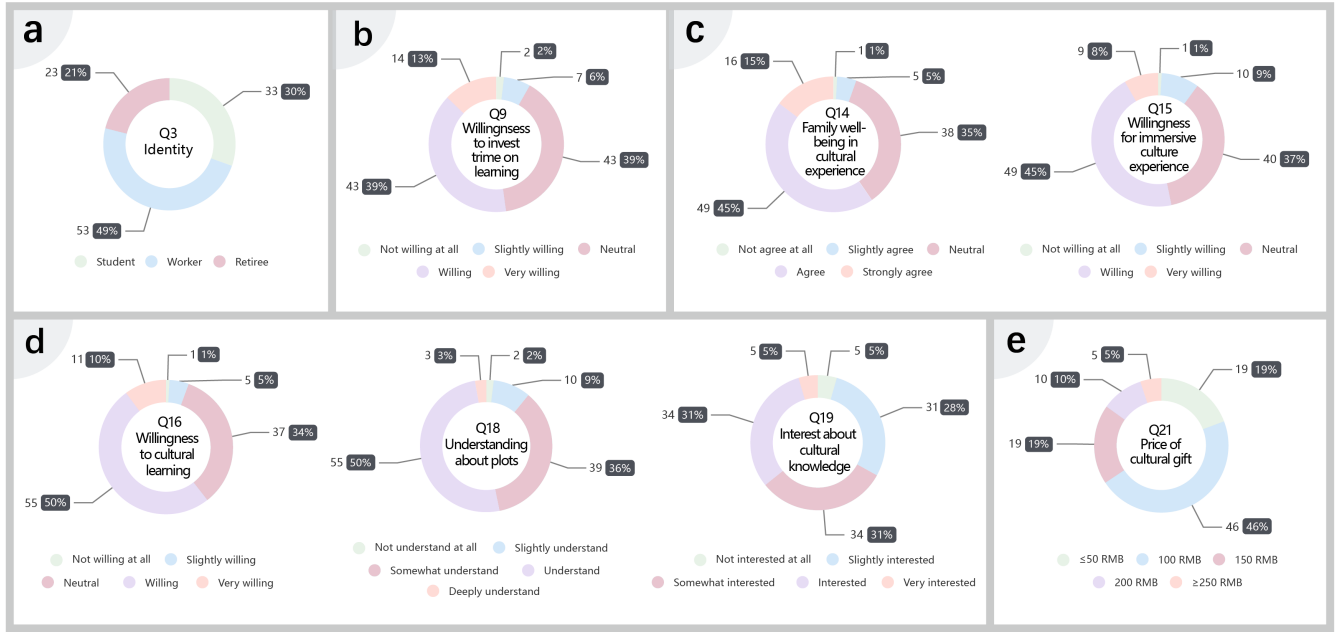
Figure 4: Survey results of (a) demographics, (b) emerging techniques, (c) cultural experience, (d) cultural learning, and (e) cultural gift.

learning; (2) although the public acknowledges that shared cultural experience contributes to family well-being, existing Yue Opera performances are still not interesting to young audiences, lacking extended interaction via immersive multimedia support; (3) the public understanding level of cultural knowledge is limited, and AR technology can incorporate gamification and visualization methods in convenient mobile experience to support cultural learning; and (4) most people would have the intention of purchasing cultural gifts in terms of some factors such as *Novelty*, *Practicality* and *Aesthetics*, as well as to see more meaningful, playful and creative design applied in the hybrid interface, in addition, the cost should be lower than a medium budget (100 RMB) according to most people's choice.

2.4 Summary of Design Goals (DGs)

To further determine the direction of the design, we aggregated our findings into a cultural journey map to present user scenarios for two people in a shared experience. We adopt the Experience Design Model [12] to define the five stages of the user journey process with the design goals. Fig. 5 illustrates how we identify existing pain points and opportunities.

DG1: Attach cultural value into gifts in daily context. First, we hope the cultural content gets close to life. Based on user interest in cultural gifts, we would help them easily touch the cultural elements via tangible interfaces, incorporating various product features such as appearance and functionality to better convey the cultural meaning (O1).

DG2: Provide comprehensive information to support immersive cultural appreciation. New ways of accessing information provide a possible solution for lacking appropriate viewing

conditions and informative data (P1, P2) in cultural performance. By combining situated visualization and interactive storytelling in embodied experience (O2), the accessibility of culture using AR technology is no longer confined to the limited onsite places [4, 15].

DG3: Satisfy user preferences in cultural practice to enhance family well-being. As an enduring relationship, family is tied to culture, common experiences and mutual support [5]. Considering the diverse motivations and behaviors among different age groups in cultural activities, we hope to incorporate their interests into shared experiences (O3).

DG4: Create sticky content to keep user retention in cultural learning. Longer knowledge retention and recall are critical for publics to comprehend the knowledge point. To address P3, technology such as gamified mechanisms and AR integrates active learning elements into the cultural activity and benefits continuous learning [15].

DG5: Foster the cultural communication through personalized creation. From survey results, we found users can perceive a certain understanding of cultural meaning, while communication is still restricted by expression. Based on distributed cognition [6], the application of educational technologies can help to expand the human mind. Thus, we aim to support individual's sense-making in cultural creation (O4), facilitating cultural transmission in social sharing.

3 LANTERNOPERAR

To extract cultural information as design content, we first filter the source data from the collected digital archives, then perform the data processing and analysis depicted in Fig. 6. We craft the tangible interface. It consists of a rotatable cuboid wooden frame with a
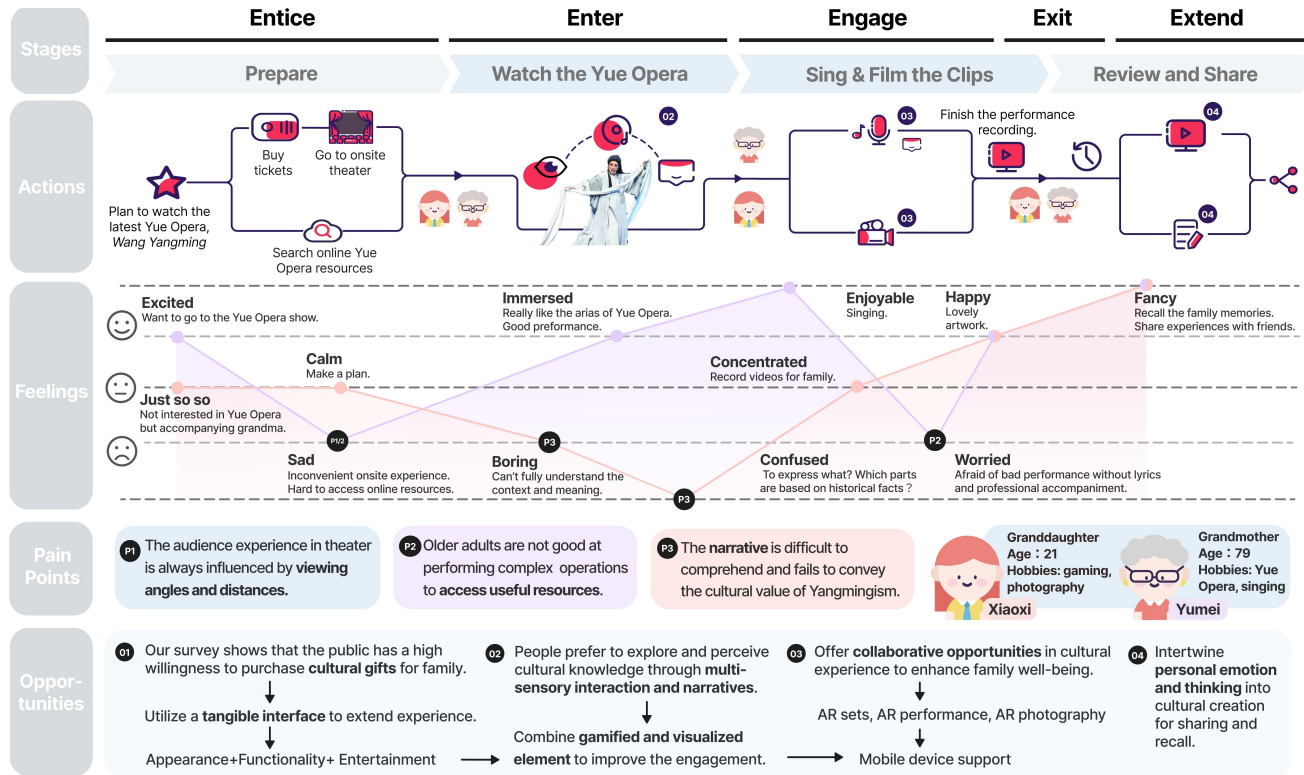
Figure 5: User journey map of cultural experience in five stages (P = Pain point, O = Opportunity).

cylinder base. PP synthesized paper, lamp slices and the LED module are used for image display. The interactive system is developed in Unity. Eventually, we formed the design, LanternOperAR, a tangible AR interface for cultural appreciation, interaction and creation, driven by design goals. Users can scan image targets to trigger the augmented information, which is controlled by physical and digital manipulation. We explain how we integrate LanternOperAR into the five stages of the cultural journey and further evaluate its performance in our user study.

3.1 Design Implementation

Product: hybrid gift. At the *entice* stage, LanternOperAR draws inspiration from the appearance of Chinese palace lanterns to attract users (See Fig. 7a). Each side of the lantern is placed with Light Painting images depicting key phases in Wang Yangming's lifetime. When the light is turned off, only some lines can be seen to outline the figures. By manipulating the illumination, we can play with light to see multi-layered colors that symbolize different emotions.

Mode I: appreciation. At the *enter* stage, we set up some traditional plaques hanging from the virtual hipped roof as an external opera stage set overlay around the physical installation. In addition to viewing the opera clips, users can trigger this visual information (see Fig. 7b) to delve deeper into relevant events. All physical landmarks of the plaques are based on time and location data mapping, promoting a comprehensive grasp and exploration of related knowledge.

Mode II: interaction. At the *engage* stage, in terms of playful interaction, we use Light Painting images as image targets to recognize and track, connecting between static images and virtual figures in Yue Opera. In this way, users can see the corresponding animation and text description of the historical background of Yangmingism, and access the hybrid cultural content from different viewpoints via virtual or tangible interaction. By integrating user interests into cultural behaviors, we allow users to collaborate on stage settings, and take on different roles as an opera singer and a photographer to control animated figures in performance jointly (see Fig. 7c and 7d). Some meaningful functions like photo-taking, lyrics display and video replay are implemented to enrich the engagement and experience.

Mechanism: achievement. At the *exit* stage, we incorporate the achievement system to guide users in cultural activities to track and record user progress. It encourages constant learning that has a direct return in increased user engagement. Users are awarded badges with historical narratives when they fulfill specific tasks or milestones. It would eventually unfold Wang Yangming's life timeline (see Fig. 7e), contributing to cultural comprehension and review.

Mode III: creation. At the *extend* stage, we aim to strengthen personal interpretation and emotional connection via user-generated content to foster growth in the cultural community. Users can interact with virtual figures and real-life objects to customize postcards. This process also involves adding written notes and cultural illustrations to transform them into meaningful memories
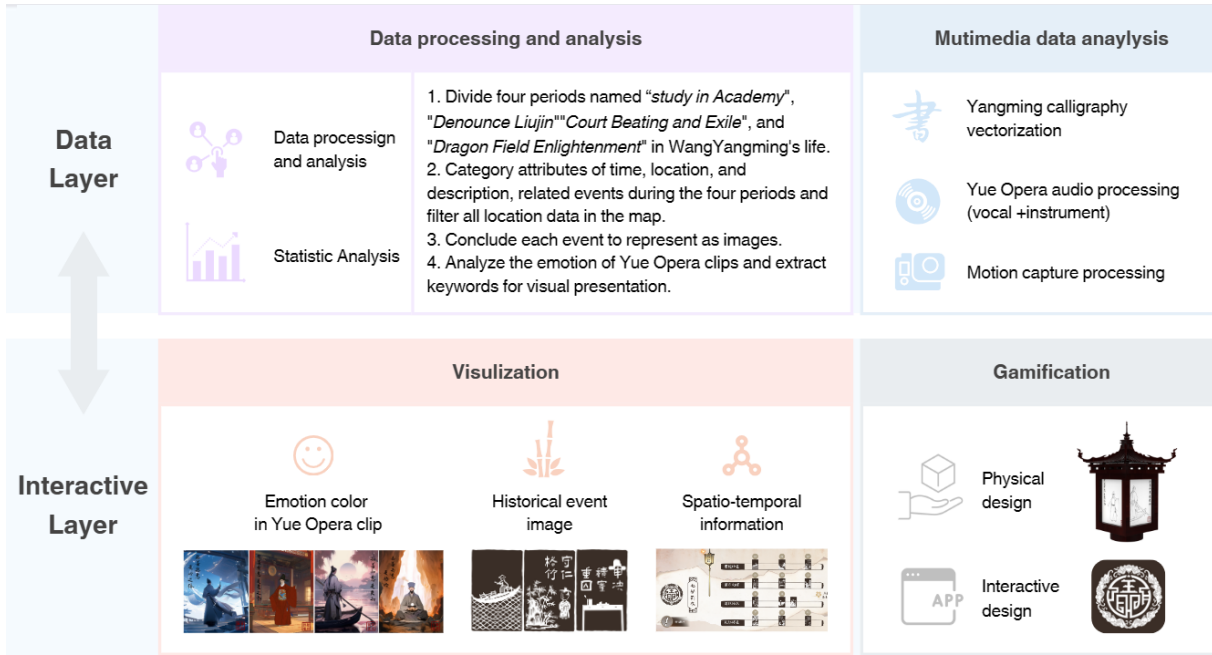
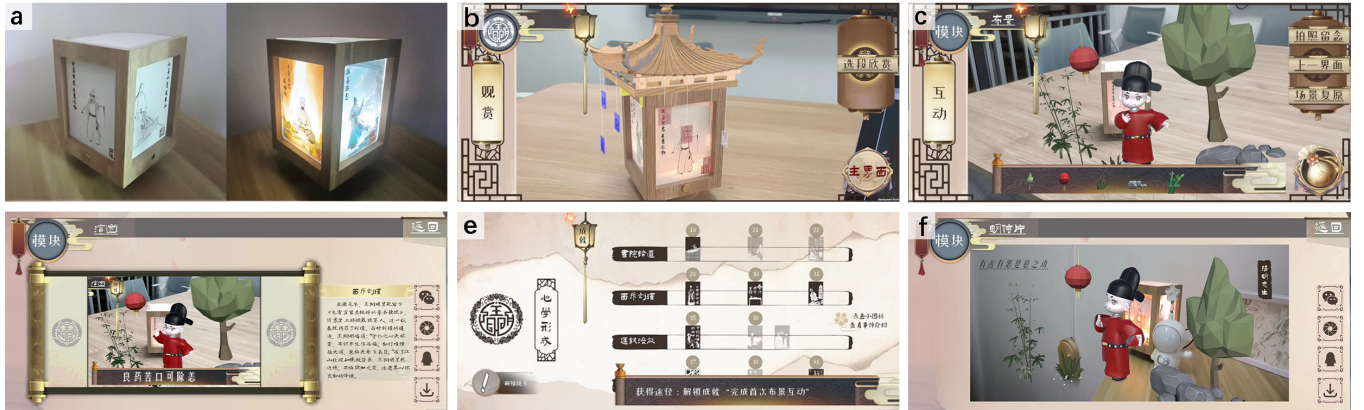Figure 6: The data workflow of the LanternOperAR design.

Figure 7: LanternOperAR: (a) appearance, (b) augmented appreciation, (c) stage settings, (d) video replay, (e) achievement, (f) postcard.

(see Fig. 7f). Social bonds are created when people share these records through reflection and discussion to convey cultural values in creations, contributing to a broader range of cultural experiences.

3.2 Evaluation

We conducted the user study with twelve participants (M = 41.92, SD = 27.29). Participants were recruited by snowball sampling, resulting in a total of eight females and four males as six pairs. Most pairs of participants are in family relationships, and only a pair of studies took place with strangers. They were invited to use LanternOperAR after tutorials. After that, participants were asked to complete the System Usability Scale (SUS) ratings [2].

Finally, we further interviewed their feeling and attitudes about LanternOperAR in (1) interactive experience, (2) cultural gifting, and (3) its contribution to SDGs. Each experiment lasted about an hour.

The SUS scores given by participants are reported in Fig 8. We adopt the validated criteria from Bangor et al.'s research [1]. As a result, the overall SUS score is 75, which falls between 'good' and 'excellent', and three participants rated LanternOperAR as 'best imaginable', indicating acceptable usability and learnability based on theme-based coding , and the qualitative findings from interview transcripts are presented as follows.
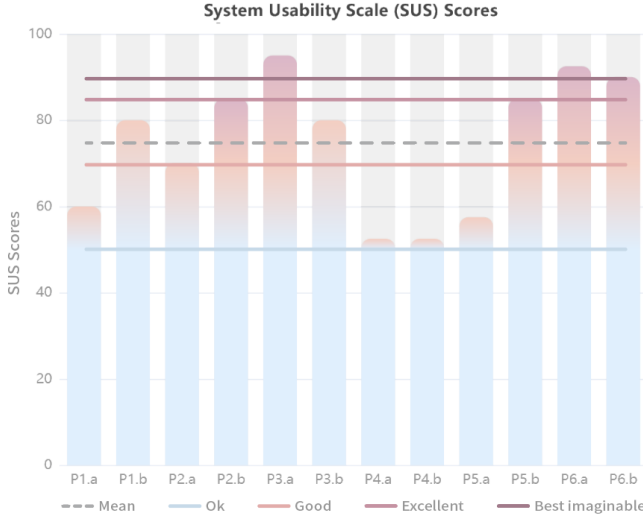
Figure 8: The SUS scores of LanternOperAR.

User Experience. Participants report their feelings in two dimensions. (1) Mechanism (N=6). For example, as P1.a said, *'I would like to share the video or postcard with friends because it is unique'*. Moreover, participants confirmed the effect of visualization on learn Yangmingism. For further exploration, P1.a noted that, *'the achievement system encourages completion of corresponding tasks to reveal the hidden meaning behind the visualized images.'*. (2) Manipulation (N=4). As P3.b said, *'the collaboration between two people requires the physical and digital blend in their interactions'*, and his partner, P3, explained that *'in collaborative tasks, such as stage setting, assigning different control methods contributes to reasoning about 3D objects and their spatial relationships'*.

Cultural Gifting. Participants evaluate the LanternOperAR in three aspects. (1) Cultural Meaning (N=4). As P6.a noted, 'it can be a supplemental cultural experience unavailable offline'. (2) Appearance (N=6). For example, P2.a is a Hanfu lover, saying that, *' it can act as knickknacks to be appreciated, or serve as decorative props in Chinese style photography'*. (3) Functionality (N=4). Participants also hope to see more utility functions, such as ambient light detection (P1.b) or audio storage with hardware support (P2.a) to improve accessibility for older people and children further.

Contribution to SDGs. All participants acknowledge the contribution of LanternOperAR to the Sustainable Development Goals. (1) SDG 3: *Good Health and Well-being* (N=4). Social interaction is vital for promoting psychological well-being. For example, P2.a noted that, *'a lot of sessions, such as performance, stage setting, photo-taking leads to the division of operation, fostering mutual understanding and communication'*. (2) SDG 4: *Quality Education* (N=6). As P5.a said, *'LanternOperAR brings a new form to elevate our lives with the light of knowledge and recreation'*. (3) SDG 11: *Sustainable Cities and Communities* (N=5). P1.b indicated that, *'as a regional culture, Yue opera helps establish a deep historical and cultural sense of belonging for the locals and also contributes to the urgent protection of the dialects.* (4) SDG 8: *Decent Work and Economic Growth* (N=5). Cultural creativity plays a key role in cultural and

economic integration. In addition to the economic benefits of itself, P6.b mentioned that, *' LanternOperAR stimulates my interest in this opera, now I would like to buy tickets to enjoy it on site with my family.*

4 DISCUSSION

LanternOperAR offers an innovative solution to engage in cultural activities outside of cultural venues. Our hybrid design strongly supports cultural transmission and strengthens family ties in shared experiences. Throughout the research process guided by cultural product and inheritance framework [10], we are committed to promoting the cultural values of both Yue Opera and Yangmingism in a consistent experience of cultural interaction, knowledge acquisition and emotional communication. LanternOperAR forges bonds between real-life space and virtual content through embodied interaction. It unfolds cultural narratives supported by emerging technologies, enhancing learning interest, engagement, efficiency and retention. We make LanternOperAR commercially acceptable by controlling the cost below 90 RMB. The evaluation indicates that it firmly aligns with the design goals of a five-stage cultural journey and has potential in education, entertainment, and business. Furthermore, our work contributes to *Quality Education* (SDG 4), *Good Health and Well-being* (SDG 3), *Sustainable Cities and Communities* (SDG 11), and *Decent Work and Economic Growth* (SDG 8).

However, our study still has some limitations and challenges. First, our evaluation of cultural experience and learning performance is only based on subjective feedback from participants, as LanternOperAR is still in the early prototype stage. Second, our current design merely presents the virtual figures with non-editable costumes prepared by us, the public awareness of Yue Opera costume culture has not been effectively raised. Third, some participants noted that Yue Opera is limited by its local characteristics. Publics would like to experience more meaningful cultures such as Ancient Airs and Dances via LanternOperAR. Lastly, based on user feedback, we see the possibility of cross-platform deployment to support more people engaging in shared cultural experiences.

5 CONCLUSION AND FUTURE WORK

LanternOperAR is designed as a hybrid gift to support cultural appreciation, interaction and creation in Yue Opera and Yangmingism. An ethnographic study of Yue Opera provides insights on how to transform related cultural content into a virtual presentation. To fully meet the user requirements, we summarize the design goals based on our findings from expert interviews and online surveys, and further implemented the design in five stages: *entice, enter, engage, exit, extend*. We perform a user study to examine the usability for an overall system design evaluation. Qualitative results provide more insight into user's expectations and needs, regarding both user interface design and product design. Our findings indicate that it can be an innovative way to facilitate family well-being with shared experiences in continuing cultural trajectory and highlight the potential of LanternOperAR for cultural gifting. For future work, we plan to improve our design in cross-platform interaction and seek opportunities from related institutions to evaluate the

long-term impact of LanternOperAR on cultural education and well-being under real user scenarios.

REFERENCES

[1] Aaron Bangor, Philip Kortum, and James Miller. 2009. Determining what individual SUS scores mean: Adding an adjective rating scale. *Journal of usability studies* 4, 3 (2009), 114–123.

[2] John Brooke. 1996. *SUS – a quick and dirty usability scale.* 189–194.

[3] Vanessa Cesário and Valentina Nisi. 2023. Lessons Learned on Engaging Teenage Visitors in Museums with Story-Based and Game-Based Strategies. *Journal on Computing and Cultural Heritage* 16, 2 (2023), 1–20. https://doi.org/10.1145/3575867

[4] Eugene Ch'ng. 2012. New Ways of Accessing Information Spaces Using 3D Multitouch Tables. In *Proceedings of the 2012 International Conference on Cyberworlds (CW '12)*. IEEE Computer Society, USA, 144–150. https://doi.org/10.1109/CW.2012.27

[5] T Goode and Wendy Jones. 2006. A guide for advancing family-centered and culturally and linguistically competent care. *Washington, DC: National Center for Cultural Competence, Georgetown University Center for Child and Human Development* (2006).

[6] Edwin Hutchins. 1991. The social organization of distributed cognition. *perspectives on socially shared cognition* (1991).

[7] Qibo Jin. 2023. Yue Opera Start a New Journey under the China's Cultural Policy. *Journal of Humanities, Arts and Social Science* 7, 1 (2023), 210–213.

[8] Jessica Laccetti. 2009. *Cruising along: Time in Ankerson and Sapnar.* Number September. 166–182 pages. https://doi.org/10.4324/9780203869437

[9] Yue Li, Lingyun Yu, and Hai-Ning Liang. 2021. CubeMuseum: An Augmented Reality Prototype of Embodied Virtual Museum. *ISMAR 2021: IEEE International Symposium on Mixed and Augmented Reality* (2021), 13–17. https://doi.org/10.1109/ISMAR-Adjunct54149.2021.00014

[10] Chih Long Lin, Si Jing Chen, Wen Hsin Hsiao, and Rungtai Lin. 2016. Cultural ergonomics in interactional and experiential design: Conceptual framework and case study of the Taiwanese twin cup. *Applied Ergonomics* 52 (2016), 242–252. https://doi.org/10.1016/j.apergo.2015.07.024

[11] Bruce A Mcconachie. 1989. Reading Context Into Performance : Theatrical Formations and Social History. (1989), 229–238.

[12] Conifer Research. 2002. Experience Design - How to Find Buried Treasure Using Experience Map. https://blog.coniferresearch.com/hubfs/blogs/20181211-conifers-5e-framework/conifer-5e-finding-buried-treasure-through-experience-maps.pdf. Accessed January 3, 2024.

[13] The Spreading. 2022. Possibility of Yangmingism as Phenomenology. 2019, 4 (2022).

[14] Ningning Xu, Yue Li, Xingbo Wei, Letian Xie, Lingyun Yu, and Hai-ning Liang. 2023. CubeMuseum AR : A Tangible Augmented Reality Interface for Cultural Heritage Learning and Museum Gifting. *International Journal of Human–Computer Interaction* (2023), 1–29. https://doi.org/10.1080/10447318.2023.2171350

[15] Ningning Xu, Yu Liu, Zhichao Zhang, and Lingyun Yu. 2023. TimeQuestAR: Unfolding Cultural Narratives via Situated Visualizations. *Proceedings - 2023 IEEE International Symposium on Mixed and Augmented Reality Adjunct* (2023), 86–91. https://doi.org/10.1109/ISMAR-Adjunct60411.2023.00026